Forest Practices Board

Resource Road Construction in Steep Terrain

Special Investigation

FPB/SIR/47

September 2017

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Board Commentary

With the vast network of resource roads in BC, it is inevitable that some of these roads are constructed on steep terrain. Roads on steep slopes represent a very small portion of the roads that are annually constructed in BC, but have long been identified as a cause of slumps, landslides and, in some cases, impacts to fish streams and private property across BC.

In many areas of the province, there is a renewed interest in accessing timber supply on difficult terrain. The Board carried out this investigation to determine whether parties who construct resource roads on steep terrain are meeting legislative requirements of the *Forest and Range Practices Act* (FRPA) and following professional standards of practice and the related guidelines put out by the professional regulatory bodies.

FRPA requires new roads to be safe for industrial use and they must not cause material adverse effects on forest resources. How this result is achieved is left to forest licensees and the professionals they employ. Licensees and their professionals determine where roads are built, when and how. In doing so, they are expected to use recommended procedures and guidelines, and to obtain professional expert advice when appropriate.

The professional associations have provided professional practice guidelines for road construction planning, design and construction to their members, but not all licensees and professionals are following them.

The Board found that 21 of the 26 steep slope road segments examined had qualified registered professional (QRP) involvement and of the 21 segments where a professional was involved, only 10 met all the legal requirements and followed all of the professional practice guidelines. These results are unacceptable.

The Board also found that 6 of 26 steep slope road segments were considered structurally unsafe, and that 5 of these 6 road segments were constructed in a manner that did not reduce the likelihood of a landslide or ensure protection of the environment. These results are also unacceptable.

These findings reflect all sizes and types of forest licensees—there is no trend. Similar to our report on bridge construction published in 2014, the Board considers this report a wake-up call to those who are not complying with the law or following the professional practice guidelines. Due to the potentially significant consequences, there are no corners to cut when it comes to road design, planning, construction and deactivation on steep terrain.

Based on these findings, the Board believes that the Compliance and Enforcement Branch of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development should increase its attention to the construction of steep slope roads. The public and government expect, and all forest road users deserve, high safety, environmental and professional performance.

In the past, the Board has made a number of recommendations about the need for a review of the Ministry's access management and resource roads policy. This investigation highlights the need for the Ministry to clarify its steep slope road deactivation policy, and specifically the difference between a wilderness road and a deactivated road.

The Board recognizes that the BC Forest Safety Council, FP Innovations, government, professionals and contractors are working together to promote safe road construction practices in difficult terrain and we fully support these efforts. Given the findings of our investigation, this collaboration is necessary.

In accordance with section 131(2) of FRPA, the Board is making the following recommendations:

1. The Board requests that, in view of the potential consequences and risks, the Ministry of Forests, Lands, Natural Resource Operations and Rural Development review current legislation and regulations, and consider including additional legal requirements related to road construction if roads are located on terrain that is unstable or potentially unstable; on terrain with slopes greater than 60 percent; or on terrain where there are indicators of slope instability.
2. The Board requests that the Joint Practices Board of the Association of BC Forest Professionals and the Engineers and Geoscientists British Columbia advise it of the steps, planned or taken, to address the professional practice issues identified in this report.

In accordance with section 132 of FRPA, the Board requests that the Ministry and the Joint Practices Board to advise it of the steps taken to implement the recommendations by March 22, 2018.

Executive Summary

In the summer of 2015, based on past audit results, the Board initiated a special investigation of resource road construction in steep terrain. The objective was to determine whether the parties who construct roads on steep slopes are meeting legislative requirements, and conforming to standards of professional practice to ensure safety and protection of the environment. Poorly built and/or maintained roads on steep slopes can lead to slumps, landslides, impacts to fish streams and private property and in some cases, compromise user safety.

Over the 2015 and 2016 field season, Board investigators examined 37 kilometres of complex road segments on slopes greater than 60 percent that were built since June 15, 2012. These 26 separate road segments were scattered across 5 geographically distributed districts around the province.

The investigation focused on safety, protection of the environment, conformance to the standards of professional practice, and compliance with legislation. Specifically, the investigation set out to answer the following questions:

1. Are forestry roads on steep slopes being constructed in compliance with legislation?
2. Are professional practice standards being met?
3. Are forestry roads on steep slopes being constructed in a manner that protects the environment?
4. Are forestry roads on steep slopes being constructed in a manner that ensures the road builders' safety, and user safety?

While these some agreement holders are doing a good job and constructing safe and stable roads, of concern to the investigators is that a number of agreement holders are not following the standards of professional practice or complying with legislation, resulting in unsafe roads.

While forestry roads on steep slopes were constructed in compliance with most of the legislative requirements, nearly one-quarter were not considered structurally safe for industrial users. Five of the road segments assessed had no specialist involvement and did not ensure the safety of the road builders or other road users, as required by legislation. In addition, most of the road segments examined had some qualified professional input on road construction techniques for roads located on “complex” terrain, but only 10 of 26 steep slope road segments fully followed the professional practice guidelines and met legal requirements. With respect to protecting the environment, 5 of the steep slope road segments assessed had no terrain specialist involvement and in each case, conventional construction techniques were used, which increased the potential for road failure and consequent environmental damage.

