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# Engineering Manual

Revision Date: December 22, 2016

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**Engineering Branch**

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## Preface

The 2009 version of the Engineering Manual (Manual) is a document intended for internal use by Ministry of Forests, Lands and Natural Resource Operations staff. The Manual underwent a detailed review through a collaborative effort of operational district, regional, branch and BCTS (including the Access Working Group) staff. All those that contributed to the revised Manual are to be commended for their attention to detail and perseverance.

Although the Engineering Manual is accessible to the public, it is intended for internal staff use. The Manual is a primary reference for Ministry of Forests, Lands and Natural Resource Operations operational engineering practices and administration. The Manual can also be considered a training and succession tool. It provides mandatory procedures, a *Forest and Range Practices Act* focus on safety (for more comprehensive guidance on expected safety or other business related protocols staff must be guided by their applicable safety procedures in addition to this manual), and due diligence (implementing best practices), related to road and bridge administration, design, construction, maintenance and deactivation works funded by the Ministry of Forest, Lands and Natural Resource Operations (FLNR), in the form of:

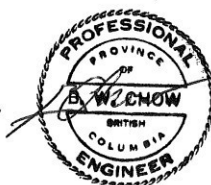
- policy direction on implementation of legislation and regulations
- mandatory procedures;
- project checklists;
- business practices for and administration of forest roads on behalf of government;
- best practice technical and professional practices throughout FLNR;
- professional reliance; and
- recommended technical, professional and administrative applications.

As with any such policy, procedures and best practices, in exceptional situations where the implementation of a policy, procedure or practice will not result in achieving the expected result, the local decision maker could vary the practice for that specific application. In such cases, the rationale for variation should be clearly documented.

The Engineering Manual is a “living document” and will be regularly reviewed and continually improved. The responsibility for maintaining and updating the manual rests with the Ministry of Forests, Lands and Natural Resource Operations Chief Engineer. This Manual is an electronic document and, as such, changes can be made efficiently and in a timely manner as regulations, policies and practices evolve. As an electronic document, it provides linkages to external sources within the context of individual topics. As such, the users must recognize that any printed text out of this Manual must be considered for short term use only so as not to risk their information becoming outdated due to subsequent amendments on-line.



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Chief Engineer



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# 1. Road Administration

## 1.1 Introduction

This chapter deals with all aspects of establishing and administering forest roads by Timber Sales Managers (TSMs) and District Managers, including Forest Service Roads (FSRs), permit roads, and roads established by Special Use Permit (SUP). The chapter also provides information on forest road management, transfer, closure, and signage.

## 1.2 Policy

The responsibilities and practices for administering a forest road will be clear and transparent for those activities carried out on the road right-of-way, from establishment to discontinuation and closure.

## 1.3 Mandatory Procedures and Best Practices

For the majority of road administration issues, this chapter provides guidance and direction to BC Timber Sales, Timber Operations and Pricing to ensure that an industrial user is able to obtain the necessary permits for their road use, or is able to be relieved of the obligations of a permit upon the completion of their use. Much of the due diligence on the part of BC Timber Sales, Timber Operations and Pricing staff relates to providing timely actions to issue or cancel permits, and ensuring that necessary information is contained in the permits being issued. Following is a table that summarizes in chronological order the mandatory procedures and best practices with respect to the administration of forest roads. Links are provided to direct the reader to the location in the manual text where the tabular item is discussed.

**Table 1-1 Road Administration**

Mandatory Procedures and Best Practices <sup>1</sup>	
Results to be achieved:	
<ul style="list-style-type: none"> <li>issuing authorities for industrial road use (Forest Act s. <a href="#">115-121</a>)</li> <li>for non-industrial use of an FSR, protecting against damage, sediment delivery or endangerment to property, health or safety (FRPA s. <a href="#">22.1</a>, <a href="#">22.2</a>; Forest Service Road Use Regulation s. <a href="#">6</a>, <a href="#">9</a>, <a href="#">10</a>, <a href="#">11</a>; Land Title Act Regulation section <a href="#">15</a>)</li> <li>consent to connect to an FSR (FRPA s. <a href="#">23</a>)</li> </ul>	
B1.	Limit activities on non-status roads to minimizing any site-specific risks (to users or the environment) that come to the attention of the TSM/District Manager. [see <a href="#">Types of Roads</a> ]
B2.	When acquiring legal access, ensure that FLNR Forest Land Acquisitions is consulted early in the process and are involved in negotiating appropriate compensation for the land and improvements, which is based on fair market value [see <a href="#">Legal Access</a> ]. Compensation value estimates are to be documented and defensible.
M1.	The status or clearance width for both FSRs and road permit roads <b>must</b> be 75 m (37.5 m each side of the proposed centreline of the road) [see <a href="#">Road Status</a> ]

