Golder Associates Ltd.

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January 22, 2008

07-1430-0130

Ministry of Transportation
231- 447 Columbia Street
Kamloops, BC
V2C 2T3

Attention: Mr. Brent Persello

RE: CULVERT ASSESSMENT, JIM AND LAJOIE CREEK CARPENTER LAKE, BC

Dear Sirs:

Golder Associates Ltd. (Golder) was retained by the Ministry of Transportation (MOT) to conduct a culvert inspection and site assessment at Lajoie Creek and Jim Creek, near Carpenter Lake. An assessment at both locations was requested by MOT to determine the condition of the culverts, assess the habitat upstream and downstream of the culvert, identify fish passage issues, and recommend potential replacement options for the stream crossing.

The scope of our assessment is limited to the biological and hydrologic issues only. It does not include geotechnical engineering, or the investigation, testing or assessment of the potential presence or impact of soil or groundwater contamination at these sites.

1.0 BACKGROUND

The main access road to Gun Lake crosses Lajoie Creek immediately downstream of the outlet of Lajoie Lake (Figure 1). In the past, the outlet channel has been blocked by small woody debris as a result of beaver activity each spring. Attempts to deter beavers and prevent blockage of the culvert by placing a heavy gauge screen at the outlet of Lajoie Lake upstream of the culvert crossing has resulted in woody debris accumulating on the surface of the screen. The blockage of the culvert has created potential fish migration

issues as well as channel, road, and property erosion problems downstream (Maricle, S (MOE). 2007. email to B. Persello (MOT), 29 June). The screen has adversely impacted the migration of adult salmonid, including bull trout (Maricle, S (MOE). 2007. email to B. Persello (MOT), 29 June).

Marshall Lake Road crosses Jim Creek, an inlet to Marshall Lake (Figure 1). The culvert crossing has repeatedly been washed out during freshet. Currently, the culvert is perched in excess of 1 m on the downstream end of the culvert, impeding salmonid fish migration upstream from Marshall Lake.

2.0 METHODOLOGY

On August 20, 2007, Tom Willms, a biologist in Golder's Kamloops office, conducted a one-day field culvert inspection and site assessment to gather information regarding site conditions and characteristics of the fish habitat. A fish assessment was not conducted. Representative photographs were taken with a digital camera. Recommendations for crossing options to improve the viability and longevity of the structures and restore habitat, in particular improve migration of salmonid species, are provided below.

On October 30, 2007, Chris Coles and Rudy Sung, water resource engineers in Golder's Abbotsford office, visited the site to evaluate the existing hydraulics of the Lajoie Creek crossing.

3.0 RESULTS AND DISCUSSION

3.1 Site Assessment

3.1.1 Jim Creek

There are two culverts at the Jim Creek crossing; the larger culvert has a diameter of 1070 mm while the smaller culvert is 620 mm in diameter (Photo 1). Jim Creek has an average channel width between approximately 3 and 4 m upstream of the culvert and between 5 and 6 m downstream of the culvert. Bank material was predominantly sand and gravel with some small cobble (Photo 2). Both banks are highly susceptible to erosion (Photo 3). Bed material at the crossing was predominantly cobble with gravel substrate as subdominant. Riparian vegetation consisted of mixed forest with shrub understorey. There is some spawning and rearing habitat available within the vicinity of

the crossing; however, the habitat is an important migration corridor. Overall, habitat within the vicinity of the culvert crossing was classified as important[1].

There is evidence of recent road washout mitigation such as fresh gravel and sand placed to repair the road (Photo 5). The culvert outlet is presently hanging 1.6 m above the surface of the water downstream of the crossing (Photos 4 and 6). There are private driveways adjacent to both sides of Jim Creek downstream of Marshall Road.

3.1.2 Lajoie Creek

The current culvert is approximately 30 m long and has a diameter of 850 mm (Photo 7 and 9). The culvert is located at the outlet of Lajoie Lake; thus the habitat upstream was primarily littoral (Photo 8 and 10). Bank material was predominantly gravels and sand with some fines. Downstream of the culvert the bed material was predominantly gravel and sand. The morphology downstream of the culvert was described as riffle pool with abundant functional large woody debris (Photos 11 and 12). Riparian vegetation consisted of primarily mixed forest with shrub understorey. Spawning and rearing habitat was observed downstream of the crossing. In addition, numerous salmonid fry were observed rearing upstream of the partially blocked culvert in Lajoie Lake. Overall, habitat within the vicinity of the culvert crossing was important. At present, salmonid passage is inhibited by the blockage of the metal gate installed upstream of the culvert (Photo 7).

