FSR Bridges
Inspections and Maintenance

Special Investigation

FPB/SIR/13
May 2005

Key Concepts and Terms

Abutment - Abutments are structures made of logs, steel, concrete or other materials which support the weight of the bridge at each end. They are part of the bridge's substructure.

Cross Tie – Cross ties are timbers perpendicular to the stringers that support the running surface materials.

Load Rating – The load rating is the weight carrying capacity of a structure as determined by a professional engineer. It is usually measured in tonnes (one tonne = 1000 kilograms).

Major Culvert - a major culvert is defined in the Code and includes pipes greater than 2000 mm and pipe arches greater than 2130 mm.

Needle Beam - A needle beam is a log or timber lashed crosswise to a bridge superstructure to add strength to carry weight.

Sill - A sill rests on the bridge substructure and directly supports the superstructure.

Stringer - Stringers extend lengthwise along the full length of the bridge and are the primary support of a log bridge superstructure.

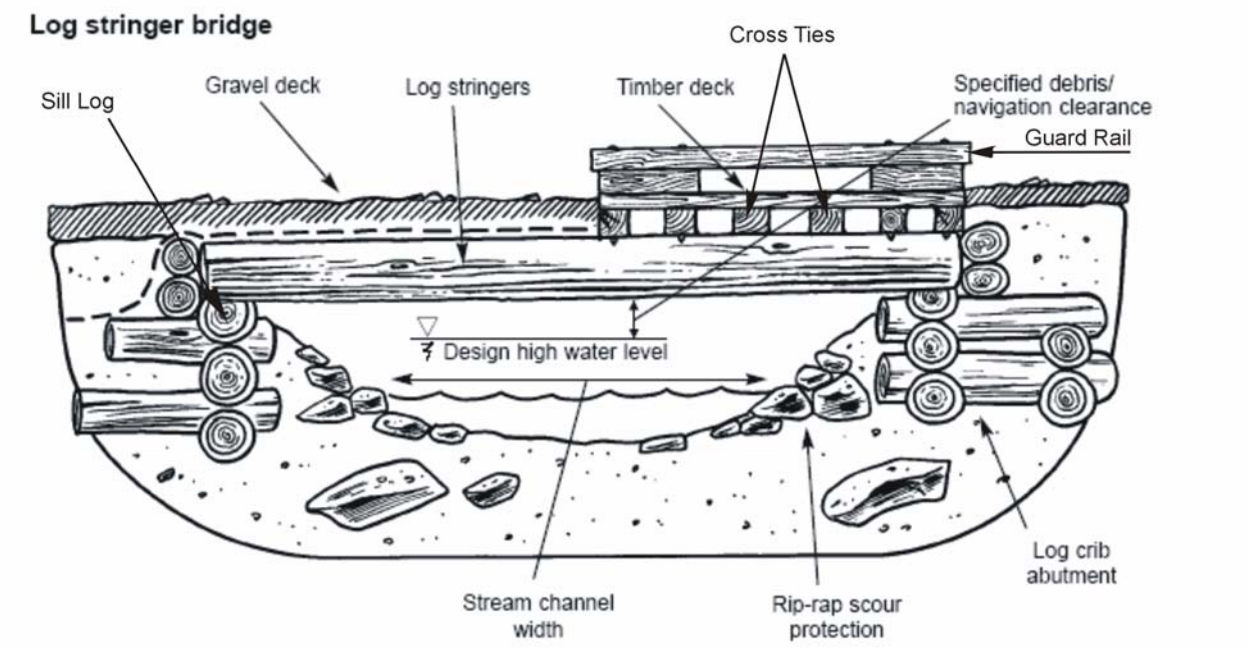


Figure 1 - Adapted from Fish-stream Crossing Guidebook, MOF, 2002

Table of Contents

Introduction

In January 2004, the Forest Practices Board initiated an investigation of bridge and major culvert inspection and maintenance practices on forest service roads (FSRs). This special investigation assessed Ministry of Forests' (MOF) compliance with the Forest Practices Code[i] (the Code) requirements to inspect, repair and maintain bridges and major culverts. The investigation, consisting of both office and site visits, was conducted in the winter and spring of 2004. The Board examined bridges and major culverts on FSRs in six forest districts: Sunshine Coast, North Coast, Peace, Headwaters (including both former Clearwater and Robson Valley districts), Central Cariboo, and Kootenay Lake (refer to map on page 2).