<p>B3. When including dumps, drop sites, and service landings in a Road Permit, ensure that the permittee provides, for each one</p> <ul style="list-style-type: none"> <li>• its location and size,</li> <li>• how long it will be needed for use, and</li> <li>• a reclamation prescription for the site.</li> </ul> <p>[see <a href="#">Road Permit</a>]</p>
<p>B4. Ensure that a Road Use Permit:</p> <ul style="list-style-type: none"> <li>• limits the weights and sizes of vehicles, when necessary;</li> <li>• controls seasonal use;</li> <li>• provides indemnification to the Crown for the permittee's actions;</li> <li>• provides deposits for works near utilities such as private railway crossings, or in other situations to indemnify the Crown against any damages or losses the Crown might suffer; and</li> <li>• identifies maintenance responsibility for the road or road section.</li> </ul> <p>[see <a href="#">Issuing</a>]</p>
<p>B5. Before the Road Use Permit of the designated maintained is cancelled, ensure that the road has been maintained to the level required for non-industrial use, to the extent necessary to ensure there is no material adverse effect on a forest resource use, as evidenced by:</p> <ul style="list-style-type: none"> <li>• structural integrity of the road prism and clearing width are protected; and</li> <li>• drainage systems of the road are functional.</li> </ul> <p>[see <a href="#">Cancel</a>]</p>
<p><b>M2.</b> Except where an industrial user has been delegated responsibility for maintenance under a Road Use Permit, BCTS <b>must</b> be responsible for ensuring that maintenance is carried out on those FSRs that:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> BCTS (or its predecessor, the Small Business Forest Enterprise Program [SBFEP]) has constructed or established since the inception of the program; or</li> <li><input type="checkbox"/> BCTS has not constructed or established, but will be using exclusively for industrial purposes</li> <li><input type="checkbox"/> there has been no agreement with Timber Pricing and Operations Division to shift the responsibility back to the District Manager</li> </ul> <p>[see <a href="#">Administration</a>]</p>
<p>B6. Ensure that any surface maintenance of an FSR undertaken by a commercial or public user is authorized by a <a href="#">Forest Service Roads Maintenance Agreement (FS 1205)</a> [see <a href="#">Entering</a>]</p>
<p><b>M3.</b> Any non-transportation-related works (facilities) constructed within an FSR right-of-way <b>must</b> be authorized by a <a href="#">Works Permit (NRS 103)</a>. [see <a href="#">Issuing Works Permits</a>]</p>
<p><b>M4.</b> All traffic control signs used on Forest Service rights-of-way <b>must</b> conform to Ministry of Transportation and Infrastructure standards, if those standards include a sign to deal with the traffic control issue. [see <a href="#">Signs</a>]</p>
<p>B.7 Ensure that a TSM/District Manager authorizes any connection to an FSR [see <a href="#">Road Junctions</a>]</p>
<p>B8. When reviewing a request for subdivision access from an FSR, ensure that the road is built to a sufficient standard to safely handle the type and volume of traffic [see <a href="#">Subdivisions</a>]</p>
<p><b>M5.</b> FSRs that are surplus to the requirements of BC Timber Sales, Timber Operations and Pricing, as determined through some local access planning process, carried out by the District Manager, <b>must</b> be permanently closed as an FSR by the District Manager following deactivation by Timber Pricing and Operations Division/BCTS or preceding transfer by the District Manager through either deactivation or transfer to another user or agency [see <a href="#">Discontinuing and Closing FSRs</a>]</p>
<p>B9. Ensure that a licensee deactivates a road permit road when:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> there is no apparent future industrial use for the road;</li> <li><input type="checkbox"/> no other party is able or willing to assume responsibility for the road after the Road Permit is cancelled; and</li> <li><input type="checkbox"/> the District Manager determines that the road will not be required for ongoing public access.</li> </ul> <p>[see <a href="#">Cancelling</a>]</p>

**M6.** When a TSM/District Manager agrees with a licensee that the latter no longer needs a road permit road, confirms that there are no other industrial users that currently require the road, and decides that the road should not be deactivated, the TSM/District Manager ***must***:

- cancel the Road Permit; and
- declare the road to be an FSR.

[see [DeclaringFSRs](#)]

In the above table of chronological events:

Mandatory Procedures are marked



and Best Practices are marked



## 1.4 Types of Roads and Applicable Permits or Authorizations

Several categories of resource roads can be built or established under the [Forest Act](#) or the [Forest and Range Practices Act](#). Note that non-status roads (roads without tenure from the ministry or other agencies) are not within the jurisdiction or responsibility of the Ministry of Forests, Lands and Natural Resource Operations except where the ministry is required to take action as an agent of the province. In these cases, limit activities on non-status roads to minimizing any site-specific risks (to users or the environment) that come to the attention of the TSM/District Manager. Restoring access is not an acceptable objective of any such work.

### 1.4.1 Forest Service Roads

A Forest Service Road (FSR) is one that is defined under the [Forest Act \(Sec. 1\)](#). TSMs/District Managers administer FSRs, and ensure that maintenance is carried out on them until the roads are either transferred to another jurisdiction or deactivated and discontinued and closed.

**Table 1-2 Responsibility matrix for administering FSRs**

Task	Timber Sales Manager	District Manager
Establishment of FSR	yes	yes
Declaration of FSR	yes	yes
Maintenance of FSR	yes	yes
Consent to connect to FSR	yes	yes
Issuing of Road Use Permit	no	yes
Issuing of Works Permit	no	yes
Entering into FSR Maintenance Agreement	no	yes

Task	Timber Sales Manager	District Manager
Discontinuation and closure	no	yes
Transfer of FSR	no	yes

## Declaring FSRs

When a licensee no longer needs a road permit road, and the TSM/District Manager confirms that there are no other industrial users to issue a road permit, and decides that the road should not be deactivated, the TSM/District Manager **must**:

- cancel the Road Permit; and
- declare the road to be an FSR.

The purpose of this “declaration” is to ensure that the road will be properly inspected and maintained until such time that a new industrial user is issued a Road Use Permit. Prior to declaration, inspect the road or road section that will become the FSR to:

- determine the present condition of the road and any structures;
- identify potential risks; and
- obtain the necessary data for the appropriate bridge register and road management system.

**Note:** The declaration process applies only to converting road permit roads.

Once the above steps have been taken, complete the [Declaration of Forest Service Road \(FS 302\)](#) form and attach an electronic version of the map/plan.

Signing the electronic form finalizes the decision to declare the road as an FSR, and the local office can proceed with any operational activities as though the road was an FSR, even if the new map notations have not yet been completed.

## Administration of Existing FSRs

The District Manager or the Timber Sales Manager is responsible for the maintenance of existing FSRs, except where an industrial user has been delegated responsibility for maintenance under a Road Use Permit. Unless the two managers have agreed otherwise for individual roads or BCTS no longer needs the road for future harvesting, BC Timber Sales (BCTS) **must** be responsible for ensuring that maintenance is carried out on those FSRs that:

- BCTS [or its predecessor, the Small Business Forest Enterprise Program (SBFEP)] has constructed or established since the inception of the program; or

- BCTS has not constructed or established, but will be using exclusively for industrial purposes;

and, for any FSRs that do not meet these criteria, Timber Operations and Pricing Division is responsible for ensuring that maintenance is carried out.

Negotiate the administrative responsibilities at the local level between the District Manager and TSM on an annual basis in situations where:

- multiple industrial users (both major and timber sale licensees) are operating on an FSR;
- the primary user designated to carry out the road maintenance (under Road Use Permit) changes;
- the industrial use is seasonal in nature and it is not obvious who should be designated responsible for the ongoing FSR maintenance; or
- the road use includes a mix of commercial operators, rural residents, and recreational access.