Introduction

British Columbia has a vast network of resource roads. There are over 600 000 kilometres of resource roads in the province and approximately 10 000 kilometres of new roads are built each year. These roads are built on varying terrain along the Coast and throughout the Interior, mainly by the forest industry.

Considering BC's rugged landscape, some of these roads are constructed on steep slopes. Roads on steep slopes require careful planning, construction and maintenance to ensure that they can be used safely and to protect environmental values. Poorly built and/or maintained roads on steep slopes can lead to slumps, landslides, impacts to fish streams and private property and in some cases, compromise user safety.

The Forest Practices Board is the public's independent watchdog for sound forest practices. Through its program of regular compliance audits, the Board has identified concerns with road construction in steep slopes. These concerns include not following plans and recommendations, not involving qualified registered professionals, not preparing terrain stability assessments, and lack of supervision and/or operator experience.

In the summer of 2015, the Board initiated a special investigation of resource road construction on steep terrain. The objective was to determine whether the parties who construct roads on steep slopes are meeting legislative requirements, and conforming to standards of professional practice to ensure user safety and protection of the environment. Specifically, the investigation set out to answer the following questions:

1. Are forestry roads on steep slopes being constructed in compliance with legislation?
2. Are professional practice standards being met?
3. Are forestry roads on steep slopes being constructed in a manner that protects the environment?
4. Are forestry roads on steep slopes being constructed in a manner that ensures the road builders' safety, and user safety?

This report provides results of the investigation.

Scope and Approach

For the purposes of this investigation, steep slopes are defined as slopes greater than 60 percent.[1] The investigation included all roads constructed on steep slopes from June 15, 2012, to October 5, 2016, in the Sea to Sky, Okanagan Shuswap, Selkirk, South Island, and Cascades Natural Resource Districts. These five districts were selected to ensure geographic distribution across the province.

[1] This figure was chosen because standards of engineering and construction have been developed over the years, some through legislation, but most through professional guidelines, for slopes greater than 60 percent.

In the summer of 2015, the Board informed licensees and government within the five districts about the investigation, compiled a list of roads constructed from June 15, 2012, to October 5, 2016, on steep slopes, and assembled all available documentation.

Board staff reviewed the documentation and a professional engineer and professional geoscientist visited each site during the fall of 2015 and spring/fall of 2016. Road segments selected as samples were field reviewed on foot. Additional areas were reviewed from a helicopter to ensure that all roads that met the selection criteria were examined. In most cases, only those segments of road that were built on steep slopes and required special construction techniques were assessed.

The team evaluated compliance with leglislative requirements and conformance with applicable professional practice guidelines. The legislative framework and professional practices guidelines are discussed in more detail below.

Road construction, whether on steep slopes or not, is governed by legislation and is overseen, in most cases, by forest professionals and professional engineers. There are risks associated with building roads on steep terrain, and managing those risks includes complying with both the legislation and the professional practice guidelines.

Legislation

Forest Planning and Practices Regulation

The *Forest Planning and Practices Regulation* (FPPR) sets out the requirements that must be met by an authorized person who constructs a road. The FPPR includes 19 requirements related to roads but only a handful deal with damage to the environment and safety. These are paraphrased below.

- **Section 37**. The person must ensure that road construction does not cause a landslide that has a material adverse effect on forest resources.
- **Section 38**. On the coast, the person must ensure that road construction does not cause a gully process that has a material adverse effect on forest resources (a gully process is a rapid erosion of sediment that creates a channel or increases the depth of an existing channel, or a debris flood).
- **Section 39.** When constructing a road, the person must maintain natural surface drainage patterns on the area both during and after construction.
- **Section 54**. On the coast, the person must ensure that road construction does not cause fan destabilization that has a material adverse effect on forest resources.
- **Section 72**. A person who constructs or maintains a road must ensure that the road and associated structures are structurally sound and safe for use by industrial users.

The Board has interpreted the word "ensure" to mean "to make certain." Note that the phrase "material adverse effect" has not been defined in legislation. If road construction caused a landslide that harmed fish or fish habitat, it would be up to government to prove that it had a material adverse effect on fish and fish habitat if it wished to pursue enforcement. Not every adverse effect will be material.

What does "material" mean?

Enforcement agencies, decision-makers, the Forest Appeals Commission, and courts will often look to dictionary definitions when interpreting undefined terms. "Material" is sometimes defined as serious, important, or consequential. It would exclude trifling or insignificant adverse effects. Essentially, there must be an unfavourable result that may have some real, appreciable consequence for there to be a material adverse effect. Each case will be decided on its own facts.

Occupational Health and Safety Regulation

The *Occupational Health and Safety Regulation* (OHSR) also sets outs requirements related to resource roads and steep slopes. Although this investigation did not assess these requirements (as they are outside the Board's mandate), these are industry requirements that licensees must adhere to.

- **Section 26.18**. In a forestry operation where there may be a risk of a landslide, the risk must be assessed. If a risk is found to be present, written safe work procedures must be prepared and workers must be educated in those safe work procedures.
- **Section 26.79**. Roads, bridges, elevated platforms, and other structures used by vehicles transporting workers, logs or other forest products in forestry operations must be constructed and maintained to a standard which will permit safe transit.