The main access road to Gun Lake crosses Lajoie Creek immediately downstream of the outlet of Lajoie Lake. Adjacent to the road on the upstream side is a boat launch providing access to Lajoie Lake (Photo 8).

3.2 Recommendations

3.2.1 Jim Creek

The existing stream crossing constricts the stream channel, which has resulted in down cutting of the stream bed downstream of the crossing. Either a bridge or a large diameter (>3m) bottomless culvert is recommended for the Jim Creek crossing. A bridge would be favourable for maintaining channel characteristics, enabling and maintaining fish passage, and avoiding future washouts.

[1] Definition of important habitat is habitat that is used by fish for feeding, growth, and migration, but is not deemed to be critical. This category of habitat usually contains a large amount of similar habitat that is readily available to the stock (BC MOF 2002).

It is important to note that some small, arch-type structures installed on fish streams require excavation and reconstruction of the streambed and banks (BC MOF 2002). These arch-type open bottom structures should be considered as closed bottom structures (BC MOF 2002), when considering potential impacts to fish habitat. Closed bottom structures are not recommended for this location because of the gradient of the stream.

Considerable down cutting of the stream bed has occurred below the road crossing. Therefore, there will need to be instream work at the crossing to adjust the stream bed to a stable gradient and reduce the potential for head cutting after the constriction to the stream channel has been removed.

3.2.2 Lajoie Creek

Option 1 – Replace Existing Culvert

Installation of a clear-span bridge would be the preferred option to allow for a wider channel, which would reduce stream velocities aiding in fish passage and reduce the impact of beaver on local flooding. However, this may not be feasible because the width of the current right-of-way. The proposed structure would have to accommodate the road and adjacent boat launch which are approximately 30 m in width. The existing location of the boat launch would have to be incorporated into the design of the bridge. To reduce the width of the structure the feasibility of moving the boat launch to the left downstream bank should be investigated.

Replacing the existing undersized culvert with an appropriately sized open bottom culvert or bridge (i.e., a structure that is wide enough that the stream channel is not constricted) would provide fish passage and maintain channel characteristics downstream and reduce the probability of blockage by beaver activity. Pipe-arch culverts may be less prone than round culverts to being plugged by beavers, most likely because they maintain the natural stream width and are generally large culverts (Jensen et al. 1999). The study conducted by Jensen et al. (1999) concluded that 81% of the culvert sites measured, culvert size (area of inlet opening) was the major determinant of whether the pipe would be plugged by beavers (see attached). Use of a box or pipe-arch culvert with a minimum inlet opening area of 1.67 m^2 would have a 47% probability of being blocked, whereas an opening area of 3.53 m^2 would have a 25% probability of being plugged (Jensen et al. 1999). Similarly, installation of an oversized open bottom culvert may not be feasible because of the current width of the right-of-way including the boat launch.

Option 2 – Install Beaver Management Structures on Existing Culvert

The width of the road crossing, including the boat launch, is approximately 30 m; therefore, installation of a bridge or open bottom culvert may not be feasible. Maintaining the existing culvert and installing an improved beaver management structure is an alternate option. Attempts to address the problem of beavers obstructing the existing culvert, which can prevent fish migration and cause localized flooding of adjacent property, by trapping the beavers and more recently installation of a metal screen upstream of the culvert, have been largely unsuccessful as the current metal screen is repeatedly blocked by small woody debris.

