



Follow-up Investigation of Bridge Planning, Design and Construction

SPECIAL INVESTIGATION

APRIL 2020

FPB/SIR/51

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BOARD COMMENTARY

This is the Forest Practices Board's second special investigation of bridge planning, design and construction. The first was published in 2014 and both investigations focused on safety, protection of the environment, planning, and professional practice.

The 2014 report revealed significant safety concerns and professional practice issues. The Minister of Forests, Lands, Natural Resource Operations and Rural Development required industry to prepare an action plan to address the safety issues, and the Board recommended that the Association of BC Forest Professionals (ABCFP) and Engineers and Geoscientists BC (EGBC)¹ advise it of the steps taken to address the professional practice issues. The response was swift and comprehensive. The forest industry, government and the professional associations rose to the challenge, and the Board was encouraged by those actions.

This 2019 follow-up investigation reveals substantial improvement in almost every area assessed. Compliance with all environmental protection and safety requirements is at the mid to high 90 percent level. Further, 100 percent of bridges constructed on forest service roads by resource districts and major licensees are safe and sound for use, and this deserves recognition.

In 2014, 15 percent of bridges had safety issues – 19 bridges were not safe and sound and investigators had significant safety concerns with a further 13 bridges. In 2019, 5 percent of bridges had safety issues – 4 bridges were unsafe, and investigators had significant safety concerns with 9 others. While this improvement is commendable, it's important to keep in mind that these structures are all less than three years old. The Board and the public expects that all new structures are safe and sound for use.

There is also work to be done with respect to planning and assurance requirements. Some professionals are not recognizing or understanding the requirements for crossing assurance statements, and some forest professionals are not correctly classifying complex crossings, which require specialized expertise. In the Board's view, there is room for the professional associations to provide additional clarity to professionals and licensees. There may also be opportunities to simplify the process.

Finally, the Board believes that effective compliance and enforcement is an essential requirement to ensure sound bridge planning, design and

¹ Formerly called the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC).

construction. In response to the 2014 investigation, the Minister directed the Ministry's Compliance and Enforcement Branch to include bridges in its inspection plans. In light of the findings of this investigation, and how critical it is to ensure public safety, there is a clear role for the Ministry to ensure that compliance monitoring, and where appropriate, enforcement, is undertaken.

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

1. The Joint Practices Board of ABCFP and EGBC should review the professional practice guidelines for crossings with an eye towards improving clarity to help their members understand their responsibilities for bridge planning and design.
2. The ABCFP should subsequently review its guidance for forest professionals to ensure it is clear and consistent with professional practice guidelines for bridge planning and design.
3. The Ministry of Forests, Lands, Natural Resource Operations and Rural Development confirm how it intends to undertake ongoing compliance monitoring and, if necessary, enforcement, of bridge planning, design and construction.

In accordance with section 132 of FRPA, the Board requests that the Ministry, ABCFP and EGBC, and the Joint Practices Board advise it of the steps taken to implement these recommendations by October 31, 2020.

INTRODUCTION

As the public's watchdog for sound forest practices, the Forest Practices Board (the Board) regularly audits the planning and practices of the forest industry and government. In 2011 and 2012, Board audits found significant issues with the planning, design and construction of bridges on forest roads. The Board decided to carry out a special investigation to determine if new bridges were safe for industrial use and whether forest resources such as fish habitat and water were being protected.

Investigators visited 216 newly constructed bridges in 5 natural resource districts in 2013 and the Board published its special investigation report on *Bridge Planning, Design and Construction*² in March 2014. The investigation identified significant issues—19 bridges were obviously unsafe and another 13 bridges were questionable. Forty per cent of the bridges did not have complete plans and 74 bridges did not have the required sign-off by a professional that the bridge was designed and built correctly.

At the time, the Board Chair stated:

“The problem is not the lack of legislation or guidance by professional associations. The problem is that some professionals are not performing to the standards government and the public expect. We are recommending that the professional associations that govern foresters and engineers take action to improve performance by their members. We also suggest that licensees ensure their bridges are safe and government compliance and enforcement staff increase their attention to bridge safety.”

The Board requested that the Joint Practices Board (JPB) of the Association of BC Forest Professionals (ABCFP) and Engineers and Geoscientists BC (EGBC) advise it of the steps planned or taken to address the professional practice issues identified in the investigation by October 31, 2014.

On October 30, 2014, the professional associations responded with 12 specific actions taken or planned to address the recommendation, including updating the professional practice guidelines for crossings (version 2 released in July 2014); delivering joint training sessions for members; and working with small licensees to remind them of their obligations to hire a professional when they are planning, designing or constructing a forest road bridge. The associations also requested that the Compliance and Enforcement Branch (CEB) carry out investigations of those licensees that did not prepare record drawings for structures.

² Available at <https://www.bcfpb.ca/wp-content/uploads/2016/04/SIR38-Bridge-Planning-Design-and-Construction.pdf>

ABC FP members also voted overwhelmingly in favour of creating a new bylaw which would require members to adhere to the updated professional practice guidelines. The new bylaw went into effect in November 2015.

The Board is also aware that several licensees that were not part of the 2014 investigation reviewed the Board's report and immediately inspected their bridges and reviewed their procedures and practices to ensure that they were complying with the law and the professional practice guidelines.

The Minister of Forests, Lands, Natural Resource Operations and Rural Development directed the CEB to include bridges in its inspection plans, and the branch developed training material for its natural resource officers to assist them in identifying issues.