Standards of Professional Practice

The legislation listed above is an expression of the result that government wants. In other words, government wants new roads to be safe for industrial use and wants to ensure that new roads do not cause material adverse effects on forest resources. How this intended result is achieved is left to forest licensees and the professionals that they employ.

Resource road construction can involve the practice of professional forestry and professional engineering. The *Foresters Act* includes, within the definition of the practice of professional forestry, "planning, locating and approving forest transportation systems including forest roads." The *Engineers and Geoscientists Act* includes, within the definition of the practice of professional engineering, "designing or directing the construction of public utilities, industrial works…" The Association of Professional Engineers and Geoscientists of BC's (APEGBC)[2] Code of Ethics requires members to "hold paramount the safety, health and welfare of the public, the protection of the environment and promote health and safety within the workplace."

To provide guidance to professionals constructing roads in the forest sector, in June 2012, APEGBC and the Association of BC Forest Professionals (ABCFP) developed *Guidelines for Professional Services in the Forest Sector-Forest Roads*. The guidelines describe the skill sets required by professionals, as well as the professional practices associated with forest roads. The guidelines establish a standard of care with respect to forest road activities and highlight the professional obligation to provide worker and public safety, and to protect the environment.

[2] Now called Engineers and Geoscientists British Columbia.

How does one know when there is a risk of a landslide?

Members of the ABCFP and the APEGBC taking a lead role in the construction of a road should be aware of the terrain conditions present within the operating area and if they are unsure, involve a qualified registered professional (QRP).

The ministry's *Engineering Manual* states that a terrain stability assessment must be conducted by a QRP to determine whether measures are required to reduce the likelihood of a landslide occurring if: terrain mapping indicates potentially unstable or unstable terrain; there is no terrain mapping but the road crosses slopes greater than 60 percent; or the road is located on terrain where there are indicators of slope instability.

Although the guidelines are not a legal requirement, they set out the general standards of professional practice that members of APEGBC and ABCFP must meet. Failure to meet the intent of the guidelines could be evidence of unprofessional conduct. A professional may still use his or her judgement to vary from the guidelines, but that decision needs to be documented and be consistent with professional standards.

The level of detail and the type of information required for professional work related to roads depends on the road design, terrain, resource values and intended use of the road. The guidelines define three categories of road segments—basic, complex, and those requiring specialist design.

A coordinating registered professional (CRP) is required to oversee and take responsibility for professional practice associated with road activities. This includes, but is not limited to, retaining qualified terrain specialists to carry out assessments or designs that are beyond the CRP's area of expertise for complex roads and ensuring the recommendations are implemented.

Complex road segments are those located on steep, unstable terrain, in close proximity to higher risk downslope values, and that have alignment and/or vertical grades that require additional construction techniques and supervision to meet design objectives, and may require more field reviews.

Coordinating Member – A member of the ABCFP or APEGBC who has lead and coordinates responsibility for professional work (also referred to as a CRP).

Terrain Specialist – A member with the appropriate skill set to conduct a terrain stability assessment (usually a professional engineer or professional geoscientist).

Complete documentation consists of, but is not limited to, a terrain stability assessment where required, geometric road design, record drawings where required, and identification of the coordinating member. Professional sign-off in the form of a construction conformance statement is also required. A construction conformance statement is generally prepared by the coordinating member and confirms that the work generally conforms to the intent of the plan and that an appropriate level of professional oversight has been provided.

Methods and Evaluation Criteria Assessing Consistency with the Legislation and Guidelines

To determine if road construction on steep slopes was consistent with the professional practice guidelines, and to answer the four questions posed in the *Introduction* section, investigators reviewed all available documentation and recorded actual site conditions. With this information, investigators assessed compliance with the legal requirements listed on page 3 and consistency with the professional practice guidelines by asking the the following questions:

Planning

1. Was the road use objective stated in the design?
2. Were all environmental and safety concerns identified?

3. Were professionals involved where required?
4. Were the designs clear and easy to understand?

Construction

5. Did the actual construction adhere to a plan?
   a) Were drainage structures accurately placed, sized and installed properly?
   b) If a specialist made specific recommendations, were they followed?
   c) Were the assumed or documented ground conditions accurate?
   d) Where changes were made to the prescribed design or location of the road, was professional input sought and followed?

Post-Construction

6. Were the design objectives met?
7. Is the new road safe for industrial use?

Results

The following table shows the results of the evaluation. Overall, 26 "complex" road segments on slopes greater than 60 percent were examined and this totaled 37 kilometres.