Culvert screening devices can be considered for small, low gradient systems where frequent maintenance problems and protection of fish access is desirable (MOE 2001). A beaver baffler structure such as the "Beaver Stop"[2] includes a double walled wire cage assembly that is fastened to the upstream end of the culvert (MOE 2001). Several design and construction criteria that are recommended for optimum efficacy of the baffler structure include the following (MOE 2001):

- the cage should be sized to fit the appropriate culvert and protrude far enough from the end of the culvert, in order to remain submerged and to prevent the beaver from plugging the wire mesh;
- the cage should be constructed of a durable material that will provide service for a period of not less than that expected for the culvert;
- the cage should be suspended at least 0.5 m above the pond floor to deter anchoring of dam materials to the bed of the pond by the beaver;
- the wire mesh should have openings of about 150 mm, as this will allow fish passage but hinder attempts by the beaver to plug the gaps and should enclose the intake end; and
- the culvert and mesh assembly should be designed to withstand a 1:10 year storm event and sized to allow fish passage.

Although these structures reduce the frequency of maintenance visits, the need to maintain the culverts and occasional cleaning is still required.

[2] Beaver Stop, Distributed by DCP Consulting, Calgary, AB (MOE 2001)

The Beaver Stop structure is manufactured by FSI Culvert Inc. (FSI Culvert) in Prince George, BC. FSI Culvert recommends a 900 mm Beaver Stop (approximately $1,410.00) for the diameter of the culvert at Lajoie Creek. Installation is straight forward and would require two people and possibly a loader/backhoe and operator for no more than a days worth of work (www.fsiculvert.com).

Fencing techniques are not recommended because of the littoral habitat upstream of the culvert. Generally, fencing is designed to safely and effectively exclude beaver from accessing upland vegetation while maintaining unrestricted stream flows (MOE 2001).

Option 3 – Install Beaver Management Structures on Existing Culvert and Installation of a Second Culvert

In addition to the installation of the beaver baffler structure such as the Beaver Stop on the existing culvert, installation of a second culvert is proposed to allow extra time for a works crew to respond to rising lake levels caused by blockage of the existing culvert. The second culvert should be appropriately sized to convey the discharge from Lajoie Lake in the event of blockage of the existing culvert. The second culvert should be installed with a higher invert elevation than the existing culvert. The culvert should be installed as high as possible giving consideration for minimum cover requirements for the culvert and any other geographically low features around the lake that may be flooded as a result of blockage of the existing culvert.

4.0 MITIGATION MEASURES AND BEST MANAGEMENT PRACTICES

To protect fish habitat (either in the stream being crossed or in downstream fish bearing stream) and to prevent degradation of water quality following construction, mitigation measures and best management practices should be incorporated into the design and construction of the crossing options implemented at each crossing. An Environmental Protection Plan (EPP) should be prepared prior to construction and would include measures to reduce and minimize adverse effects to the environment during construction, including fish and fish habitat. For example, the EPP should include, but not be limited to, an erosion and sediment control plan. In addition, the applicable regulatory agencies must be notified and the necessary approvals and permits obtained before construction proceeds at Jim Creek and Lajoie Creek crossings. In 2006, DFO developed Operational Statements (OS) that include an OS for the construction of clear-span bridges (Attachment). If the project can meet or exceed the Clear-Span Bridge Operational Statement requirements then DFO's habitat protection requirements will be satisfied.

The applicable regulatory agencies must be notified and the necessary approvals and permits obtained before construction proceeds at Jim and Lajoie creek crossings. Notification is recommended as soon as possible to prevent delays in the commencement of the project. The following approvals and permits may be required:

- *Fisheries Act* Section 35(2) Authorization;
- *Navigable Waters Protection Act* Approval; and
- *Water Act* Section 9 Approval.

5.0 CONCLUSIONS

Based on results of the site assessment of the culvert crossing at the Jim Creek and Marshall Lake Road crossing, construction of a bridge is the favourable replacement option for maintaining channel characteristics, enabling and maintaining fish passage, and avoiding future washouts. A site assessment was conducted at the Lajoie Creek culvert crossing immediately downstream of Lajoie Lake to evaluate site conditions, characteristics of fish habitat, and existing hydraulics. Three replacement options were proposed, including replacing the existing culvert, installing beaver management structures on the existing culvert, or installing beaver management structures on the existing culvert and installation of a second culvert. Installation of a beaver management structure such as the "Beaver Stop" on the existing culvert is the favourable option. In addition, installation of a second culvert is warranted. In the event that the option to construct a second culvert is selected, Golder would be pleased to provide MOT with a cost estimate and work plan to provide detailed drawings with the appropriate size of culvert to be installed.