In the six years since the bridge special investigation was published, the professional associations have remained focused on professional practices around crossings, and revised professional practice guidelines (version 3) are being prepared. Many of the Board's audits have found good bridge construction results, however other recent audits have identified significant compliance problems.

The Board remains concerned with the inconsistency of audit results for crossings and it decided to follow-up on its previous work and see if the changes that have been made in response to the 2014 report have led to improvements in bridge and major crossing practices.

This investigation looked at whether the parties who plan, design and construct bridges and/or wood box culverts³ (WBC) are meeting the legislated requirements of the *Forest and Range Practices Act* (FRPA) and conforming to certain standards of professional practice of the professional regulatory bodies. In other words, are new bridges and WBCs safe for industrial use and are forest resources being protected?

While the investigation assessed the planning and practices carried out by professionals, it did not assess the qualifications and competence of professionals, as that is within the realm of the professional associations.

Scope

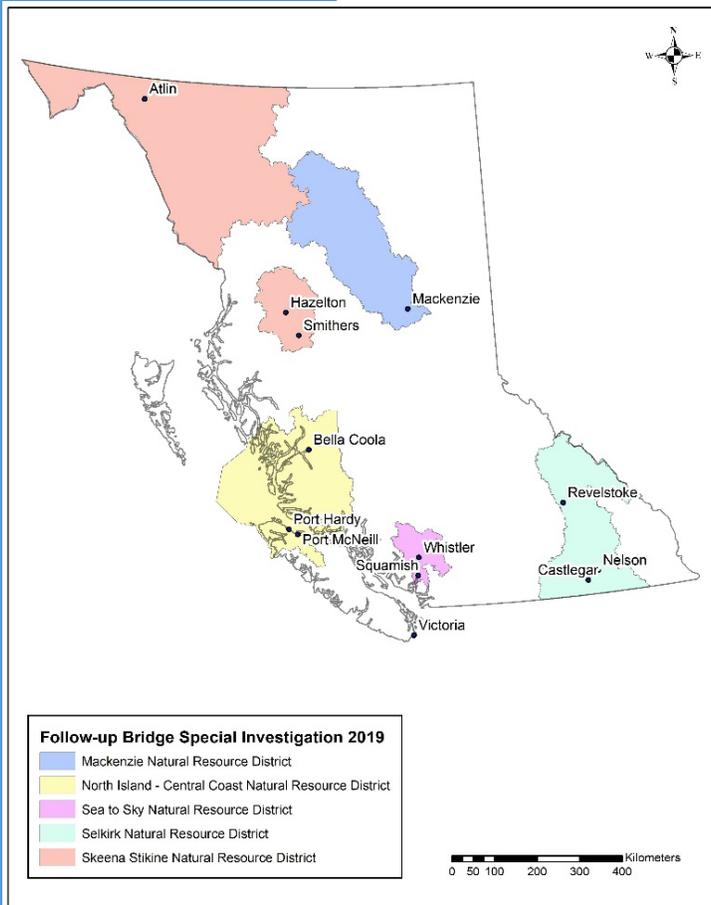
The investigation includes bridges and WBCs with a span greater than four metres constructed since January 1, 2017, by government and agreement holders in the Mackenzie, North Island – Central Coast, Sea to Sky, Selkirk and Skeena Stikine Natural Resource Districts (see Map 1 on page 3). These districts were not examined in the previous special investigation and were selected to ensure geographic distribution across BC.

³ A WBC is a log crossing structure covered in soil and/or gravel with a span less than six metres (bearing to bearing).

Approach

In April 2019, Board staff contacted all licensees and government in the selected districts to compile a population of all bridges and WBCs greater than four metres in span built since January 1, 2017. They also requested any available designs, fabrication drawings, record drawings, and crossing assurance statements for the structures.

Between June and October, two teams, each consisting of a professional forester and a professional engineer, visited the selected districts to confirm that the structures (or a sample of structures) were built in accordance with legislated requirements and also conform to certain standards of professional practice.



MAP 1. Natural resources districts included in the investigation.



Investigators examine a log stringer bridge.

Legal Framework and Standards of Professional Practice

Bridge planning, design and construction on resource roads is governed by legislation and overseen, in most cases, by professional engineers and forest professionals (Registered Professional Foresters and Registered Forest Technologists). FRPA, the *Forest Planning and Practices Regulation* (FPPR) and the *Woodlot Licence Planning and Practices Regulation* (WLPPR) specify certain requirements for the planning, design and construction of bridges. In general, these requirements are aimed at ensuring bridges are safe for industrial users and that forest resources such as water, soil and fish are protected.

The JPB of the ABCFP and EGBC has developed guidelines for professional practice for crossing projects.

The second version of the *Guidelines for Professional Services in the Forest Sector—Crossings* (crossing guidelines) was released in June 2014. A third version is now being prepared.

WHAT IS A CROSSING?

A crossing is defined as a forest road bridge or an engineered culvert. A bridge includes the superstructure, substructure, connections, approach road fills, and scour protection works. A steel or concrete superstructure of any length and log bridges greater than six metres in span are considered bridges.



Three examples of crossings (from left to right): 27-metre steel girder bridge, log stringer bridge, and an engineered open-bottomed arch culvert.



A wood box culvert. This is not a log stringer bridge because the span is less than six metres.

The general requirements of the legislation and the professional practice guidelines are discussed in the following sections.⁴

⁴ For exact requirements, please refer to the *Forest Planning and Practices Regulation* available at <http://www.canlii.org/en/bc/laws/regu/bc-reg-14-2004/latest/bc-reg-14-2004.html> and the Guidelines for Professional Services in the Forest Sector – Crossings, available at <https://www.egbc.ca/getmedia/97dcbad3-5482-416a-9bc0-55b3c662e71a/APEGBC-Guidelines-for-Forest-Sector-Crossings.pdf.aspx>.