Consider the following when negotiating the administrative responsibility for FSRs:

- whether the road in question provides access to communities (in this case, the long-term responsibility would be that of Timber Operations and Pricing Division);
- the future use of the area by BCTS or others;
- the current level and type of industrial use (including other non-forest related industrial users); and
- whether the access is currently required to reach residences, cabins, commercial operations, parks or recreation sites (in this case, the long-term responsibility would be that of Timber Operations and Pricing Division).

Once the TSM has determined that BCTS will no longer need an FSR for future harvesting, report this to the District Manager, for determining whether:

- the road should be deactivated by BCTS; or
- the responsibility for its administration should be shifted to Timber Operations and Pricing Division.

Also, small-scale salvage operations are not considered to be representative of operations that alone would generate future maintenance responsibilities for BCTS. These salvage operations are not tied to one program, but “piggy-back” on any regular harvesting operations.



### ***Issuing Road Use Permits***

All industrial users on an FSR are required to obtain a [Road Use Permit \(FS 102\)](#), unless an exemption is granted in accordance with section [22.1 \(4\)](#) of *FRPA*. Road Use Permits, including those Road Use Permits required by BCTS licensees, are issued by the District Manager. Ensure that the proposed use will not adversely affect other authorized users of the road, and that the permit:

- limits the weights and sizes of vehicles, when necessary;
- controls seasonal use;
- provides indemnification to the Crown for the permittee's actions;
- provides deposits for works near utilities such as private railway crossings, or in other situations to indemnify the Crown against any damages or losses the Crown might suffer; and
- identifies maintenance responsibility for the road or road section.

Designate only one Road Use Permit holder to be responsible for carrying out all maintenance operations on a road or road section. However, other Road Use Permit holders are expected to contribute a reasonable amount to the expense of maintaining the road [Forest Planning and Practices Regulation ([Sec. 79](#))].

Track the issuance and administration of Road Use Permits in a ledger (such as FRMA) and record:

- the identity of the RUP holders;
- the identity of the maintainer;
- the termination of any RUPs and/or the conclusion of any maintenance responsibilities.

Ensure that the process for shared maintenance of an FSR described in [Appendix 1.2](#) is applied where the process in place on a given road is not suitable for one or more of the parties expected to share the maintenance costs.

In addition, any disputes between road users for maintenance can be resolved by a third party or through a more formal process, such as the [Commercial Arbitration Act](#). The District Manager is not responsible for resolving disputes, but may provide that service in any case if all parties agree.

Road maintenance includes any activity such as routine maintenance, road upgrading, or repair or replacement of structures that is carried out until the FSR is deactivated. Refer to Chapter 6 of this manual for details of road and structure inspection and maintenance.

### ***Issuing Works Permits***

Any non-transportation-related works (facilities) constructed within an FSR right-of-way ***must*** be authorized by a [Works Permit \(NRS 103\)](#). Examples include

water,

gas, hydro, or telephone line works. The Works Permit does not authorize road works or the harvesting of timber, nor does it convey tenure to any part of the right-of-way other than to permit the facilities to remain in place.

### ***Entering into FSR Maintenance Agreements***

For situations where the wilderness level of maintenance is not sufficient for a commercial or public user, that user may elect to undertake some or all of the surface maintenance of the FSR as authorized by the [Forest Service Road Maintenance Agreement \(FS 1205\)](#). The agreement authorizes the end user to carry out incremental maintenance on FSRs at no cost to the ministry. The works envisioned under this agreement are routine in nature. FSR Maintenance Agreements are issued by District Managers, including any proposed non-industrial maintenance proposed for FSRs that are administered by BCTS.

### ***Discontinuing and Closing FSRs***

FSRs that are determined to be surplus to the requirements of the ministry, according to current budgetary requirements and as determined through some local access planning process carried out by the District Manager, ***must*** be discontinued and closed as an FSR by the District Manager following deactivation or preceding transfer by the District Manager (delegated to Director of Forest Tenures) to another user or agency, in keeping with the [Forest Act \[Sec. 121 \(9\)\]](#) and as delegated from the minister.

To declare an FSR discontinued and closed once it has been deactivated, or once it has been determined that another tenure will be established over the road, the District Manager ***must*** complete and sign an [FSR Discontinue and Close Form \(FS 301\)](#), and attach the Exhibit A. Forward a copy of the completed FSR Discontinue and Close Form (FS 301) with attachments to the FLNR Forest Land Acquisitions Group, Forest Tenures Branch in Victoria to ensure FSR project history remains current.

In accordance with the [Forest Act \[Sec. 121 \(9\)\]](#), notification of FSR discontinuance and closures ***must*** occur and shall be at the discretion of the District Manager (as delegated from the minister), depending upon scale and location of the FSR as per the 2012 FLNR policy called [Discontinue and Close Forest Service Roads Notification](#). In accordance with that policy, the methods and dates of notification must be recorded on the [FSR Discontinue and Close Form \(FS 301\)](#).

Notification should be done a minimum of three (3) months prior to the FSR closure unless ecological, environmental or public safety circumstances dictate otherwise.

Once the District Manager signs the FSR Discontinue and Close Form (FS 301), proceed with any administrative activities, such as transfer to the



BC Ministry of Transportation and Infrastructure (BCMoT) or to a tenure holder, as though the road is not an FSR any longer, even if new map notations have not yet been completed.

### ***Transferring FSRs to BCMoT***

For those instances where BCMoT wishes to take over administrative responsibility of an FSR as per the [Forest Act \[Sec. 121 \(9\) \(c\)\]](#), the next step, after reaching agreement in principle with the local BCMoT manager, is to involve the FLNR Forest Land Acquisitions Group, Forest Tenures Branch in Victoria to arrange for the delegated authority of each ministry to execute the assignment. Prior to the final execution of the assignment, the District Manager ***must*** declare the FSR discontinued and closed by completing and signing an [FSR Discontinue and Close Form \(FS 301\)](#).