6.0 CLOSURE

We trust the information presented in this report meets your current requirements. Should you have any questions or concerns, please do not hesitate to contact Golder.

Yours truly,

GOLDER ASSOCIATES LTD.

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NE/RS/JDH/PM/mp

Attachments Figure 1 Key Plan
Photos 1 to 12
Small Clear-Span Bridges Operational Statement
Managing Nuisance Beavers Along Roadsides, A Guide for Highway Departments (Jensen et al 1999)

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7.0 REFERENCES

Jensen, P.G., P.D. Curtis, and D.L. Hamelin. 2001. Managing Nuisance Beavers Along Roadsides, A Guide For Highway Departments. A Cornell Cooperative Extension Publication, Ithaca, NY. 14 p.

Ministry of Environment, Lands and Parks, Vancouver Island Region (MOE). 2001. Beaver Management Guidelines – DRAFT, Version 1, May 10, 2001.

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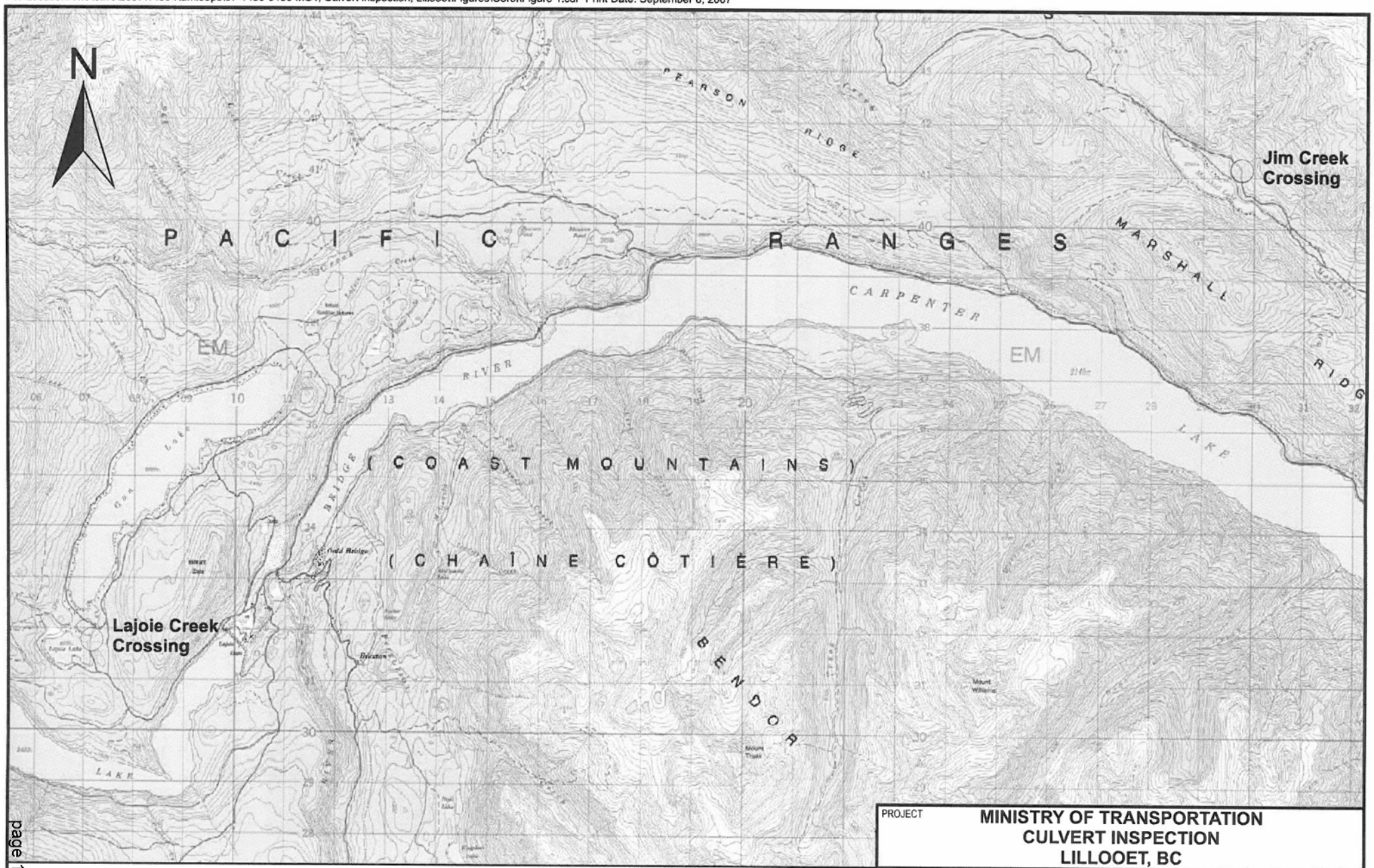