Figure 2 – Bridge in the Kootenay Lake Forest District

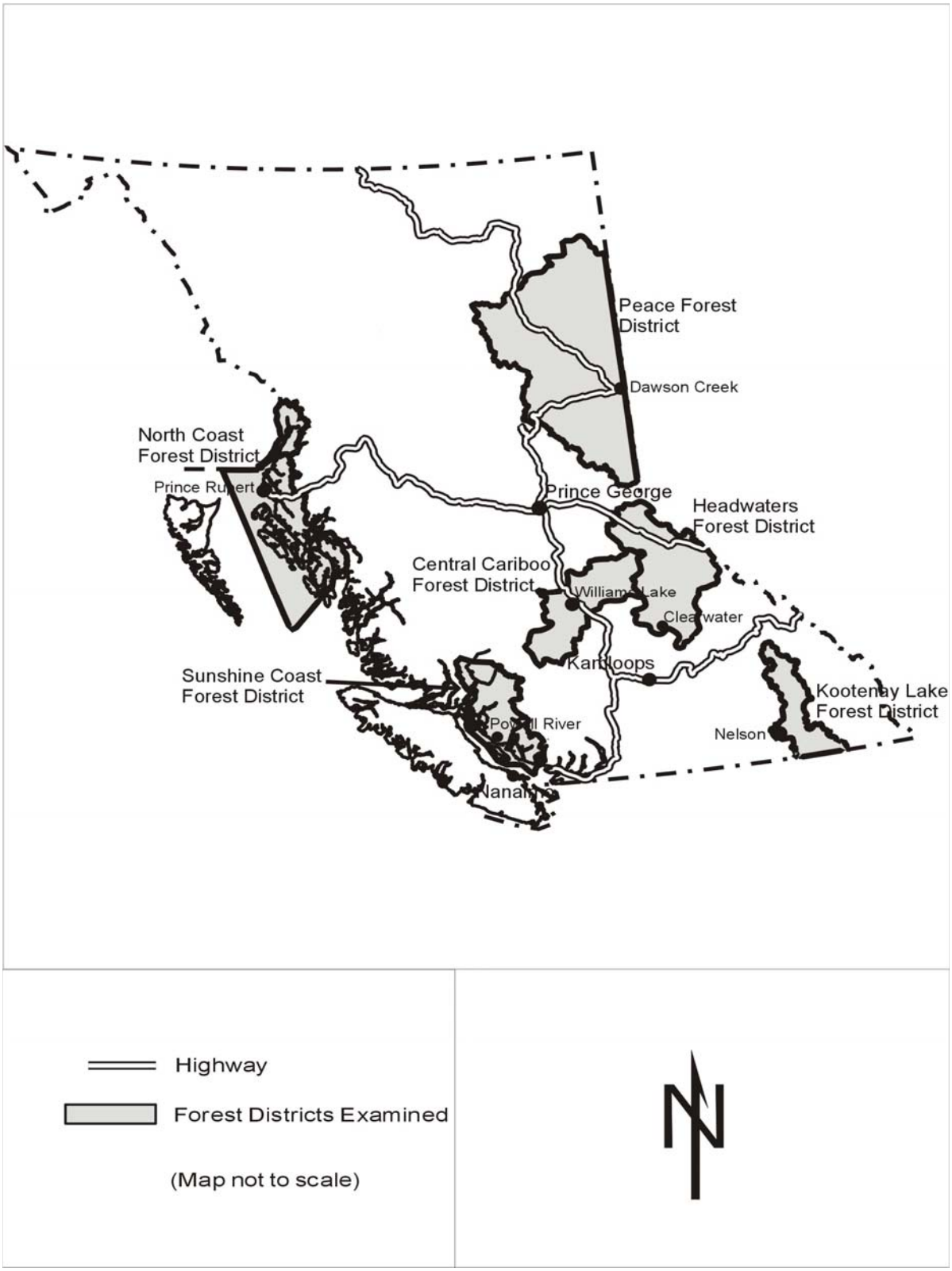
The Board investigated MOF obligations to:

1. meet timing requirements to carry out bridge and major culvert inspections; and
2. adequately follow up inspections by:
    - correcting structural deficiencies in a timely manner;
    - closing, removing or replacing a bridge before users or downstream improvements and forest resources are placed at risk;
    - ensuring a professional engineer evaluates a deficient bridge according to the requirements of CAN/CSA-S6 standard[ii]; and
    - restricting traffic loads to a safe level, for example by posting signs stating the actual capacity of a bridge as determined by a professional engineer.

Background

The Board initiated this special investigation because bridge problems, including bridges on FSRs, have been relatively common in past Board audits. The Board considers bridge problems to be high risk, since there is a potential for harm to people using the bridges, as well as the streams below the bridges. Previous Board work has focused on roads managed by forest licensees, but little work has been done to examine FSRs, which are the responsibility of MOF and are often more heavily used by the public.

FSR Bridges
Special Report



In the majority of past Board audits, bridge-related non-compliances were minor in nature; however, there have been several cases where the identified bridge issues were considered significant by the Board. For example, a recent audit report[iii] identified a bridge that had been designated for closure but not physically closed or removed, resulting in a lingering safety hazard to traffic.

In 2001 the Board published a special report on bridge maintenance[iv]. In that report, the Board described numerous bridge maintenance problems identified during past audit work. The Board found non-compliance where licensees did not meet the timing requirements to conduct inspections and did not complete required repairs in a timely manner. The Board reported that over half of the bridges audited for maintenance obligations in 1999 and 2000 were not in compliance with at least one Code obligation in effect at the time. Although many of the compliance problems noted were procedural, bridge maintenance warrants periodic review due to the safety and environmental risks associated with bridge deterioration.

Approach

Six forest districts were selected for examination, based on their dispersal throughout the province. The investigation included both office and field components; bridge inspection and maintenance files were reviewed in January and February of 2004, and follow-up field examinations were undertaken in May and early June to determine the condition of bridges where file information was inconclusive.

Investigators compiled the inventory of FSR bridges and major culverts in each district through consultation with district and regional engineering staff and review of databases. Investigators relied on MOF data, because aerial overviews for testing the inventory for completeness would not be cost effective. Because the number of bridges in all districts except North Coast was relatively large, investigators chose a sample of higher-risk structures for review rather than reviewing all structures. A higher-risk structure, for example, is one constructed of logs and timbers as compared with one constructed of steel and concrete. Also, older bridges tend to be higher risk than ones recently installed. Investigators reviewed all structures in the North Coast district because it had a relatively small number of bridges. The records for each selected bridge were examined for inspection reports and associated information about bridge condition and repairs. In several districts, Board investigators noted in the file reviews that there were few field-related problems, so field work was not warranted. In other districts, bridges were field assessed for repairs, appropriate load rating signs, and their overall safety.

Investigators selected a total of 268 bridges and major culverts for examination and assessed each structure against Code requirements over its lifespan (or since 1995 for bridges older than the Code). Each structure was assessed for its potential to be a significant safety risk at the time of the investigation. These results are reported in the following section.

Findings

A total of 268 bridges and major culverts were reviewed. Investigators examined the inspection and repair records for all 268 bridges and major culverts. In addition, investigators field-examined bridges and major culverts in some districts where they were not able to conclude on the condition of the bridge from available documentation.

The tables in the following sections summarize the findings on FSR bridge inspection and maintenance practices. The tables combine both bridges and major culverts, since Code requirements are the same for both types of structures.

Inspection Frequency

Table 1: Special Investigation Findings for Inspection Frequency

Parameter	Kootenay Lake	Headwaters	Central Cariboo	Peace	North Coast	Sunshine Coast	Totals	Percentages
Total number of bridges and major culverts reviewed	46	67	20	48	29	58	**268**	
Number where the inspection frequency requirements were not met[v]	3	13	4	4	18	19	**61**	**22.8%**

The Code requires bridge inspections to be done every two or three years, depending on the materials used for bridge structural components. Where the stringers or other structural components of the bridge's substructure are made of untreated wood, inspections must be done every two years. The investigation found 61 cases where the required inspection frequency was not met by one or more years.