### ***Transferring Public Highways to FLNR***

For those instances where FLNR wishes to take over administrative responsibility of a public highway there are currently two methods available, after reaching agreement in principle with the local BCMoT manager ***and*** the District Manager:

- **Method 1** – transfer the public road as per the [Land Act \[Sec. 106\]](#) in consultation with Forest Land Acquisitions Group, Forest Tenures Branch.
- **Method 2** – obtain the survey of the public road, or survey the public road, and contact FLNR Forest Land Acquisitions Group, Forest Tenures Branch in Victoria to submit the necessary land transfer in the provincial Land Title System. Authority has been delegated to the respective directors at FLNR Forest Tenures Branch and BCMoT Properties and Land Management Branch. This may involve the payment of property transfer taxes.

District staff would then proceed with the FSR establishment process.

## **1.4.2 Road Permit Roads**

Road permit roads are roads built, used, and maintained by timber licensees under a [BCTS Road Permit \(FS 582\)](#) or a [Major Licensee Road Permit \(FS 582\)](#). Both of those permits are issued to a harvesting license holder [see [Forest Act \(Sec. 115 and Sec. 121\)](#)]. Such roads usually connect cutblocks and tie harvesting areas to FSRs, public highways or log dumps, but may also include on-block roads that are built before a Cutting Permit is issued. Other industrial users are expected to contribute a reasonable amount to the expense of maintaining the road [[Forest and Range Practices Act \[Sec. 22.3 \(1\) and \(2\)\]](#)].

Optionally, grant an exemption for the use of the road in accordance with the Act ([Forest Planning and Practices Regulation section 79.1](#)).

A road is defined in the [Forest Planning and Practices Regulation \(Sec.1\)](#) as including landings. Therefore, in addition to the usual temporary landings authorized for harvesting the right-of-way timber, it is acceptable for a road permit to also authorize the upland portion of log dumps, helicopter drop sites, and helicopter service landings. However, when including such dumps, drop sites, and service landings in a Road Permit, ensure that the permittee provides, for each one:

- its location and size;
- how long it will be needed for use; and
- a reclamation prescription for the site.

### **BCTS Road Permits**

Within the [BCTS Road Permit \(FS 582\)](#), the Schedule R provides for both:

- roads constructed, maintained, and deactivated by the Timber Sale Licence holder; and
- roads constructed and maintained by the Timber Sale Licence holder, but not deactivated by the holder.

Construction and maintenance specifications are included in Schedule R and form contractual requirements. Construction specifications are either:

- General Construction Specifications – form fields on the schedule are filled in for such details as design vehicle load, road width, and road alignment; or
- Detailed Construction Specifications – road design drawings, such as plan profiles, are included as part of the package.

Maintenance specifications are divided into two sets of requirements:

- those concerning the maintenance of roads during operations—this maintenance is intended to protect the road from damage (such as from erosion and from debris at culvert inlets); and
- those concerning works and repairs once operations are complete—these works are intended to put the roads in shape when the Timber Sale Licence expires.

#### **1.4.3 Cutting Permit Roads**

A cutting permit road is one authorized by a Cutting Permit (or by a license that does not have Cutting Permits). Such permits are only used on roads that are wholly contained within a cutblock. The one exception to this requirement is for roads constructed under a Woodlot Licence: all roads in that case can be authorized by a Cutting Permit, including those outside a specific cutblock. Other industrial users are expected to contribute a reasonable amount to the expense of maintaining the road [*Forest and Range Practices Act*, Sec. [22.3 \(1\) and \(2\)](#)].

#### 1.4.4 Special Use Permit Roads

Under the Provincial Forest Use Regulation, a [Special Use Permit \(FS 998A\)](#) is issued by a District Manager for the construction and maintenance of a road for non-forest use, including construction and maintenance of bridges and other drainage structures for non-forest use. Currently, these roads are normally restricted to mining operations outside a claim area, but other resource uses can be contemplated where another agency is not in a position to issue tenure over the road.