PROJECT
MINISTRY OF TRANSPORTATION
CULVERT INSPECTION
LILLOOET, BC

TITLE
KEY PLAN

0 1,000 2,000 3,000 4,000
Scale: 1:100,000 Metres

REFERENCE
Base mapping from ETOPO 1:50,000 NTS mapsheet 92J/15.

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PROJECT No. 07-1430-0130			FILE No. PLAN	
DESIGN	NE	6-Sep-07	SCALE AS SHOWN	REV.
CADD	BL	6-Sep-07	**FIGURE 1**	
CHECK	NE	6-Sep-07		
REVIEW	DH	6-Sep-07		

Photo 1: View of culvert crossing on Jim Creek looking upstream, 20 August 2007.

Photo 2: View of channel and habitat characteristics of Jim Creek downstream of the culvert crossing, 20 August 2007.

SELECTED SITE PHOTOGRAPHS

Golder Associates
Kamloops, BC

PROJECT No. 07-1430-0130			SCALE: None	REV. 0
DRAWN	NE	Sep 7, 2007	PLATE 1	
CHECK	NE	Sep 7, 2007		
REVIEW	DH	Sep 7, 2007		

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Photo 3: View of eroding left downstream bank downstream of the culvert crossing on Jim Creek, 20 August 2007.

Photo 4: View of hanging culvert at Jim Creek crossing, 20 August 2007.

SELECTED SITE PHOTOGRAPHS

Golder Associates
Kamloops, BC

PROJECT No. 07-1430-0130			SCALE: None	REV. 0
DRAWN	NE	Sep 7, 2007	PLATE 2	
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Photo 5: View of culverts upstream of road crossing on Jim Creek, 20 August 2007.

Photo 6: View of hanging culvert at Jim Creek crossing, 20 August 2007.

SELECTED SITE PHOTOGRAPHS

Golder Associates
Kamloops, BC

PROJECT No. 07-1430-0130			SCALE: None	REV. 0
DRAWN	NE	Sep 7, 2007	PLATE 3	
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Photo 7: View of culvert with wire grate at the outlet to Lajoie Lake, 20 August 2007.

Photo 8: View of boat launch adjacent to upstream end of culvert and road crossing, 20 August 2007.