Some inspections were not completed because the bridges are in isolated locations, currently not used for industrial purposes and not accessible to the general public. This circumstance was common in the two coastal districts, where several road networks are located in remote areas and it was difficult and expensive to reach bridges for inspection. Because these bridges are inaccessible, they represent a very low risk to user safety, and the lack of inspections is not a significant safety concern. Although not a safety concern, the bridges pose an unknown environmental risk. Because of their isolated location, the investigation was not able to assess their potential risk to the environment.

Some bridges had minor structural components consisting of untreated wood, but were otherwise constructed with permanent materials such as steel and concrete. Most of these were

bridges with a log or timber sill made of untreated wood. Several had been inspected every three years but, because a component of the substructure was untreated wood, they were legally required to be inspected every two years. The additional risk of bridge failure from untreated compared to treated sills is quite low, so these cases were not of significant concern to investigators.

Although the inspection frequency required by the Code was not met for 61 (22 percent) of the 268 bridges and major culverts examined, these non-compliances are not considered to be significant because the safety risks associated with these bridges is generally low.

Structural Deficiency

Although not explicitly defined in the legislation, structural deficiencies are those that may reduce the bridge's original load rating, or that may result in detrimental environmental impacts. An example of a structural deficiency is a log stringer bridge (see Figure 1) containing rot, a condition that reduces load capacity over time. A second example is bridge abutments undercut by stream erosion, a deficiency that can compromise the structure's capacity to bear weight. Most structural deficiencies are associated with bridges constructed of logs and timbers, and are inevitable as these bridges deteriorate over time.

Examples of non-structural deficiencies are worn bridge deck materials (see Figure 1) or missing bridge delineator signs (see Figure 3). Such deficiencies do not compromise the ability of the structure to continue to bear traffic loads as evaluated by a professional engineer. However, it is important to address non-structural deficiencies, especially to ensure safety is maintained.

Table 2: Special Investigation Findings for Structural Deficiency

Parameter		Kootenay Lake	Headwaters	Central Cariboo	Peace	North Coast	Sunshine Coast	Totals	Percentages
Total number of bridges and major culverts reviewed		46	67	20	48	29	58	**268**	
Number with structural deficiencies[vi]		22	25	0	7	3	15	**72**	**26.9%**
Number where structural deficiencies corrected[vii]		4	8	0	5	0	3	**20**	**7.5%**
Number with structural deficiencies that were closed, loads reduced, appropriately signed, etc.[viii]		13	12	0	2	3	12	**42**	**15.7%**
Number where there is a potential safety issue because structural deficiencies were not adequately addressed		0	4	0	0	0	0	**4**	**1.5%**
Number where there is a safety issue because:	no load rating signs	5	0	0	0	0	0	**6**	**2.2%**
	signed as closed; not blocked off	0	1	0	0	0	0		

The Code provides a variety of options to address structural deficiencies in bridges, including timely repair, closure, removal or replacement, and reducing load ratings to safe levels. The investigation found a total of 72 bridges with inspections that identified structural deficiencies—slightly more than a quarter of all bridges reviewed. Investigators found that the Kootenay Lake and Headwaters Forest Districts had a large proportion of older log structures and thus had more structural deficiencies to address. Of the 72 bridges, investigators found that structural deficiencies were repaired on 20 of them. For an additional 42 bridges, investigators found that the structural deficiencies were appropriately managed so that the risk to users was minimal. In most cases this involved reducing the load ratings and placing appropriate signs. In a few cases, bridges were closed to vehicular traffic and therefore did not represent a safety risk to users.

However, the investigation found actual or potential safety risk in ten cases (3.7 percent of bridges reviewed), where identified structural deficiencies had not been adequately managed.

Figure 3 - Bridge K-1051 – not load rated, although MOF inspections note significant rot in stringers. One of the bridge delineators is knocked down.

- Four bridges were determined to be a potential safety concern, all in the Headwaters Forest District. Bridges K-750 and K-1051 have substantial rot in the log stringers but were not load rated because there was confusion over road status and whether the bridges were the responsibility of MOF or the licensee. Bridges G3-051 and G3-060 had structural deficiencies that were communicated to the road use permit holder to address, but the necessary work was not undertaken.