### 1.5 Road Establishment

#### 1.5.1 Road Status

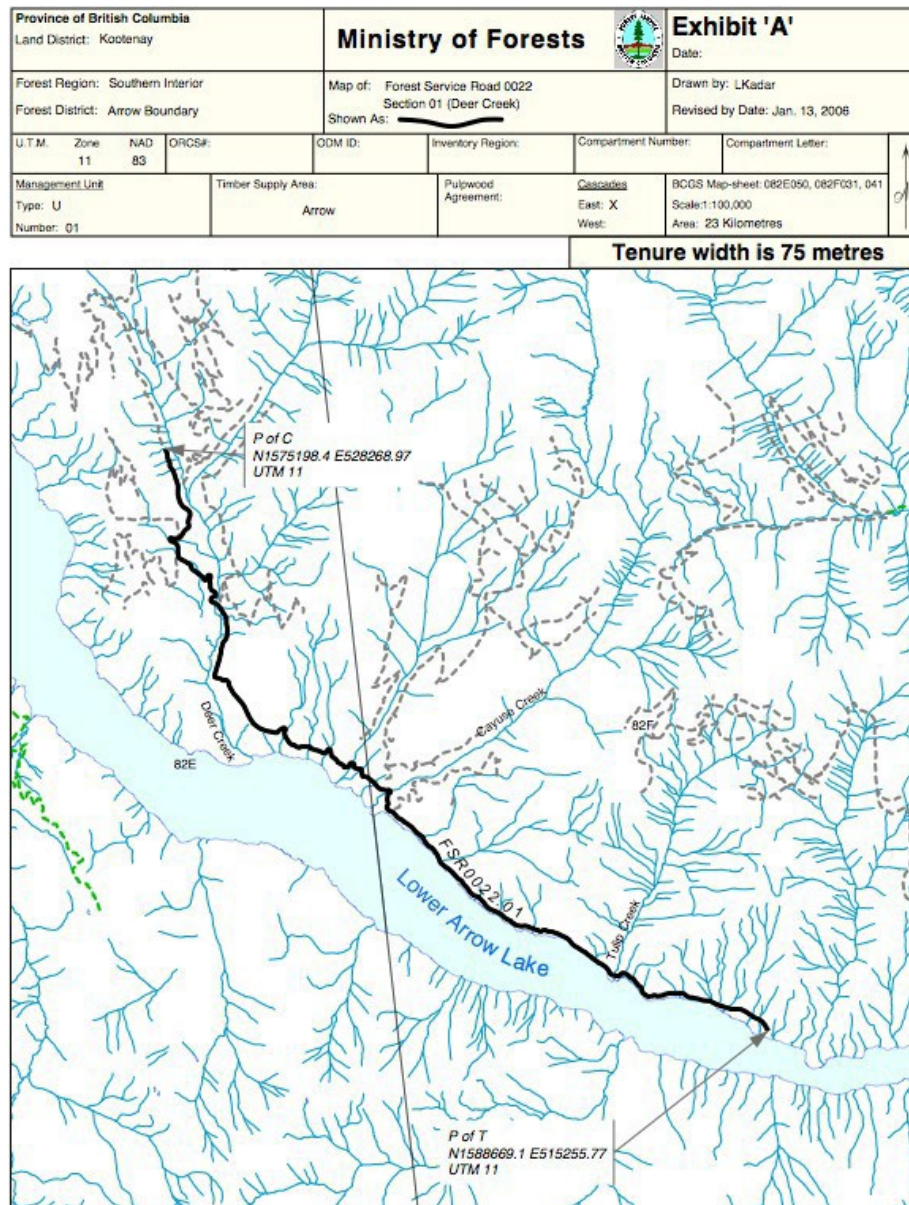
##### Preparing Road Status Requests

When a new FSR or road permit road is required, or when an existing non-status road is to be established as an FSR or road permit road, some basic information is needed to move the decision forward to implementation. To identify what interests or rights that may exist and to establish a registered interest over the land, carry out a road status (adjudication report). The status or clearance width for both FSRs and road permit roads *must* be 75 m (37.5 m each side of the proposed centreline of the road), which is also the width of the FSR right-of-way and the width of the Road Permit. When preparing a status request, ensure that:

- the proposed or actual road route has been plotted on the area reference map and an [Exhibit “A” sketch](#) produced;
- a status of the route shown on the Exhibit “A” sketch has been performed and all file or other reference numbers recorded;
- each file or other reference number has been investigated to determine if any tenures have been issued;
- copies of all tenure documents have been obtained and examined to determine if a conflict between the tenure rights and the proposed road location exists; and
- negotiations with tenure holders have been conducted and the agreement of the tenure holder obtained before road use or construction begins.



Figure 1-1 Exhibit "A" sketch



### Road Status and Resolving Road Status Conflicts

Road establishment involves identifying appropriate road location, “clearing” such road routes, and issuing appropriate authorization to physically construct the road. Appropriate status and clearance procedures are key to avoiding conflicts, including possible legal action with other authorized tenure holders.

### Status Procedure

The status process involves plotting the selected road route and file reference number on a digitized reference map. This updates the reference map so that other



potential tenure holders are aware of the *prior rights* of the applicant. It also provides a report of existing tenures on or within 37.5 m each side of the centreline of the road.

### ***ClearanceProcedure***

The adjudication report is actually a report of file numbers and legal descriptions related to tenure and other land use activities assigned by various resource agencies. In order to complete the clearance process, research all file numbers and legal descriptions in the land information systems [e.g., Tantalus (Gator)] to determine whether any conflicts exist and, if so, their nature. Determine whether a tenure has been issued or is pending, and whether the tenure area and tenure rights conflict with those about to be granted to the road applicant. Where conflicts do exist, resolve them before the road is constructed and used. Conflicts may arise with SUPs, mineral claims, Indian Reserves, leaseholds and private property.

### **Resolving Conflicts with Mineral Claims**

Where pits and quarries are identified for the purposes of Forest Service Road (FSR) building and maintenance, establish a [Forest Act](#) map notation or [Land Act](#) reserve (plus a mineral staking reserve in the case of rock quarries, or placer staking reserve in the case of gravel pits located in placer mining areas) to prevent future tenures being issued under the [Mineral Tenures Act \(Sec. 22\)](#). The first step is to consult the regional [Gold Commissioners and Coal Administrators](#) to check for recently issued mineral tenures or to request a mineral staking reserve.

If proposed operations are to take place adjacent to a mineral, placer, or other tenure—and so possibly interfere with the tenure holder’s rights—consult the tenure holder before operations take place.

- If the proposed operating area is in conflict with a mineral, placer, or other tenure and operations will still proceed, seek consent from the tenure holder to surrender rights to the proposed operating area. Document such consent (for amending a mineral or placer claim, confirmed with a quit claim from the mineral claim holder). Ensure that the tenure area is amended before operations begin. Protect operations in such amended areas by a staking reserve, as above.
- If consent cannot be obtained, relocate the gravel pit or quarry. If it is not possible to do this and the consent of the tenure holder cannot be obtained, consult with FLNR Forest Land Acquisitions for advice on arbitration procedures, as provided for in the *Mineral Tenure Act* or other relevant Acts.

## **1.5.2 Legal Access for FSRs**

Through the planning process, decide whether the access requirements related to the establishment of an FSR are of a temporary or permanent nature (long term).

When acquiring legal access, ensure that FLNR Forest Land Acquisitions negotiates appropriate compensation for the land and improvements, which is based on fair market value.

To initiate the acquisition, complete a Right-of-Way Acquisition Request (FS 959A) form, and submit it using the Shana forms located on the ministry's forms directory. Time is of the essence when requesting a right-of-way, as negotiating compensation and providing the legal survey can be time consuming.

Where access is required for a limited period of time, consider the use of a temporary statutory right-of-way agreement (Guidelines for Legal Forest Access). Secure permanent or long-term access with a dedicated right-of-way involving a legal survey and purchase of right-of-way from the landowner.

Obtain a junction permit from the Ministry of Transportation and Infrastructure where an FSR joins a public highway. Exercise care in choosing the best junction site possible—ideally, a T junction with ample sight distance—since relocating highway junctions can be difficult and expensive, particularly where private property is involved.

### **1.5.3 Right-of-Way Acquisition Compensation**

The framework of the Ministry's compensation policy is based in the existing legislation. The Forest Act and the Ministry of Forests and Range Act (Section 5) provide the legislative authority to the Minister of Forests, Lands and Natural Resource Operations to acquire land for forestry purposes. The Expropriation Act and the Financial Administration Act both refer to the requirement of government to deal in terms of fair market value when acquiring land and other assets.