Table 1. Results of Evaluation Criteria

Requirement	Conformance Rate	Comments
Legislation		
S. 37 FPPR – must not cause a landslide that has a material adverse effect on forest resources.	88%	Road construction did not cause any landslides that had a material adverse effect on forest resources. That being said, 23 had no issues and 3 have the potential to impact a resource and cause a material adverse effect.
S. 38 FPPR – must not cause a gully process that has a material adverse effect on forest resources (coast).	100%	Road construction did not cause any gully processes that had a material adverse effect on forest resources on the coast.
S. 39 FPPR – must maintain natural surface drainage patterns during and after construction.	73%	Seven of the roads sampled had issues with maintaining natural drainage patterns.
S. 54 FPPR – must not cause fan destabilization that has a material adverse effect on forest resources (coast).	N/A	No roads in the population were in the vicinity of a fan.
S. 72 FPPR – must ensure that the road and associated structures are structurally sound and safe for use by industrial users.	77%	For the purposes of this investigation, investigators considered all roads reviewed as “active” because they were recently constructed and used for industrial purposes during the investigation time frame

Requirement	Conformance Rate	Comments
Evaluation Questions		
1. Road use objective stated in the design?	58%	A road use objective, such as the life span of the road, was stated for 15 of the 26 segments. There were no designs for 4 segments.
2. Identification of environmental and safety concerns?	73%	The environmental and safety concerns were not identified by the licensees for 7 of the 26 segments. There were no designs for 4 segments, and environmental and safety concerns were not identified in 3 designs. Safety concerns could involve oversteepened fill slopes, excessive cutslope heights, road prisms not capable of bearing the weight of a loaded truck on outer road edge, and excessively steep road grades. Environmental concerns primarily referred to a lack of drainage structures in order to maintain drainage patterns.
3. Professional involvement where required?	81%	Professional involvement was required for all 26 road segments because the road segments were considered "complex". A terrain specialist was involved in 21 of the 26 segments, but 5 had no professional involvement.
4. Clearly understandable designs?	69%	Eighteen segments had clearly understandable designs; 4 designs were not clear; and 4 segments had no designs.
5. Overall, was the road built according to a plan?	46%	Twelve segments were built according to the plan. Ten segments were not built according to plan and there were no plans for the remaining 4 segments.
5a. Appropriate drainage structures?	46%	The road design should incorporate drainage measures appropriate for local climate and hydrologic conditions, ground conditions, and adjacent terrain. Appropriate drainage structures were installed on 12 of 26 segments.
5b. Specialist recommendations followed?	65%	Seventeen of 26 segments were constructed in accordance with a specialist's recommendation. Specialist recommendations were not followed for 4 segments and 5 segments did not have the involvement of a specialist, although required.
5c. Ground conditions accurate?	81%	Ground conditions were accurately documented for 21 of the 26 segments.
5d. Professional involved in any changes?	64%	Changes were made to the plans for 11 of the 22 segments that had plans. A qualified professional was involved in 7 of those changes.
6. Were design objectives met?	68%	Design objectives were met for 15 of the 22 segments that had plans.
7. Was the road safe for use?	77%	Twenty of the 26 segments examined were considered safe for industrial use at the time of the field visit. Six were considered unsafe for industrial use.
All Legislation, procedures and guidelines met by Agreement Holder?	38%	Ten of the 26 segments met all the critreria for a safe and environmentally sound road and overall resulted in good practices.

Discussion

Question 1: Are forestry roads on steep slopes being constructed in compliance with legislation?

The investigators referenced five legislated sections that are applicable to forest road construction from the FPPR to assess compliance (see Table 1). Sections 37, 38 and 54 of the FPPR states that a person who constructs a road must not cause a landslide or gully process, or destabilize a fan that has a material adverse effect on forest resources. Section 39 states natural surface drainage patterns must be maintained. Section 54 was not applicable to the investigation as no roads crossed or were in the vicinity of a fan. Section 72 states that roads must also be structurally sound and safe for use by industrial users. However, once a road is no longer being used for industrial purposes, it does not have to be safe for industrial use. A road not used for industrial purposes is considered a "wilderness road." None of the road segments examined in this investigation were being actively used for industrial purposes at the time of the field visits; however, they are considered "active" roads for the purpose of this investigation because they were recently built and used for industrial purposes during the investigation period.[3]

The requirement in section 37 to not cause a landslide that has a material adverse effect on forest resources, was likely not met for three of the roads reviewed. The investigators did not measure the full extent of adverse effects to each of the 11 resources referenced in section 37, but in their professional judgment, the effects of the observed failures where the road fill material had travelled downslope due to improperly placed fill and inadequate drainage were not minor, and the potential for further harm is significant.

All roads reviewed on the coast met the requirement of section 38 with no gully processes initiated.

A total of 14 road segments were considered non compliant with section 39—maintaining natural drainages. These road segments had various issues with drainage, ranging from too few culverts or cross drains (resulting in long stretches of ditch line accumulating flows) to damaged culverts with reduced hydraulic capacities. Poorly placed or inadequate drainage structures can direct water onto unstable slopes and contribute to adverse effects on the environment. While none of these drainage deficiencies appeared to have a material adverse effect on forest resources at the time of the field visit, there is a risk of potential adverse effects occuring in the future. Only 12 of the 26 road segments examined had adequate drainage structures in place to handle the expected flows and reduce the potential for future harm to the environment.

Six of the road segments were considered unsafe and not structurally sound and therefore not in compliance with section 72. These road segments had no professional involvement, or professional recommendations were not followed, and were constructed in a manner that cannot ensure user safety due to over steepened fill slopes and cut slopes on potentially unstable terrain.

[3] The investigation period is from the date the road was constructed (after June 15, 2012) to the date of the investigation field visit.