Legislation

The FPPR sets out the requirements that must be met for bridge planning, design and construction for resource road bridges on Crown land. The requirements ensure safety for industrial users and protection of forest resources, and they have not changed since the first Board investigation.

The FPPR requirements examined in this investigation are:

- Section 39 – natural surface drainage patterns must be maintained
- Section 55 – the stream channel and banks must be protected
- Section 56 – fish passage must be maintained
- Section 57 – activities must not harm fish or damage habitat
- Section 72 – bridges must be safe for industrial users
- Section 73 – bridges must be designed to meet or exceed applicable standards
- Section 74 – bridges must be designed to pass the highest expected peak flows
- Section 77 – certain records and as-built/record drawings must be retained

Standards of Professional Practice

The *Guidelines for Professional Services in the Forest Sector–Crossings* (the guidelines) are intended to establish standards of practice that members should meet to fulfill professional obligations, including the duty to protect the safety, health and welfare of the public and the environment. Delivery of professional services for a crossing can involve the practices 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, railways, bridges ...” There is long standing historical involvement of members of both professions with respect to crossing projects.

In 2015, the ABCFP enacted bylaw 12A.2 which states that every member providing services included in the practice of professional forestry in relation to a crossing project must comply with the guidelines.

Simple and Complex Crossings

A key feature of the guidelines is the concept of simple and complex crossings. The guidelines recognize that the design and construction of certain simpler crossings do not always require the same specialized expertise as more complex crossings. The guidelines identify simple crossings, where the crossing location and its approaches require relatively straightforward and commonly used planning elements and construction practices.

Although a simple crossing may be less complex, it still must meet the same standards of planning and documentation, including, but not limited to: general arrangement drawings, hydrological flow calculations and channel stability assessments, assessment of the design bearing pressure for the applicable ground conditions and final record drawings (formerly called as-built drawings) and both crossing assurance statements. Detailed structural designs or design aids for the superstructure (either logs or steel) and, in some cases, the substructure must be prepared, signed and sealed by a professional engineer, and these drawings must be referenced in the bridge plan as applicable.

A structure that does not meet the definition of a simple crossing is considered a complex crossing.



This 12-metre portable steel girder bridge with a timber deck sitting on double log sill abutments is a simple crossing.



A 12-metre steel girder bridge with timber deck. The substructure of this bridge required extensive engineering expertise to determine the design bearing capacities, as well as the safety and stability of approach excavations. This is a complex crossing.

The guidelines state that each bridge must have both a Coordinating Registered Professional (CRP) and a Professional of Record (POR), but a practitioner may undertake both roles if qualified. These roles are described in the following sections.

CROSSING ASSURANCE STATEMENT

A Crossing Assurance Statement is a professional document confirming that the implementation and significant aspects of the construction of the work, substantially complies in all material respects with the concepts and intent reflected in the "issued for construction" professional documents prepared for the crossing, including all revisions to the plans, field reviews and supporting documents for the crossing. The Crossing Assurance Statements can only be signed by the POR/CRP.

Coordinating Registered Professional

The CRP is a forest professional or a professional engineer (P.Eng.) who is a member, in good standing, of the ABCFP or EGBC and has the competence (education, training and experience) for this role. The CRP is responsible for planning and coordinating all the professional services for the crossing project, including assessments, the design, field reviews, record drawings and a CRP - Crossing Assurance Statement (CAS). The CRP must direct those activities with sufficient oversight and supervision such that they can take **overall responsibility and accountability** for the planning and coordination of the crossing.

Professional of Record

The POR is a P.Eng. or a forest professional **responsible for the design of the crossing**, which includes all of the following:

- preparation of the general arrangement drawing
- completion of field reviews as required
- completion of the POR CAS, including preparation of record drawings

The guidelines clearly delineate the skill sets required by "Professionals of Record" when constructing a simple crossing or complex crossing.

Evaluation Criteria

To determine if a bridge met legal and certain professional practice requirements, the investigators reviewed all available documentation and recorded structural and site conditions on a field inspection form. The investigators provided the completed forms to each party as soon as possible after the site visits to ensure that licensees and government were aware of the results, and also to offer the builder an opportunity to provide additional information. For any significant safety concerns, the investigators notified the parties immediately.

Section 39 – natural surface drainage patterns: Natural surface drainage patterns were maintained if the bridge and riprap did not constrict and/or divert the natural channel.

Section 55 – protection of banks and channel: Stream banks were adequately protected if they were vegetated and undisturbed or armoured with rock. Disturbance included channel constrictions, increased sediment delivery into the stream and damaged banks and vegetation.

Section 56 – maintenance of fish passage: Fish passage was maintained if the crossing or associated construction practices did not physically block the stream to fish passage.

Section 57 – protection of fish habitat: In addition to sections 39, 55, and 56 requirements, a crossing was considered unlikely to harm fish or fish habitat if the bridge did not contribute significant amounts of sediment to the stream.

Section 72 – safe for industrial use: Investigators reviewed the bridge to ensure approaches were safe and the structural components were in good condition, and reviewed documentation to ensure the bridge was designed and built to handle the anticipated loads. Evidence of abutment erosion, inadequate clearance, inadequate guard rails (also called bull rails) or unsafe approaches were noted as potential safety issues, depending on the severity or risk.