- The investigation concluded that six bridges were unsafe in their current condition. There was a safety risk for five bridges where engineers had reduced their load ratings, but they were not posted with appropriate load rating signs. These bridges (N7-039, N7-044, N7-114, N7-173 and N7-196) are all in the Kootenay Lake Forest District. In addition, there was a safety concern involving a bridge in the Headwaters Forest District (bridge K-045) that had a sign stating the bridge was closed and unsafe to carry any loads (0 tonne load rating). However, it was not blocked to prevent vehicle traffic so it continued to be a safety hazard.

Figure 4 - Bridge N7-114 – no load rating sign or bridge delineators.

Subsequent to the investigation, MOF has remedied 5 of the 10 deficient bridges, including removal of the bridge that had been posted at 0 tonnes but not blocked (K-045). Also, two bridges were repaired (G3-051 and N7-039). Bridge N7-039 was also posted with an appropriate load rating sign, as were two other bridges (N7-044 and N7-173).

Discussion

Responsibility for Bridge Maintenance and Replacement

For several years after the Code's implementation in 1995, MOF directly handled: inspections; structural maintenance, such as installation of needle beams or replacing cross ties; and replacements of bridges on FSRs. The primary user (licensee) was only responsible for surface maintenance of bridges, such as deck cleaning or replacing running planks. In April 2001, MOF published engineering standard operating procedures in connection with its core services review[ix]. It included guidance on administration of FSRs and their bridges, and prescribed the transfer of responsibility for major infrastructure repair and replacements of bridges on industrial-use FSRs to licensees. Inspections were to remain the responsibility of MOF staff. In June 2002 this was followed by a letter[x] from the MOF assistant deputy minister of operations to licensees, describing these changes to FSR road and bridge maintenance responsibility.

The investigation found that where the MOF was responsible for bridge inspections but had assigned responsibility for corrective work to licensees, there was occasionally a lack of evidence to show that problems were followed up to ensure the corrective action was planned or completed by the licensee. Typically, inspection reports showing various deficiencies were sent to licensees, but no follow-up action was taken before the next inspection.

The MOF Small Business Forest Enterprise Program (SBFEP) was replaced by British Columbia Timber Sales (BCTS) in 2003. BCTS is a new program that is separate from MOF district offices. In conjunction with the establishment of BCTS, responsibility for FSR and bridge maintenance in certain areas was transferred from the district manager to BCTS. This process was not yet complete at the time of the investigation. In one region, the responsibility to conduct bridge inspections was also transferred to BCTS, and led to a minor delay in meeting inspection frequency requirements on several bridges. Additional re-alignments of responsibility for FSR bridges are likely to occur in connection with the Province's forestry revitalization initiative[xi], which requires licensees to return about 20 percent of their replaceable tenure to the Crown for redistribution as opportunities for woodlots, community forests, First Nations, and an increase to the BCTS allocation.

Bridge Administration

The timing of this investigation coincided with MOF's substantial organizational changes. From 2001 to 2003, MOF reduced the number of forest regions from six to three, and the number of forest districts from 46 to 29. BCTS replacement of the SBFEP occurred during this time as

well. These changes have been extremely challenging for the organization. Not surprisingly, investigators noted some administrative problems related to these changes, such as missing files and reassigned responsibilities.

The old regions each used a bridge register to list, track, and locate structures along FSRs. During the investigation the new regions were consolidating registers, but the process was not yet complete. Consequently, the systems in use varied among regions and between districts at the time of the investigation. The level of regional involvement, collaboration and responsibility also varied among the assessed districts as workloads were redistributed in line with the organizational changes. MOF has informed the Board that much of the system integration has been completed.

The investigation also found the six districts examined relied primarily on the Code to guide programs for inspecting and maintaining bridges, rather than policies or procedures specific to inspecting and maintaining bridges. In general, policies and procedures were not mentioned during interviews and appear to be lacking as a bridge program reference, with the exception of a bridge maintenance SOP checklist in the Engineering Manual[xii].