Question 1 Summary

Forestry roads on steep slopes are being constructed in compliance with some of the legislative requirements, although 3 road segments had a landslide that has the potential to impact a resource and cause a material adverse effect. All road segments complied with requirements related to not causing gully process (coast) and no roads were located in the vicinity of a fan. However, only 19 of the 26 road segments complied with requirements to maintain natural drainage, and nearly one-quarter were not considered structurally safe for industrial users.

Question 2: Are professional practice standards being met?

Professional Involvement

Building roads in complex terrain is part of the practice of professional forestry or engineering, which means that a qualified professional or specialist must be involved. The investigation identified the following issues related to involvement of professionals:

- ***Plans were not prepared for road construction in steep terrain.*** Section 26.18 of the *Occupational Health and Safety Regulation* (OHSR) clearly identifies the acceptable standards for performing landslide risk assessments and developing written safe work procedures. Where there was no professional input, plans identifying potential risks were not prepared.
- ***Plans being prepared by non-professionals.*** Licensees need to understand the practices of professional forestry and engineering. Forest road works must be consistent with legislation and follow the OHSR. Professional practice activities must be carried out by a member or, where necessary, a QRP.
- ***Coordinating registered professionals (CRP) not recognizing the need for a specialist.*** A CRP needs to ensure he or she has the skill set to do this work and understand what triggers the need for retaining a specialist for the various components of a road to be constructed on steep slopes. Previously, prior to the implementation of FRPA, the existence of one of three terrain indicators, (1) potentially unstable or unstable terrain as indicated on terrain mapping, (2) indicators of unstable terrain in the field, and (3) slopes greater than 60 percent, triggered the requirement for a terrain assessment, which in turn provided guidance or recommendations for safe construction practices as required. Under the current professional guidelines that decision falls to the CRP.
- ***CRPs being reluctant to involve a specialist due to the potential cost increases from recommendations.*** This is a poor way to manage risk. A CRP has an ethical duty to ensure the safety of workers and protect the environment.
- ***Plans being prepared by a professional but the licensee did not follow it.*** Not following a professionally prepared plan could be a conscious decision or could reflect difficulty understanding and following the plan. Designs vary from the various programs being utilized by forest professional and consultants. The terminology used in geometric road designs can, at times, be confusing, leading road builders to estimate grades, vertical curves and locations for specific construction techniques, such as full benching. Investigators were told by some construction crews that they were not referring to the design packages and instead were relying on experience. Licensees need to understand the practice of professional forestry and the consequences of not managing risk, and realize who will be reading and utilizing the plans and profiles.

- ***Licensees changing a professionally prepared plan but not consulting the professional.*** Licensees need to understand the practice of professional forestry and the potential ramifications of changing a professionally prepared road plan. Should a proposed development change due to unforseen circumstances or conditions, the QRP who developed the plan should be contacted so that recommendations contained in the plan can be reviewed and, if required, altered.

Table 1 (see pages 6-7) shows that professional practice guidelines are not being followed universally. Each of the 26 road segments examined in this investigation was considered "complex," yet only 21 of them had professional involvement.

When changes are made to a plan prepared by a professional, that professional should be involved or another professional should be engaged to review the changes. Plans were changed for 11 of the 22 segments that had a plan and professionals were only involved in 7 of those changes.

Some licensees told investigators they were reluctant to engage a terrain specialist to provide recommendations for construction on steep slopes or post harvest road deactivation measures, because of the additional costs of the potential recommendations (e.g., full bench, end haul and full pullback of over-steepened fills).

The fact that 5 complex road segments had no professional involvement and 4 segment designs were changed without professional involvement indicates that non-professionals are involved in the practice of professional forestry and engineering. A lack of professional input and oversight where changes are made to approved designs and recommendations completed by a terrain specialist has, in the past, been the direct cause of failures of road prisms and created a safety issue for both industrial and public users of the roads.

Examples of Both Good and Poor Practices

The following two photos are examples of roads that had professional involvement throughout the construction stages. These examples also involved a qualified registered professional's input to alterations made to the plan due to changing or unforeseen terrain conditions.