Section 73 – bridge design: Designs were reviewed to determine whether they met the applicable standards as well as any indications that the site conditions for foundations and substructures were accounted for (allowable bearing pressures, etc.). Structural components such as stringers, decking and abutments were examined to ensure they met applicable standards.

Section 74 – peak flow: Designs were reviewed to ensure that peak flow was considered. In the field, investigators assessed the adequacy of the bridge to pass expected peak flows based on observable high water indicators compared to the design information, measured the opening size (underside of the bridge to the channel bed) and reviewed the upstream and downstream channel conditions.

Section 77 – records: In addition to having designs that meet standards, a person who builds a bridge must maintain records of the construction, crossing assurance statements and produce a record drawings which depicts the actual condition of the bridge, as opposed to the general arrangement drawings or proposed conditions.

Completeness of Plans: Plans and designs were considered complete if they included a conceptual design/general arrangement drawing supplemented with the detailed superstructure and substructure drawings, as well as other fabrication, material and construction specifications, and in-plant assurance statements, signed and sealed by a professional engineer, or a forest professional if applicable.

Adequacy of Plans: Plans were considered adequate if they were complete and accurately reflected site and structure conditions.

Crossing Assurance Statements: Documentation was reviewed to determine whether a CRP CAS and a POR CAS were completed, and by whom.⁵ It was also noted whether the structure was simple or complex.

Population

Licensees within the selected districts indicated that they built 518 bridges and 139 WBCs larger than 4 metres in span since January 1, 2017.

Investigators examined 269 bridges and 59 WBCs in the field. Tables 1 and 2 show the sample by district and by builder type.

Table 1. Sample by District

District	WBCs	Bridges
Mackenzie	0	72
North Island Central Coast	40	87
Sea to Sky	19	19
Selkirk	0	54
Skeena Stikine	0	37
Total	59	269

Table 2. Sample by Builder

Builder*	No. of Bridges
BCTS – FSR	35
FLNRORD – FSR	28
Major – FSR	13
Major – RP	181
Other	12
Total	269

*BCTS – FSR	Built by BC Timber Sales on a forest service road (FSR).
FLNRORD – FSR	Built by Ministry of Forests, Land, Natural Resource Operations and Rural Development (FLNRORD) on a FSR.
Major – FSR	Built by a major licensee on a FSR. Major licensees are larger companies that are not included in the Other category below.
Major – RP	Built by a major licensee on a road permit road or in a cutblock.
Other	Built by a woodlot licensee, timber sale licence holder, non-replaceable forest licence holder, a holder of a forest licence issued under section 47.3 of the <i>Forest Act</i> , or an independent power producer. Note that although this category includes a range of smaller tenure holders, all bridges sampled were built by timber sale licence holders.

⁵ The Board did not examine the competencies or qualifications of individual professionals in this investigation.

RESULTS

Wood Box Culverts

WBCs under six metres span (centre-to-centre of bearings) do not require the same level of planning and professional design expertise as longer structures. In past audits, the Board has encountered structures that were planned as WBCs but, when built, were longer than six metres. Although these structures were actually bridges, the required planning for a bridge was not carried out. To capture this situation, any WBCs four metres and longer were included in the scope of the investigation.

Investigators examined 59 WBCs in the North Island – Central Coast and Sea to Sky Natural Resource Districts, and none of the structures examined exceeded six metres in span. Some licensees took a cautious approach and treated larger WBCs as bridges for planning purposes, preparing general arrangement drawings. As a result, there were no concerns with the WBCs sampled.

Bridges

Table 3 shows overall compliance with legislation⁶ and conformance with professional practice requirements. Individual results by natural resource district and category of builder are provided in Appendix 1.

When fieldwork for the first bridge investigation was carried out in 2013, only one crossing assurance statement was required for each crossing, and it was signed by a coordinating registered professional, which was either a registered professional forester or a professional engineer. Today, two assurance statements are required for each crossing – a CRP CAS and a POR CAS. The 2013 CAS is most comparable to the current crossing guidelines version 2 POR CAS.

The green highlighting indicates an improvement over the results reported in 2014.

Table 3. Overall Compliance – 2020 vs. 2014

	% COMPLIANCE	
	2020	2014
Planning		
Complete plans (s. 73, 77 FPPR)	74	60
Adequate plans (question was not posed in 2014)	95	n/a
Record drawing prepared (s. 77 FPPR)	76	72
Accurate record drawing (s. 77 FPPR)	85	84
Peak flow (s. 74 FPPR)	92	64
Environment		
Natural surface drainage maintained (s. 39 FPPR)	99	89
Protected banks and channel (s. 55 FPPR)	95	89
Fish and fish habitat protected (s. 57 FPPR)	98	96
Fish passage maintained (s. 56 FPPR)	100	99
Safety		
No abutment erosion (s. 72 FPPR)	96	89
Safe approaches and alignment (s. 72 FPPR)	99	93
Adequate clearance (s. 72 FPPR)	98	94
Safe and sound (s. 72, 73 FPPR)	95	85
Professional Assurance		
Crossing Assurance – CRP	55	n/a
Crossing Assurance – POR	87	66

⁶ In some situations, the requirements set out in legislation for how a forest practice is conducted is determined through professional practice guidelines such as the Crossing Guidelines. In these cases, the Board will examine conformance with the parts of those guidelines that pertain to achievement of a forest practice requirement in FRPA.