Legislative Considerations

Since the Code's introduction in 1995, regulatory obligations for bridge and major culvert maintenance have changed significantly. The following table shows the main bridge inspection and maintenance obligations in three versions of the applicable regulation, over a seven-year period.

Table 3 - Bridge inspection and maintenance obligations over the years

	Forest Road Regulation (Code) Reg. 106/98	Forest Road Regulation (Code) Reg. 351/2002	Forest Planning & Practices Regulation (FRPA) Reg. 14/2004
Effective period / Requirement	1998-2002 (in effect for 2001 report)	2002-2003 (in effect for this report)	2004-2005
Bridge must be inspected every 3 years or every 2 years if stringers or substructure component is untreated wood.	Section 16(1)	Section 11(1)	Not required
Inspection must be done by a qualified inspector.	Section 16(1)	Not required	Not required
Inspection must include specific elements including recommendation and schedule for repairs.	Section 16(3)	Not required	Not required
Inspection records must be retained for at least one year after removing a bridge or culvert from a site.	Section 16(4)	Section 11(3)	Section 77(2)
If bridge has structural deficiencies address by repair, close, remove, replace, restrict traffic loads to safe level, place sign for max. capacity.	Section 17(1)&(3)	Section 12(1)&(2)	Section 75

In January 2004, the *Forest and Range Practices Act* (FRPA) replaced the Code as British Columbia's forest practices legislation, although transition provisions of FRPA require that road maintenance obligations, including bridges, comply with the Code[xiii].

Under the Code, bridge inspection and maintenance obligations were initially quite detailed and prescriptive; over time, most of the prescriptive elements were removed. Under FRPA and its associated regulations, requirements for bridge and major culvert maintenance are results oriented, with essentially none of the procedural requirements that existed under the former Code. For example, there is no requirement to conduct inspections, although if voluntary inspections are conducted, the records must be kept for at least one year after a bridge or culvert removal.

Although inspections are not mandatory, FRPA requires the person who built the bridge to ensure that it is structurally sound and safe to use by industrial users[xiv] and to address structural defects or deficiencies if they occur[xv]. This responsibility can be transferred in whole or in part by the district manager to the road use permit holder[xvi], usually a licensee.

The alternatives available to address structural deficiencies are essentially the same in FRPA as in the Code: correct the deficiency, close, remove or replace the bridge, restrict traffic loads, or place signs identifying the maximum load capacity. How the defects or deficiencies are to be identified is no longer prescribed in the legislation.

Where a road is not being used by industrial users (whether an FSR or other road on Crown land) it is a wilderness road. On a wilderness road, there is no requirement to ensure that the bridge can be safely used by industrial users, or to ensure it is functional, except to ensure there is no material adverse effect on a forest resource[xvii]. However, there is still a requirement to address structural deficiencies to ensure that the bridge is not a safety hazard to users.

Findings Compared with the 2001 Board Special Report

When comparing the 2005 and 2001 Board reports on bridges, it is important to note the 2001 report is a roll-up of findings from all audits, including both licensees and MOF for 1999 and 2000. The current report is a special investigation specifically examining MOF bridges on FSRs. The 2001 report encompasses 277 bridges that were reviewed both on paper and in the field. In this investigation, 268 bridges were reviewed on paper, of which 40 bridges were also field-examined.

Moreover, several Code requirements in effect from 1999 to 2001 were no longer in effect at the time this investigation took place. The following table provides a comparison of results of the two reports for the key bridge maintenance obligations examined in this investigation:

Requirement	2001 Bridge Report	Special Investigation	Comments
Bridge must be inspected every 3 years or every 2 years if stringers or substructure component is untreated wood	Inspection frequency requirements not met in 9.7% of bridges reviewed (27 of 277)	Inspection frequency requirements not met in 22.8% of bridges reviewed (61 of 268)	Poorer results, perhaps due to the large proportion of bridges in remote locations
If bridge has structural deficiencies address by repair, close, remove, replace, restrict traffic loads to safe level, place sign for max. capacity	Structural deficiencies not addressed on 7.6% of bridges reviewed (21 of 277)	Structural deficiencies not addressed on 3.7% of bridges reviewed (10 of 268)	Better results
	Load rating signs missing on 2.2% of bridges reviewed (6 of 277)	Load rating signs missing on 2.2% of bridges reviewed (6 of 268)	Similar results

Conclusion

The purpose of this special investigation was to determine if MOF met timing requirements to carry out FSR bridge and major culvert inspections, and to assess whether bridges with structural deficiencies were appropriately managed.