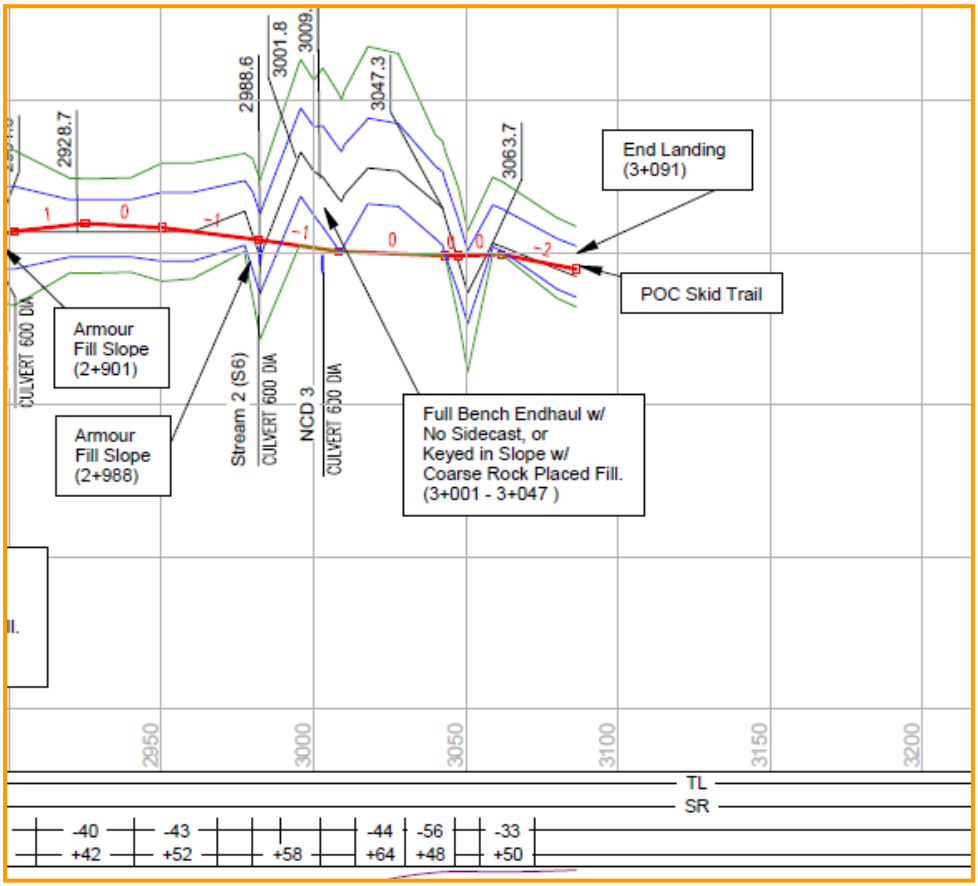
Examples of Continuous Professional Oversight

#1 – This is a new road that had professional oversight throughout all stages of construction. The licensee encountered unforeseen ground conditions at the initial construction stage and had to adjust the design and plan, involving a QRP. The end result is a good, safe road.

#2 – This is a road segment located through an area of imperfectly drained soils that required additional drainage structures and armouring of cutslopes and culvert outlets to avoid erosion. The work was well done.

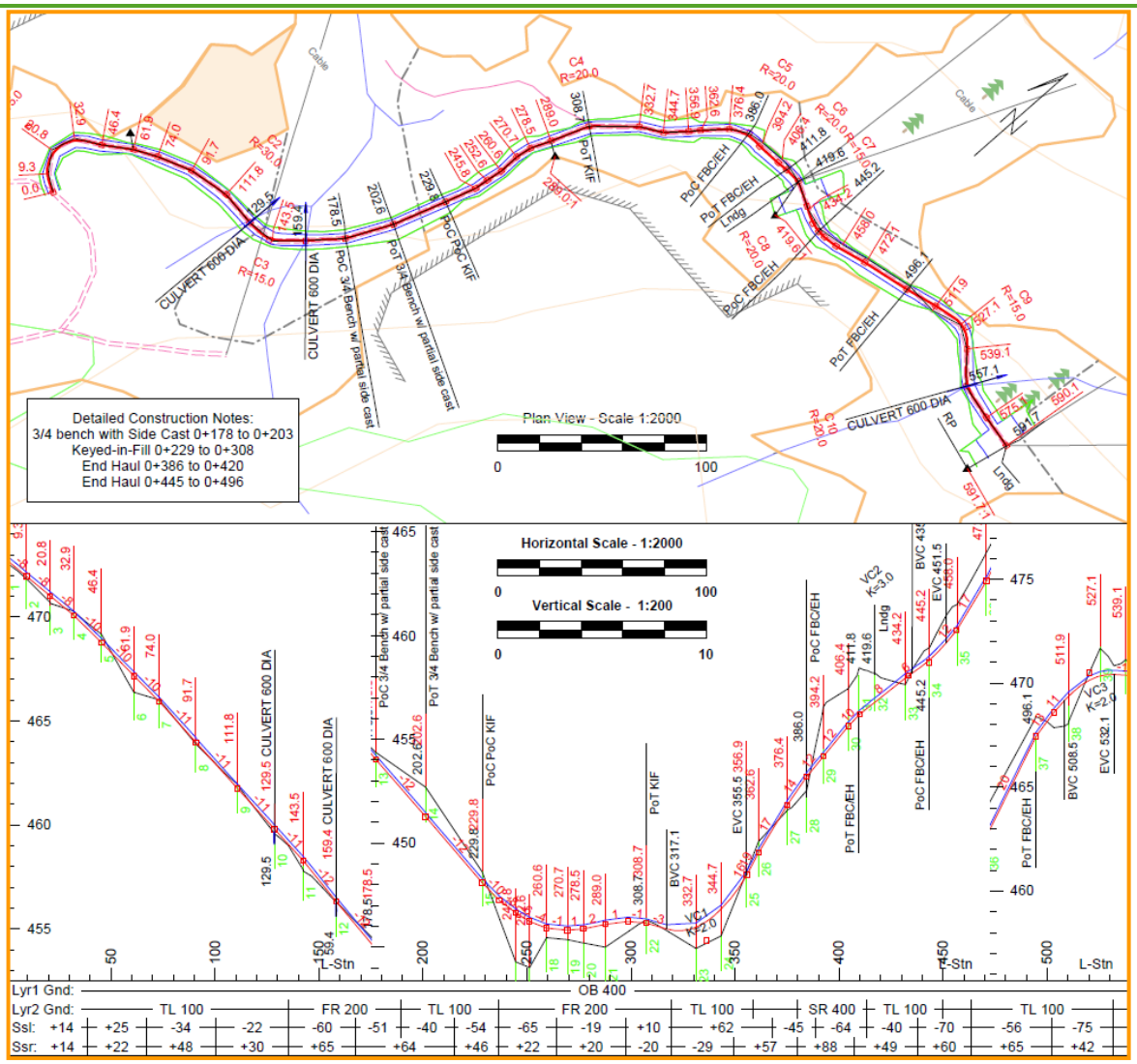
The following set of photos are examples where professional recommendations for design and construction were not followed, resulting in poorly built roads and excessively steep, potentially unsafe grades for industrial users.