In evaluating compliance with legislated requirements, and in keeping with its audit methodology, the Board uses the concept of significance. An instance of non-compliance must have the potential to be significant and be worthy of reporting to the public to be included in the figures above. For example, minor amounts of sedimentation in a stream or minor concerns with the protection of banks would not be reflected in the percentages above.

Table 3 shows that, on average, licensees and government are doing a better job of protecting the environment and ensuring safety, but there is still work to do with respect to safety, preparing complete plans; the preparation and accuracy of record drawings; and professional assurance of structures. In terms of safety, it is the Board's view that one unsafe structure is one too many, especially considering that all of the structures examined were less than three years old.

Planning

With the exception of the accuracy of record drawings, planning results have improved since the 2014 investigation. Seventy-four percent of the bridges had complete plans and of those plans, 94 percent were adequate. Record drawings were completed for 75 percent of structures, and 84 percent of those plans were accurate. That was the same accuracy found in 2014. Some licensees used generic general arrangement drawing templates that did not adequately consider site specific peak flows, approach alignment or local site conditions.

Ninety percent of designs considered expected peak flow and that is a significant improvement over 2014 (64 percent).

Environment

In general, builders are complying with the requirements and protecting the environment when installing bridges. The biggest improvement was in maintaining natural surface drainage patterns with a score of 99 percent. In 2014, the Board found several structures where riprap constricted the channel and the structure was too short for the channel. Protection and maintenance of fish habitat through the minimization of erosion was very good.

Safety

The safety of structures has improved in all categories examined. In 2014, 15 percent of bridges had safety issues—19 bridges were not safe and sound and investigators had significant safety concerns with a further 13 bridges. In 2019, 5 percent had safety issues—4 bridges were unsafe, and investigators had significant safety concerns with 9 others.

Professional Assurance

A CRP signed a crossing assurance statement for 55 percent of crossings, and a POR signed a crossing assurance statement for 87 percent of structures. For 29 structures, there were neither a CRP CAS nor a POR CAS.

Discussion

Crossing Assurance Statements

The professional associations implemented the CRP and POR crossing assurance statement system to assist forest professionals and professional engineers in fulfilling their professional obligations. Those obligations are to ensure structures are safe and that the environment is protected. The CRP takes responsibility and accountability for the planning and coordination of the crossing, while the POR is responsible and accountable for the overall design and construction of the structure.

The crossing guidelines state, "Every crossing project must have a CRP and a POR. These roles can be filled by the same or different members." Even if the same individual fulfilled both the roles of CRP and POR, the guidelines require two crossing assurance statements. The CRP CAS is to be retained by the CRP and placed on file for the life of the crossing. The POR CAS is to be retained by the POR and the CRP, and is to be filed for the life of the crossing. The guidelines provide examples of a CRP CAS and a POR CAS.

Ideally, the CAS should be completed before a crossing is used for industrial purposes. In practice, this is not always the case because it is not reasonable to expect a CAS on the day construction is complete. However, a CAS should be completed as soon as possible after construction is complete. This is a commonly accepted practice, and it makes sense that a professional provides assurance that a structure is safe before it is actively used for industrial purposes.

Almost all of the structures examined in the field were accessible and had been used for industrial purposes. The investigation considered why the completion rate for CRP CASs and POR CASs was 55 percent and 87 percent respectively.

Aside from simply not completing the crossing assurance statements, lack of understanding of the guidelines is one explanation. There were examples of PORs who designed a structure and took overall responsibility and accountability for it, only signing a POR CAS. Ninety-one structures did not have a CRP CAS, but did have a POR CAS.

A widely used FLNRORD form is also contributing to the situation. Form FS1414 is the FLNRORD's CRP - Crossing Assurance Statement. It is available on the internet and is commonly used by government and non-government professionals. Part three of the form indicates that a POR CAS is not required if the CRP also completed field reviews during construction. This is not consistent with the professional practice guidelines, which require both a CRP CAS and a POR CAS.

While the factors above may provide insight into why CAS documentation is not complete, there were no CASs for 29 structures sampled, 5 of which were complex crossings. This means that there was no professional accountability or responsibility for those structures.⁷

Incorrect classification of crossings

Simple crossings are defined in the professional practice guidelines and anything that does not meet this definition is considered a complex crossing. Examples of complex crossings include those built in active flood plains, engineered culverts over 2000 millimetres in diameter, those using geosynthetic reinforced soil (GRS) abutments, those with field welding or grouting and those built with curved approaches where vehicles do not track straight onto the structure.

The investigation revealed that for eight crossings, a professional considered the crossing to be simple, when, in the opinion of Board investigators, the crossing was complex. All eight misclassifications were made by forest professionals.

The failure to correctly determine that a crossing is complex is a concern because complex crossings require specialized expertise to ensure that relevant design aspects are adequately considered and that the bridges are safe and sound for use. It is beyond the scope of this investigation to determine whether professionals taking on the role of POR for complex crossings possess the POR skill sets described in the crossing guidelines.

POR changes from a Professional Engineer to a Forest Professional

Finally, the Board noted several examples where a professional engineer prepared and sealed a general arrangement design for a structure, but a forest professional signed and sealed the record drawing. By doing so, the forest professional took on the full POR responsibilities for the crossing.

⁷ Investigators did not expect CASs for bridges under construction or that were recently built. However, if a bridge had obviously been used for industrial purposes e.g., recent logging or road construction, investigators expected crossing assurance statements.

This practice raises a number of professional practice questions related to whether professionals fully understand the role they are taking on. These are outside the scope of this investigation but deserve attention.