Ultimately, the fair market value for land, combined with a value determined for depreciated road improvements, represents the compensation due to a property owner. This value may be capitalized to represent an annual fee for a short-term agreement, or paid in full for long-term or permanent acquisitions. Road use fees or charges based solely on the volume of timber or the amount of use are not reflective of fair market compensation and do not serve the equitable interests of the property owner and the Province. However, volume and use charges may be applied to maintenance costs, provided they reflect the actual costs to maintain the road used.

#### **Estimating the Value of Depreciated Road Improvements (DRIV)**

Direct all matters regarding the acquisition of land and the application of the compensation policy to the Senior Advisor, FLNR Forest Land

Acquisitions, Forest Tenures Branch (FTB). Acting on the advice and recommendations of Ministry forest land acquisitions staff, the Director, FTB, who is the only delegated signing authority for the Minister, reviews all land agreements to determine that the principles of fair market value have been applied, and signs off on the agreement.

It is recommended to involve and consult with ministry Forest Lands Acquisitions staff, early in the process, when considering entering into an agreement for the purchase [dedication] or rental [statutory right of way agreement] of land to become a forest service road. Forest Lands Acquisitions staff will assist in the determination of appropriate compensation.

Ministry engineering staff will be required to inspect, or have inspected by individuals knowledgeable in road construction and costing, the current road condition and provide an estimate for the value of the road, and associated improvements, in its present condition. This value is referred to as the depreciated road improvement value [DRIV]. Forest Land Acquisition staff are not specialists in road cost estimating. A DRIV will need to be provided by ministry engineering staff to the Forest Land Acquisition Project Manager working on each forest service road project. The DRIV will be used in the compensation negotiations and if necessary, where a mutually satisfactory agreement cannot be reached, in expropriation. Any DRIV calculation should be documented and supported by background preparation guidelines/policy/direction for provincial consistency. In the case of expropriation, the compensation estimate (DRIV) and methodology is required to be shared with the land owner per section [20 \(1\) \(e\) of the Expropriation Compensation Act](#).

There are a number of ways that can be used to estimate the DRIV. One method is to estimate what the road would have cost to construct in the first place and subtracting the cost of repairs to bring it back to its original condition.

1. Inspect the road
2. Determine how much it would cost to construct the road today.  
Possible approaches to estimating value of the road and improvements include:
  - Detailed engineering cost estimate
  - Using information from the appropriate *appraisal manual*
  - Use of comparable, recent road construction contract results
  - Application of local knowledge
  - Current value per unit rate

3. Determine the costs of any road failures, required upgrades and repairs to bring the existing improvements up to a new road standard [culverts, structures, ditching, surfacing, grading, brushing, etc]. Some wooden bridges might have a negative value (require works to remove or other measures to make safe).
4. Reduce the cost of [1] by the cost of [3] and you have the DRIV.

Assistance in developing road construction cost estimates can be obtained through the Engineering Branch, Engineering Group for the respective region.

### **Acquiring Right-of-Way for Railway Crossings**

Crossing a railway right-of-way is costly and requires ongoing maintenance obligations. The type of crossing and required safety features are dictated by the railway authority. In cases where railway crossings cannot be avoided, obtain tentative approval in principle from local railway authorities and prepare a plan. Keysteps in this process are:

- submit a formal application for approval by railway and federal or provincial transport agencies, including the plan and the following information:
  - whether the proposed road right-of-way is junior or senior to trackage;
  - who will pay for construction and crossing;
  - what the projected daily traffic count will be for all vehicles (public and industrial);
  - whether school buses will be using the crossing; and
- allow eight months from the time of application to the time the crossing permit receives final approval.

### **Legal Access for Utility Right-of-Way Crossings**

Obtain interim approvals for the location of the crossing from local utility (power, oil/gas, and communications) field offices. Special considerations are involved if the utility is situated within private property.

### **Legal Access for Road Permit Roads**

Where the status/clearance process has identified conflicts with a proposed road permit route, licensees are expected to resolve such conflicts themselves. If the permittee is unfamiliar with the steps necessary to resolve such conflicts, assistance can be obtained from the private sector. FLNR Forest Land Acquisitions can provide a list of firms and individuals providing this service.

## Legal Access for Cutting Permit Roads

Since proposed harvest areas are statted and cleared before Cutting Permits are issued, a separate status and clearance procedure is not necessary for roads constructed within these areas. Because the permittee needs the flexibility to locate roads as best suits the harvest operations, and as these roads are usually of a temporary low-order nature, their location is normally not specified in the Cutting Permit document itself.

## Legal Access for Special Use Permit Roads

Under certain circumstances, roads within a provincial forest or wilderness area may be authorized by SUP, in keeping with the [Provincial Forest Use Regulation \[Sec. 7 \(1\)\(a\)\]](#).

These types of roads are normally issued to holders of rights authorized by the [Coal Act](#), [Geothermal Resources Act](#), or [Mineral Tenure Act](#), and may also be issued to Clean Energy Projects (CEP) proponents if they choose to apply for a road authorization under an SUP rather than under a *Land Act* Licence of Occupation, but in rare cases may be issued for other purposes.

SUP roads are normally mapped and statted in a process similar to that described for FSRs or road permit roads (described above). Like Road Permits, Special Use Permits authorize road construction and use only on unalienated Crown land. If tenure conflicts are identified during the status process, Special Use Permit holders are expected to resolve such conflicts before road construction and use. If the Special Use Permit holder is unfamiliar with the resolution process, this service is available from the private sector. FLNR Forest Land Acquisitions should be consulted for further information on private sector firms or individuals providing this service.

## Road Junctions

Ensure that a TSM/District Manager authorizes any connection to an FSR using a [Road Junction Requirements Form Letter \(FS1209\)](#).

**Note:** A Road Permit, Cutting Permit and Timber Sale Licence incorporate an authorization for a junction of the road permit road to the FSR.

Before approving an application to connect, ensure that the location, sight distances and drainage are acceptable (see [3.6.2: Road Design Criteria](#)). Ensure that requests from landowners for variance from the established alignment conditions are accompanied by a Professional Engineer's recommendation.

## 1.6 Subdivisions off Forest Service Roads

The subdivision process involves the legal survey and creation of a number of separate smaller parcels of land from a larger parcel of privately owned or Crown land.