Examples of Designs Not Followed



#3a – This professional design shows incorporation of a terrain specialist's recommendations. Note the comment box pointing to station 3+001, specifically stating "Full Bench Endhaul with No Sidecast…".

#3b – This is a photo of the actual constructed road at station 3+001. Note the overloaded slopes with no full benching attained and the logging debris cast over the steep slopes. The plan was clearly not followed.
(Photo was taken from downslope of the road looking up to the full bench section, indicating the level of sidecast and perched debris.)



#4a – This is an example of professional designs completed incorporating terrain specialist's recommendations. The terrain specialist recommended full bench construction with end haul from road stations 0+386 to 0+420.

#4b – This is a photo of the final result. Road grades are considerably steeper than recommended. The road prism was constructed using logging debris (organics) with no attempt to attain full benching or end haul of waste materials. The road prism should have been constructed of native soil and rock. The excess native material should have been hauled to an approved waste site rather than deposited on the slope below.

The following example shows a lack of professional involvement. An older (pre-1995 Code) road was re-activated in order to access a cutblock. Older road construction techniques, in many cases, involved excessive sidecast of materials over steep, unstable slopes, as well as fill supported by stumps and logs. Over time, drainage structures can collapse or be infilled with debris, rendering them ineffective. This can result in redirected water flows over the unstable slopes.

Example #5: Lack of Professional Involvement

This photo clearly indicates the results of a re-activated older road without professional assessments prior to use. In this case, redirected water from plugged ditchlines and drainage structures deposited water over the unstable fill slopes during a high precipitation season, resulting in a large debris slide deposited material in a fish stream.

Question 2 Summary

Out of the 26 segments field reviewed, 17 had terrain specialist involvement prior to construction, of which, 5 had terrain specialist involvement throughout the course of construction and 7 road segments had professional approval in the form of a construction conformance statement. Of the 9 segments with no terrain specialist involvement prior to construction, 5 had no terrain specialist involvement at all and 4 segments had no plans.

Lastly, only 12 of the 26 road segments sampled were built according to a plan.

Question 3: Are forestry roads being constructed in a manner that protects the environment?

The risk of adverse effects to the environment can be managed by accurately identifying ground conditions, identifying environmental concerns at the planning stage, ensuring adequate drainage structures are in place, and deactivating roads according to a plan once they are no longer needed for industrial purposes.

A terrain stability assessment (TSA) is a key part of identifying environmental concerns before construction. A TSA is carried out by a terrain specialist (professional geoscientist or professional engineer) to evaluate risk and provide recommendations to manage the risk. TSAs typically involve an estimation of the likelihood of a forest road being impacted by, or increasing the likelihood of, a landslide. The overall goal of a TSA is ultimately to protect the health, safety and welfare of the public, protect the environment, and provide health and safety in the workplace. A TSA generally

identifies environmental and safety concerns. Elements at potential risk from a landslide include, but are not limited to, private land and residential structures, human safety, fisheries values, transportation corridors, water quality for both human consumption and fishery resources, and visual quality.

Investigators noted that five of the road segments assessed had no terrain specialist involvement. In each of the five cases, the potential for failure was increased because conventional construction techniques were used. One newer segment was deactivated immediately following harvesting and the road "retired," which relieved the permit holder of any further obligations. Board investigators reviewed the road segment and found the deactivation measures to be minimal, with the potential for gully instability due to inadequate deactivation of stream crossings and vulnerable road fills remaining on steeper slopes. As this road segment was located on steep, potentially unstable slopes, a deactivation prescription would have been required by a QRP, as a best practice. In another instance, the coordinating member was hesitant to involve a specialist for deactivation measures due to the potential costs to be incurred with the required works. In all five cases there is potential for impact to the environment.

The photo below shows a road that was terminated because there were no further plans for use. In this example, investigators were told that there were no plans for deactivation due to the potential costs involved. The photo shows that the road is insloped and the ditches were infilled due to cutslope failures. In addition, this road was constructed with woody debris (puncheon) in the subgrade, which is not a good practice when constructing on steep slopes. The potential for negative environmental impacts at this site will increase over time as the organics decay, and the road prism stability will be compromised.