CONCLUSIONS

This investigation considered whether new bridges and WBCs are safe for industrial use and whether forest resources are being protected. The Board assessed compliance with legislated requirements for planning, safety and protection of the environment, as well as conformance with the assurance aspects of the professional practice guidelines. The Board wanted to know if practices have improved following the Board's 2014 report.

The 2019 results show significant improvement in almost every area assessed. The compliance rates with environmental protection and safety requirements are all at the mid to high 90-percent level. There were 4 unsafe structures and 9 with significant safety concerns this year, versus 19 unsafe and 13 with significant safety concerns in 2014. In percentage terms, there were significant safety concerns with 15 percent of structures examined in 2013 versus 5 percent of structures examined in 2019. While safety has improved, the Board's view is that all new structures should be safe for use and unsafe structures are unacceptable.

There is also room for improvement with respect to planning and professional assurance of bridges. Only three-quarters of structures had complete plans. Record drawings were prepared for only 74 percent of structures and only 85 percent of those record drawings were accurate.

Each completed structure should have a crossing assurance statement signed by the CRP and another signed by the POR before a bridge is used for industrial purposes. Only 55 percent of structures had a CRP CAS and 87 percent had a POR CAS. It is apparent that some professionals may not be correctly interpreting the crossing guidelines and are not noting the requirement for two assurance statements. A widely available ministry form may also be contributing to the situation.

Finally, in some cases, forest professionals are misclassifying complex crossings as being simple. A complex crossing requires specialized expertise. Forest professionals must also be mindful that if they are signing and sealing a record drawing, they are taking on the role of professional of record, which means that they must possess the POR skill sets as described in the crossing guidelines.

APPENDIX 1: Detailed Summaries

The Board is reporting the 2019 results by district and builder, rather than attributing findings to individual licensees. This is consistent with the Board's 2014 report.

Table 4. Overall Results – Compliance by District

		COMPLIANCE BY DISTRICT (%)				
	Overall Compliance (%)	Mackenzie	North Island Central Coast	Sea to Sky	Selkirk	Skeena Stikine
PLANNING						
Complete plans (s. 73, 77 FPPR)	74	46	80	58	94	92
Adequate plans (% of completed plans)	95	81	100	100	100	88
Record drawings prepared (s.77 FPPR)	76	80	84	39	79	62
Accurate record drawings (s.77 FPPR) (% of record drawings prepared)	85	78	99	86	98	38
Design peak flow determined (s.74 FPPR)	92	82	96	95	96	95
ENVIRONMENT						
Natural surface drainage maintained (s. 39 FPPR)	99	97	100	89	100	100
Protected banks and channel (s.55 FPPR)	95	88	99	100	98	92
Fish and fish habitat protected (s.57 FPPR)	98	94	100	100	100	95
Fish passage maintained (s.56 FPPR)	100	100	100	100	100	100
SAFETY						
No abutment erosion (s.72 FPPR)	96	91	99	100	100	94
Safe approaches and alignment (s.72 FPPR)	99	97	100	94	100	100
Adequate clearance (s.72 FPPR)	98	96	100	100	100	94
Safe and sound (s. 72, 73 FPPR)	94	88	99	89	96	91
PROFESSIONAL ASSURANCE						
Coordinating Registered Professional - Crossing Assurance Statement	55	79	61	28	30	41
Professional of Record - Crossing Assurance Statement	87	89	87	39	89	100

Table 5. Overall Results – Compliance by Builder

		COMPLIANCE BY BUILDER (%)				
	Overall Compliance (%)	BCTS on FSR	District on FSR	Major on FSR	Major on Road Permit	Other
PLANNING						
Complete plans (s. 73, 77 FPPR)	74	86	93	69	69	83
Adequate plans (% of completed plans)	95	84	100	100	98	70
Record drawings prepared (s.77 FPPR)	76	75	96	42	78	42
Accurate record drawings (s.77 FPPR) (% of record drawings prepared)	85	89	100	100	82	40
Design Peak flow determined (s.74 FPPR)	92	97	100	100	92	100
ENVIRONMENT						
Natural surface drainage maintained (s.39 FPPR)	99	100	100	92	99	83
Protected banks and channel (s.55 FPPR)	95	86	100	92	98	67
Fish and fish habitat protected (s.57 FPPR)	98	94	100	100	98	92
Fish passage maintained (s.56 FPPR)	100	100	100	100	100	100
SAFETY						
No abutment erosion (s.72 FPPR)	96	97	100	100	99	67
Safe approaches and alignment (s.72 FPPR)	99	97	100	100	99	92
Adequate clearance (s.72 FPPR)	98	94	100	100	99	100
Safe and sound (s. 72, 73 FPPR)	94	92	100	100	95	75
PROFESSIONAL ASSURANCE						
Coordinating Registered Professional - Crossing Assurance Statement	55	75	46	8	56	42
P Professional of Record - Crossing Assurance Statement OR is an RPF or P.Eng.	87	97	96	58	87	50

Planning – Bridge and Major Culvert Design

Legal Requirement

Section 73 of the *Forest Planning and Practices Regulation* (FPPR) requires a person who builds a bridge to ensure that the design and fabrication of the bridge meets or exceeds applicable standards established by the Canadian Standards Association, Canadian Highway Bridge Design Code, CAN/CSA-S6 and soil properties, as they apply to bridge piers and abutments, as established by the Canadian Foundation of Engineering Manual. Bridge designs must also take into account the effect of logging trucks with unbalanced loads and off-centre driving.

Why is this requirement important?