The investigation found that MOF did not meet the inspection timing requirements on 22 percent of bridges reviewed, although the risks to user safety were considered low. The investigation also found 10 of 268 bridges posed a safety concern (3.7 percent of those reviewed), which is a better result than in the 2001 report. However, the findings show that there are still bridges requiring attention because they pose immediate or potential safety hazards. It is the Board's view that no structurally unsafe bridges should be open for public use at any time.

Under FRPA, most procedural obligations, such as conducting inspections, have been eliminated. Those responsible for bridge maintenance need to compensate, by ensuring that their internal processes result in diligent inspection of bridges, and timely addressing of problems so that user safety is maintained. It is important for MOF to review and strengthen its internal processes for bridge maintenance, including voluntary or informal inspections, to ensure that FRPA legislative obligations for bridge safety can be met. Future Board audits and investigations would logically evaluate these processes when assessing compliance with legislative requirements.

MOF reorganization and the policy shift to delegate responsibility for repair to licensees were both found to be complicating factors in effective bridge maintenance on FSRs. Despite these challenges, this report has found a better level of performance on many bridge maintenance requirements compared to previous Board assessments.

Recommendation

The Board makes the following recommendations, based on this report:

1. MOF should address the remaining five bridges with structural deficiencies identified in the investigation as not having been adequately managed, so that the risk to user safety is minimized.

The Board requests that the Ministry of Forests take action on this recommendation as soon as possible and report the results to the Board by July 31, 2005.

2. MOF should communicate to the Board how it will ensure it can deliver the results required for bridge maintenance under FRPA.

The Board requests that the Ministry of Forests report to the Board on this recommendation by December 31, 2005.

[i] In January 2004 the *Forest and Range Practices Act* (FRPA) replaced the Forest Practices Code as British Columbia's forest practices legislation. FRPA will be phased in over a transition period ending on December 31, 2006 (with government authorized to extend the period until December 31, 2007). The transitional provisions of FRPA state the Code continues to apply to forest practices carried out under a forest development plan. This continues until there is an approved forest stewardship plan, at which point, the requirements of FRPA apply. Therefore, although FRPA came into effect near the end the investigation period, the legislated forest practices requirements examined in this investigation were the requirements of the Code.

[ii] This is the Canadian Standards Association (CSA) Canadian Highway Bridge Design Code, which is a set of standards for bridge design and repair.

[iii] FPB audit report, February 2004, Audit of Forest Planning and Practices, Richmond Plywood Corporation Limited, Forest Licence A19243, http://www.fpb.gov.bc.ca/audits/ARC59/ARC59.pdf

[iv] FPB special report, July 2001, Bridge Maintenance not up to Code, http://www.fpb.gov.bc.ca/special/reports/SR05/Bridges%20report%20incl%20cover%20and%20isbn.pdf

[v] Forest Road Regulation, Section 11(1)

[vi] Forest Road Regulation, Section 12(1)

[vii] Forest Road Regulation, Section 12(1)(a)

[viii] Forest Road Regulation, Section 12(1)(b)(c)(d), 12(2)

[ix] BC MOF Engineering Manual May 2002, Chapter VIII – Administration of Forest Service Road Maintenance

[x] BC MOF, June 14, 2002, letter to licensees from (then) Assistant Deputy Minister Doug Konkin

[xi] http://www.for.gov.bc.ca/mof/plan/

[xii] BC Ministry of Forests Engineering Manual, May 2002, Chapter V – Road and Bridge Maintenance

[xiii] FRPA section 193

[xiv] Forest Planning and Practices Regulation, Section 72

[xv] Forest Planning and Practices Regulation, Section 75

[xvi] Forest Planning and Practices Regulation, Section 79(4)

[xvii] Forest Planning and Practices Regulation, Section 81