When reviewing a request for subdivision access from a Forest Service Road (FSR), ensure that the Engineering Group Leader confirms that the road is built to a sufficient standard to safely handle the type and volume of traffic. The minimum requirements set out in the [Land Title Act Regulation \(Sec. 15\)](#) (BC Reg. 334/79) concern the road width as it relates to the maximum width of vehicle allowed on the road.

Examine the width of the entire length of the FSR from the end of the nearest public road to the location of the proposed subdivision and determine whether or not the road width meets the requirement of the Regulation.

In addition, record all relevant factors (e.g., the general condition of the roads, expected traffic volumes, condition of structures, and safety features such as turnouts, widenings, and signage).

The process of subdivision normally requires the dedication and construction of public access roads administered by the Ministry of Transportation and Infrastructure, or a municipality if the subdivision falls within an organized area. However, the use of other forms of access to subdivided areas is also considered, and [Section 15 of the Land Titles Act Regulation](#) deals with access by FSRs and prescribes the maximum allowed width of vehicles based on different minimum road widths. Minimum widths mean the width of the entire running surface from the nearest public road to the subdivision, other than for permitted exceptions that are spelled out in the Regulation.

Approving Officers consider a number of factors when deciding whether a particular subdivision application should be approved. However, the Approving Officers cannot approve a subdivision application that relies on an FSR for access until the Engineering Group Leader certifies that the FSR in question meets the width requirements of the Regulation.

## 1.7 Signs on Forest Service Roads

Signs may not be erected on a Forest Service right-of-way without the approval of the District Manager. In general, commercial signs are not approved.

All traffic control signs used on Forest Service rights-of-way ***must*** conform to Ministry of Transportation and Infrastructure standards in their [Manual of Standard Traffic Signs and Pavement Markings \(Chapter 2\)](#) if those standards include a sign to deal with the traffic control issue.

The Forest Service road sign (see [Appendix 1.1](#)) ***must*** be placed at the start of an FSR system where there is a potential for public or multiple industrial users. Determine:

- whether name signs are necessary on a particular road;
- the size of the signs; and

- where the signs should be placed.

A primary justification for a traffic control sign is that the risk to users is greater than what a user would normally encounter on an FSR such that the safety of the user may be dependent on the sign being in place.

### **1.8 Abandoned Vehicles on Forest Service Rights-of-Way**

Occasionally, ministry staff is faced with having to deal with abandoned vehicles or logging or road building equipment along Forest Service rights-of-way. Consider the following when deciding whether or not to remove or dispose of such vehicles:

- The vehicle or equipment may or maynot have some residual value.
- The vehicle or equipment owner may or may not be identifiable if the licence plates or serial numbers have beenremoved.
- The cost of moving and disposing of the vehicle may be greater thanthe recoverable costs.
- The vehicle may be causing a danger to other road users or it may be a visible disturbance.

### **1.9 Temporary Closures of Forest Service Roads**

Where the District Manager determines that a road will be closed temporarily because of safety, sediment delivery, or property issues, place a “road closed” sign at the beginning of the road and install a physical barrier to keep vehicles off the road. Notify potential users of the closure through some form of local advertising. Closures of roads for environmental protection issues such as pressures on wildlife populations are carried out by Ministry of Environment staff through their legislation, and not through the powers provided to FLNR.

### **1.10 Cancelling Road Permits**

Cancel a licensee’s Road Permit at the request of the permittee where it is evident that the permittee will not need the road any longer to harvest timber under a harvesting agreement.

Ensure that the permittee deactivates a road permit road when:

- there is no apparent future industrial use for the road;
- no other party is able or willing to assume responsibility for the road after the Road Permit is cancelled; and
- the District Manager determines that the road will not be required for ongoing public access.

Where a major licensee has deactivated a road according to regulations, it normally provides a declaration to the District Manager that the licensee has met its deactivation obligations. The District Manager has up to 15 months to approve

the works after the licensee has provided the declaration. Once the works are approved, or the 15 months passes without inspection, the District Manager will terminate the road permit.

For those road permit roads that a TSL holder deactivates, the TSM ensures that the road deactivation was carried out properly and in accordance with the regulations, and then notifies the District Manager that the work has been completed. The District Manager will normally rely upon the advice of the TSM but may carry out an inspection of the deactivated road to ensure that the work has been carried out satisfactorily.

For those road permit roads operated by a TSL holder where future use of the road by non-BCTS users may preclude deactivating the road, the TSM notifies the District Manager accordingly, preferably well in advance of the completion of the TSL. Should the District Manager determine that the road should be deactivated in any event, he will so notify the TSM, again prior to completion of the TSL. If the District Manager determines that the road will not be deactivated, the District Manager may either issue a permit to another user or declare the road to be an FSR under the administration of the District Manager.

Once the road has been deactivated, or the tenure has been shifted to another user, or the road has been declared to be an FSR, subject to the notifications and possible inspections as described in the preceding paragraphs, the TSM will terminate the existing road permit held by the timber sale licensee.

Do not create non-status roads by cancelling Road Permits for non-deactivated roads unless either transferring the responsibility to another party or taking on a clear ministry administrative role by declaring the road an FSR.

### **1.11 *Cancelling Road Use Permits***

An industrial user may apply to the District Manager to be relieved of its Road Use Permit on an FSR when that road will not be required for industrial purposes. Before the Road Use Permit of the designated maintainer is cancelled, ensure that the road has been maintained to the level required for non-industrial use, to the extent necessary to ensure there is no material adverse effect on a forest resource, as evidenced by:

- structural integrity of the road prism and clearing width are protected; and
- drainage systems of the road are functional.

Otherwise, the permit will remain in force even while the user is idle for periods of time, and any designated maintenance obligations remain during those same periods.



### **1.12 C cancelling Works and Special UsePermits**

Works Permits and SUPs will either expire on a given date (as shown in the permit) or be cancelled when the permittee advises the District Manager that the permit is no longer required for its intended purpose.

If a Works Permit has been issued for a Forest Service Road (FSR) that is about to be permanently discontinued and closed or transferred, and the permittee intends to continue using the works, refer the permittee to another agency to obtain a replacement tenure for these works.