Example #6: Potential for Environmental Damage

This road prism is considered a wilderness road with no further plans for extension or deactivation. The road was constructed with organics in the prism, and insloped with ditches infilled due to failing cutslopes. Many of the drainage structures have been damaged or rendered ineffective. There are no plans for any deactivation measures.

Question 3 Summary

Twenty-one of the road segments located on "complex" terrain had professional involvement in the design of the road with recommendations to reduce the likelihood of a landslide and protect the environment. However, 5 of the road segments assessed had no terrain specialist involvement in the design or construction of the road system.

Question 4: Are forestry roads on steep slopes being constructed in a manner that ensures the road builder's safety, and user safety?

The FPPR states that roads must be safe for industrial use if they are "actively" being used for industrial purposes. Because all of the road segments assessed in this investigation were constructed since June 2012, they were actively being used for industrial purposes during the investigation period. Investigators considered 6 road segments to be unsafe when viewed, as these road segments were also likely unsafe at the time of construction. All 6 required specialist involvement due to terrain conditions, but only 1 had a terrain specialist review the proposed alignment of the road prior to construction. In this case, the specialist's recommendations were not followed, resulting in over steepened fill slopes and ravelling of excess materials. For the remaining 5 segments, the road prisms were constructed on steep slopes with over steepened fill material cast over the slopes and tension cracks forming across the prism. In each case, the load bearing capacity[4] of the road structure and integrity of the driving surface were unsafe.

Below are examples of 2 new road segments constructed on steep slopes with no qualified registered professional involvement. Both of these road segments are considered unsafe.

Examples of Unsafe Roads

#7 – This photo is an example of fill materials side cast over steep slopes, resulting in tension cracks forming over the outer edges of the road. Lateral movement of the sidecast fill material often results in tension cracks forming along the edge of the road bed, as it did in this example. This is an indicator of an unstable road fill and that the fill may be moving downslope. Infiltration of water into tension cracks during heavy winter rains can trigger the road fill to fail completely. Where roads on steep slopes exhibit such tension cracks, the potential for large landslides to occur increases.

#8 – This is an example of a road segment constructed without any QRP involvement. The road was constructed across slopes greater than 60 percent through a series of draws with erodible soils sidecast over the steep slopes. In these situations, full benching and end hauling of the material is required, in particular at the transitioning zones into and out of the draws. Note the cut off tree in the lower right of the photograph indicating how much fill material was deposited over the slope. This resulted in the road prism failing.

Question 4 Summary

Forestry roads on steep slopes were constructed in a manner that ensured the road builders' safety, and user safety, on 20 of the 26 road segments assessed. Of the road segments examined, 6 were deemed unsafe during and following road construction.

[4] Load bearing capacity is defined as the resistance of the soil to wheel loading.

Positive Practices

During the course of the investigation, investigators identified numerous areas of positive practices by some agreement holders. Out of the 26 road segments investigated, 10 were done well, resulting in a stable and safe road.

The following factors contributed to making construction of the road segments a success:

- Geometric road designs (plans, profiles, cross-sections) accurately reflected ground conditions
- Geometric road designs met the requirements
- Designs were clear and understandable by all involved, including construction crews.
- There was adequate field markings identifying critical construction sections
- Vehicle types and axel configurations intended for the specific road section were identified
- Safety requirements were met
- There was a clear indication of who the coordinating member was
- Professional obligations were met
- Specialist were involved when and where required
- Adherence to the plans
- Adequate field reviews were documented and there was on-site supervision
- A specialist (QRP) was retained for unforeseen ground conditions encountered during the construction phase to provide recommendations, if necessary
- Drainages were adequate and maintained
- Where changes were made to the road plan, documentation of the changes was made by the coordinating member
- The construction assurance satement was signed and sealed following construction
- The completed road is safe and sound

Conclusion

This investigation set out to answer the following questions:

1. **Are forestry roads on steep slopes being constructed in compliance with legislation?**

   While all road segments complied with requirements related to not causing gully process (coast) and no roads were located in the vicinity of a fan, only 19 road segments complied with requirements to maintain natural drainage and 6 road segments were not considered structurally safe for industrial users. In addition, 3 road segments had landslides that have the potential to impact a resource and cause a material adverse effect.

2. **Are professional practice standards being met?**

   Of the 26 roads segments reviewed, 21 had qualified professional input on road construction techniques for roads located on "complex" terrain, but only 7 fully met the professional practice standards.

3. **Are forestry roads on steep slopes being constructed in a manner that protects the environment?**

   Twenty-one of the road segments had professional involvement in the design of the road segments with recommendations to reduce the likelihood of a landslide and protect the

environment. However, 5 of the steep slope road segments assessed had no terrain specialist involvement. In each case, conventional construction techniques were used, which increased the potential for road failure and consequent environmental damage.

4. **Are forestry roads on steep slopes being constructed in a manner that ensures the road builders' safety, and user safety?**

   Only 20 of the 26 road segments examined were constructed in a manner that ensured safety. Five of the road segments assessed had no specialist involvement and 1 did not follow the recommended construction techniques, and therefore did not ensure the safety of the road builders or other road users.

While the majority of the road sections assessed in this investigation had some issues noted, 10 road segments were well done, resulting in stable and safe roads.

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