The design and fabrication of a bridge must meet established standards to ensure that it can safely support the design load. A properly designed bridge protects both user safety and environmental values.

What Were Our Assessment Criteria?

Plans and designs were considered complete if they included a conceptual design/general arrangement drawing supplemented with the detailed superstructure and substructure drawings, as well as other fabrication, material and construction specifications, signed and sealed by a professional engineer, or a forest professional if applicable for simple bridges.

What Did We Find?

Seventy-four percent of the bridges examined had complete bridge designs. Of those, 95 percent were considered adequate.

Performance in the Selkirk Natural Resource District was particularly good, where 94 percent of plans were complete and all of those plans were adequate. Performance in Mackenzie district was poor at 46 percent. Sea to Sky was slightly better at 58 percent. The number of complete plans for bridges built by major licensees on forest service roads and road permit roads was slightly below average. Overall there is room to improve the completeness of plans.

Investigators noted the following examples that contributed to inadequate plans:

- Structural drawing does not match the installed bridge.
- General arrangement drawing missing information.
- Generic general arrangement template did not accurately reflect site conditions
- General arrangement drawing template for one span used for a different span (for example, 6-metre design used for 15.24-metre structure).
- Unsealed general arrangement drawing marked "Issued for Review" or "Preliminary Not For Construction."
- Load rating on structural drawings differs from load rating on general arrangement drawing.
- Designed structure inadequate to span the stream.

Planning – Records and Record Drawings

Legal Requirement

Section 77 of the FPPR specifies the information that must be prepared or obtained for a crossing, including: pile driving records, mill test certificates, in-plant steel fabrication drawings, concrete test results, soil compaction results, and other relevant field and construction data. A person must also prepare record⁸ drawings of the bridge or major culvert. This information must be kept until the bridge is removed or the person is no longer required to maintain the road. Record drawings document any significant changes to the design made during construction, or confirm that the bridge was built in general conformance with the conceptual design.

Why is this requirement important?

Relevant field and construction information and the record drawings provide a record of what was actually installed at the site.

What Were Our Assessment Criteria?

The investigation team reviewed the available documentation to ensure that relevant field and construction information was complete. Record drawings were adequate if they accurately reflected what was built and were signed and/or sealed by an appropriate professional.

What Did We Find?

Record drawings were prepared for 76 percent of bridges examined. Of those, 85 percent accurately reflected site and structure conditions.

Record drawings were prepared for only 39 percent of the structures in the Sea to Sky Natural Forest District. In Skeena Stikine, one professional did not prepare record drawings but made a statement for 14 structures that they “were built in compliance with the design to the level of durability and resistance expected.” That statement does not satisfy the FPPR requirement to prepare an as-built drawing.

Among licensees, “Other”⁹ tenures and major licensees building structures on a forest service road were least likely to prepare as-built drawings. That was also the case in the 2014 investigation. Only 40 percent of record drawings prepared by the “Other” category of licensee were accurate.

⁸ Record drawings were formerly called as-built drawings.

⁹ Other tenures are woodlot licences, timber sale licences, non-replaceable forest licences, and forest licences issued under section 47.3 of the *Forest Act*, or an independent power producer.

Planning – Peak Flow

Legal Requirement

Section 74 of the FPPR requires a person who builds a bridge to ensure that it can pass the highest peak flow expected while the bridge is in place.

Why is this requirement important?

If a bridge is not designed and constructed to be able to handle the expected peak flow with a reasonable allowance for floating debris, it could wash out or be damaged, posing a significant risk to user safety and the environment.

What Were The Assessment Criteria?

This requirement was met if the design considered the peak flow to be expected over the life of the bridge. Typically this included a calculation of watershed drainage area, average and peak flows for various return periods depending on the design service life of the structure.

What Did The Investigation Find?

Licenseses and government considered peak flow for 92 percent of the bridges.

Ministry designs for bridges on forest service roads were particularly good as all considered design peak flows.

Peak flow was considered more than 95 percent of the time in all districts other than Mackenzie where it was considered 82 percent of the time.



This 15.24-metre bridge was designed to accommodate the peak flow expected in 50 years (Q50). It will remain in place for up to 15 years.



This 12-metre permanent pre-cast concrete girder bridge is designed to accommodate the peak flow expected in 100 years (Q100).

Environment – Maintaining Natural Surface Drainage Patterns

Legal Requirement

Section 39 of the FPPR requires a person who builds a road to maintain natural surface drainage patterns both during and after construction.

Why is this requirement important?

Altering the natural flow of water can adversely affect user safety, infrastructure, water quality and timing of flow, fish and fish habitat. Constriction of the channel can also increase the potential for erosion of the abutments, which is a safety concern. Bridges and culverts must be designed with adequate consideration for channel hydraulics to mitigate potentially adverse impacts.

What Were The Assessment Criteria?

Natural surface drainage patterns were considered maintained if the bridge and rip rap did not constrict and/or divert the natural channel. Typically a channel is constricted when a bridge is too short for the channel.

What Did The Investigation Find?

Natural surface drainage patterns were maintained at 99 percent of crossings.

This log stringer bridge maintains natural surface drainage patterns.



Riprap has restricted the channel of this stream.

Environment – Protection of Fish Habitat, Stream Banks and Channels

Legal Requirements

Section 55 of the FPPR requires a person who builds a stream crossing to protect the stream channel and stream bank immediately above and below the stream crossing, and mitigate disturbance to the channel and banks at the crossing.

Section 57 of the FPPR requires a person installing a bridge to do so at a time and in a manner that is unlikely to harm fish or destroy, damage or harmfully alter fish habitat.