SELECTED SITE PHOTOGRAPHS

Golder Associates
Kamloops, BC

PROJECT No. 07-1430-0130			SCALE: None	REV. 0
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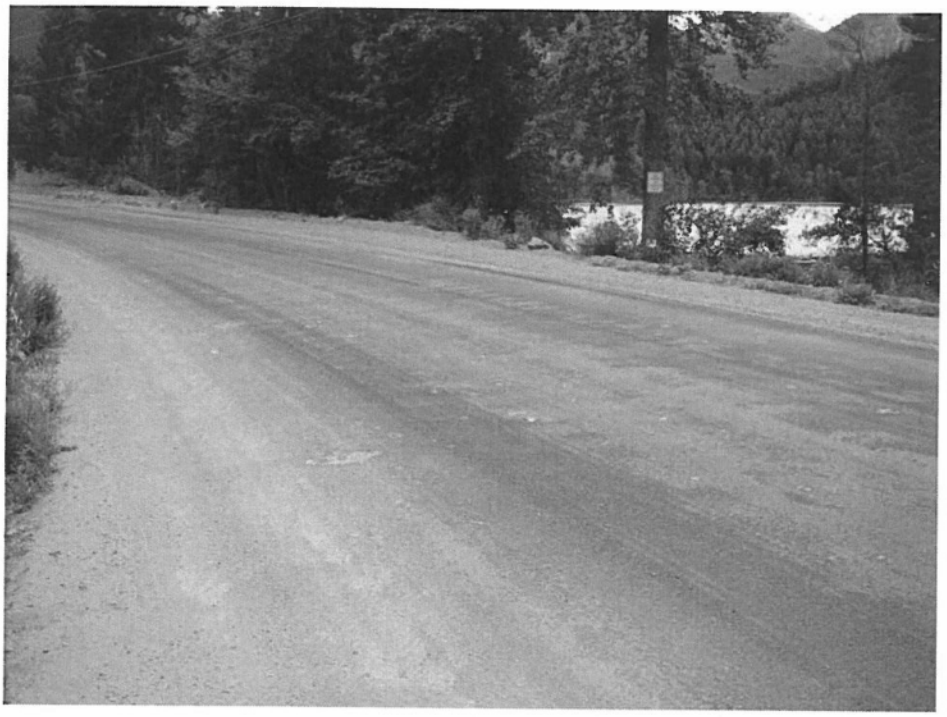

Photo 9: View of road crossing with Lajoie Lake and boat launch in background, 20 August 2007.

Photo 10: View of culvert downstream of road crossing, 20 August 2007.

SELECTED SITE PHOTOGRAPHS

Golder Associates
Kamloops, BC

PROJECT No. 07-1430-0130			SCALE: None	REV. 0
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PLATE 5

Photo 11: View of habitat characteristics of Lajoie Creek downstream of culvert crossing, 20 August 2007.

Photo 12: View of habitat characteristics of Lajoie Creek downstream of culvert crossing, 20 August 2007.

SELECTED SITE PHOTOGRAPHS

Golder Associates Kamloops, BC	PROJECT No. 07-1430-0130		SCALE: None	REV. 0
	DRAWN	NE	Sep 7, 2007	PLATE 6
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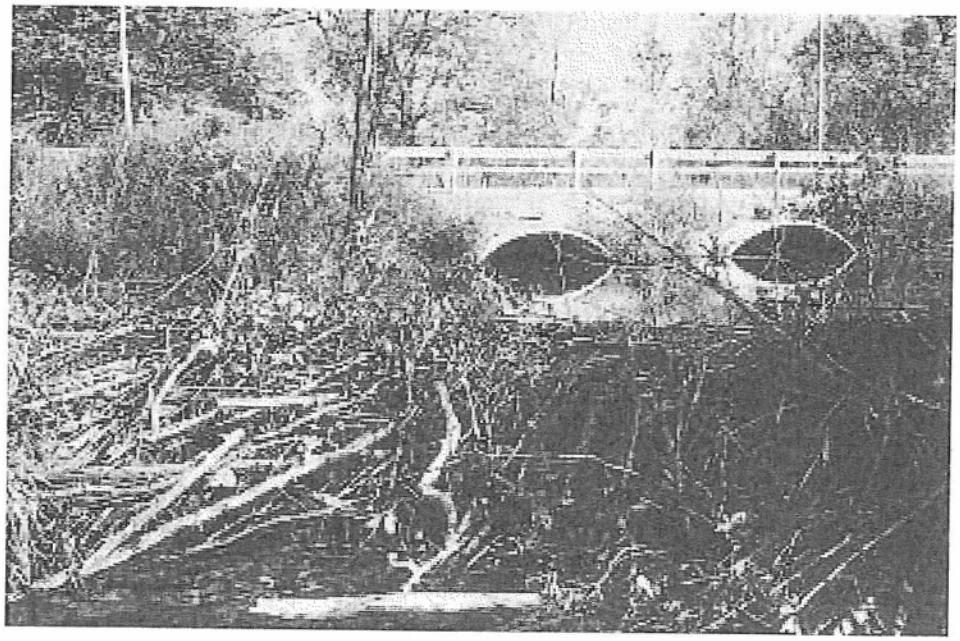
Managing Nuisance Beavers Along Roadsides

A Guide for Highway Departments



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