Why are these requirements important?

The installation of stream crossing structures involves the removal or disturbance of trees, shrubs and soil immediately within and adjacent to the stream channel. As a result, it is necessary to mitigate this disturbance, ensuring that the channel is sufficiently stable and can withstand expected water flows.

Fish generally require clean water for feeding and breathing and habitat for spawning, rearing and overwintering. The construction, maintenance or deactivation of roads, particularly near and across streams, has the potential to affect these requirements. The excessive disturbance of stream channels at a bridge location can damage or alter fish habitat directly. A lack of planning and implementation of erosion and sediment control during bridge structure installation, deactivation and long-term road use, can cover spawning gravels and affect the ability of fish to feed and breathe.

What Were The Assessment Criteria?

Stream banks were adequately protected if they were vegetated and undisturbed or armoured with rock. Sediment control was adequate if the bridge and approaches did not contribute excessive sediment to the stream.

What Did The Investigation Find?

Stream banks were adequately protected at 95 percent of the crossings. The Other category of licensees performed significantly below average—where only two-thirds of the crossings had protected banks.

Sediment control was adequate at 93 percent of the crossings. Sediment control in Mackenzie and Skeena Stikine districts was below average at 89 and 78 percent respectively. Installation of bridges in wet, fall conditions is common in these districts, as are erodible soils.



This crossing is contributing significant amounts of sediments to this fish-bearing (S4) stream.



This stream bank is not armoured with rock and sediment is being introduced to the stream.



Inadequate armouring of the bank. Rock is not properly keyed in to withstand the stream flow and to retain the fill.



These banks are well armoured and disturbed areas have been seeded with grass to minimize sedimentation.



These banks were relatively undisturbed during construction.

Environment – Fish Passage

Legal Requirement

Section 56 of the FPPR requires a person to ensure that they do not cause a material adverse effect on fish passage.

Why is this requirement important?

A bridge should not damage fish habitat or affect the movement of fish through the site. If the channel banks are narrowed to accommodate a bridge that is too short or the bridge is set below the high water mark, the hydraulic effects can include increased water velocity, channel scour, aggradation (deposited sediment and gravel raise the stream bed) and altering the natural movement of bed load and woody debris. If this happens, the channel can become partially blocked and the water velocity can increase, making fish passage through the area for the purposes of feeding or spawning more difficult.

What Were The Assessment Criteria?

Fish passage was considered maintained if the crossing did not physically block the stream.

What Did The Investigation Find?

Fish passage was maintained at all of the bridges. In general, bridges and arches do not impede fish passage.



Safety

Legal Requirement

Section 72 of the FPPR states that a person who constructs or maintains a road must ensure that the road and associated structures such as bridges, culverts, and fords are structurally sound and safe for industrial users.

Why is this requirement important?

An unsound bridge could lead to loss of life, equipment and damage the environment.

What Were The Assessment Criteria?

Teams reviewed the bridges for safe use by industrial and public users. This involved a review of the built bridge on site. Using professional judgment, the investigators specifically evaluated:

- horizontal and vertical alignment of approaches, delineators and approach barriers where required by OHS regulations; stability of the approaches (considering the proposed vehicle configurations);
- clearance of the bridge related to existing channel morphology;
- superstructure and substructure conditions; and
- design load ratings with respect to the anticipated loads.

Note that concerns about abutment erosion, alignment and clearance did not necessarily mean that the bridge was unsafe. For example, abutment erosion could become a safety concern over time if allowed to continue, but may not be a serious safety issue at the time of inspection.

What Did The Investigation Find?

Ninety-nine percent of bridges had safe approaches and alignments. Ninety-six percent showed no erosion of abutments, and 98 percent had adequate clearance (the ability of the bridge to pass expected peak flows.)

Overall, 94 percent of crossings were considered safe and sound. Four bridges were unsafe, and there were significant safety concerns with 9 others. This is a significant improvement over the 2014 results where 85 percent were safe and sound.





Three of the four bearing plates for this structure were not adequately supported by the timber sills. This structure was not sound and safe for use. The Board immediately notified the licensee and it promptly lifted the structure and repositioned the timber sills.



Both sills of this structure were undermined by the creek. The foundation materials supporting these log-bundle abutments have been eroded and are not structurally sound. This structure is unsafe for hauling.



This 8-metre structure was used for a few weeks in the winter and then pulled for reuse elsewhere. It had severe installation damage and was completely fractured full width (circled in red). This structure was unsafe for use. This highlights the importance of inspecting portable structures prior to re-use.



This 19.3-metre span was made up of two railcars. There was no information provided indicating that the railcars had been inspected prior to use by a qualified structural professional. Parts of the superstructure were also damaged. No load rating had been determined for the structure. Access had been blocked after industrial use.

Professional Assurance – Crossing Assurance Statement (CAS)

Professional Practice Guideline

The Coordinating Registered Professional (CRP) and the Professional of Record (POR) must give an assurance that a crossing has been built in general conformance with the plans and supporting documents.

Why Is A Crossing Assurance Statement Important?

CAS demonstrate that qualified professionals were responsible for the planning and/or design and field reviews as required for the crossing. The professionals assure that the significant aspects of the construction work generally conformed to the plans and supporting documents, including revisions, or they take full professional responsibility for any modifications.

What Were The Assessment Criteria?

This guideline was considered met if CASs were signed by a CRP and a POR.

What Did The Investigation Find?

A CRP signed a CAS for 55 percent of structures and a POR signed a CAS for 87 percent of structures.



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