### **1.13 Protocol Agreements Related to Roads**




Ministry of Forests, Lands and Natural Resource Operations, Engineering Branch

Engineering and FLNR Forest Land Acquisitions: [Protocol Agreements](#) (only accessible to internal users)

## Appendices

### Appendix 1.1: Forest Service Road Signs

Figure 1-2 Road Sign on Forest Service Road

	<b>STANDARD SIGN DESIGN</b>	<b>Catalogue Item #</b>  <b>Fi-008-1</b>				
<b><u>Forest Service Road Name Sign – Aluminum Substrate</u></b>						
<b>A</b> ➡						
<b>Special instructions:</b>						
Insert the name of the Forest Service Road (Line A) when ordering the sign						
Screen print only						
Proofs to be provided by supplier for FLNR approval						
Complete and provide a standard electronic order form to the sign fabricator from the following web page: <a href="http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm">http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm</a>						
						
<b>Sign Item Number</b>	<b>Dimensions (W x H) mm</b>	<b>Substrate Sign Blank #</b>	<b>Reflectivity</b>	<b>Colour</b>	<b>Approval Required</b>	<b>Typical Application</b>
Fi-008-1	1200 x 600	0.081 Alum	ASTM 1	Various	N/A	Forest Service Road



Ministry of Forests, Lands and  
Natural Resource Operations

## STANDARD SIGN DESIGN

### Catalogue Item #

1.0 Fi-008-2

### FSR Name Sign – Plywood Substrate

A ⇒



#### Special instructions:

Insert the name of the Forest Service Road (Line A) when ordering the sign

Screen print only

Proofs to be provided by supplier for FLNR approval

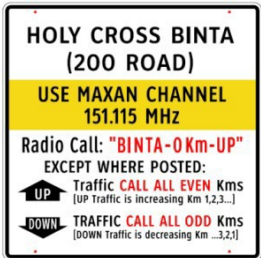

Back of sign to painted brown with (Pantone S321-2 match) with one coat of exterior oil based enamel paint over a compatible primer per Sec. 635.26 of the Ministry of Transportation and Infrastructure's [Standard Specifications for Highway Construction](#).


Complete and provide a standard electronic order form to the sign fabricator from the following web page:


[http://www.for.gov.bc.ca/hth/engineering/sign\\_standards.htm](http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm)





Sign Item Number	Dimensions (W x H) mm	Substrate Sign Blank #	Reflectivity	Colour	Approval Required	Typical Application
Fi-008-2	1200 x 600	14mm MDO Ply	ASTM 1	Various	N/A	Forest Service Road

FLNR FSR Standard Sign Design	Sign Use and Application	Catalogue Item #:
Road Entry Sign Type 1		Fi-008-3A & Fi-008-3B
<p><b>Option A (Fi-008-3A)– two lined of text for FSR name</b></p> <p>A ⇒ </p> <p>B ⇒</p> <p>C ⇒</p> <p>D ⇒</p> <p>E ⇒</p> <p><i>Shows standard default call content/order</i></p> <p><b>Option B (Fi-008-3B) – one line of text for FSR name</b></p> <p>A ⇒ </p> <p>B ⇒</p> <p>C ⇒</p> <p>D ⇒</p> <p>E ⇒</p> <p><i>Shows sample alternative call content/order</i></p> <p>Substrate: Aluminum (0.081)          No. Sides: Single Sided          Size: 120 cm X 120 cm          Font: ClearviewHwy (3-B, 2-B, 1-B)          Reflectivity: ASTM Type 1          Anti-graffiti: 3M 1160 UV          Border: inset 1.25cm / width 1.5 cm          Corner Radius: 38mm          Hole Diameter: 12mm dia          Hole Mount: two post, provide hole location at time of order</p>	<p><b>Road Entry Advisory Sign – Type 1:</b></p> <ul style="list-style-type: none"> <li>provides guidance for road radio call protocols at beginning of road or where call protocol may vary</li> <li>Use sign Type 1 (Fi-008-03) where there is no existing signage showing the road name and radio channel. If existing signage clearly displays both road name and radio channel, use Road Entry Sign Type 2 (Fi-008-04)</li> <li><b>Sign information is to be consistent with approved District Calling Protocol</b></li> </ul> <p><u>Must</u> contain:</p> <ul style="list-style-type: none"> <li>road name banner             <ul style="list-style-type: none"> <li>Option A – two lines of text</li> <li>Option B – one line of text</li> </ul> </li> <li>call content and order</li> <li>one of:             <ul style="list-style-type: none"> <li>local channel name &amp; frequency (MHz) or</li> <li>RR channel # (eg. RR-18A) [note: do not post RR frequency (MHz) or tone]</li> </ul> </li> </ul> <p>Sample up/down call language:</p> <ul style="list-style-type: none"> <li><b>Standard Default:</b> EXCEPT WHERE POSTED ( Arrow Up) Traffic <b>CALL ALL EVEN</b> Kms [Up Traffic is increasing Km 1,2,3...] (Arrow down) Traffic <b>CALL ALL ODD</b> Kms [Down Traffic is decreasing Km ...3,2,1]</li> <li><b>Sample Option1</b> ( Arrow Up) Traffic <b>REMAIN SILENT</b> (Arrow down) Traffic <b>CALL ALL</b> Kms</li> <li><b>Sample Option2</b> ( Arrow Up) Traffic <b>CALL ALL</b> Kms (Arrow down) Traffic <b>CALL ALL</b> Kms</li> </ul> <p>Note that modifications are <b>intentionally in red</b> to highlight the difference</p>	<p><b>Special instructions:</b></p> <ul style="list-style-type: none"> <li>Provide the following when ordering:             <ol style="list-style-type: none"> <li>name of the Forest Service Road                     <ul style="list-style-type: none"> <li>Option A – two lines of text</li> <li>Option B – one line of text</li> </ul> </li> <li>road channel name and frequency (MHz), or RR Road Channel number (no frequency (MHz) or tone)</li> <li>radio call content and order</li> <li>radio call pattern/frequency for the “up” direction</li> <li>radio call pattern/frequency for the “down” direction</li> <li>hole locations for mounting</li> </ol> </li> <li>Screen print only</li> <li>Proofs to be provided by supplier for FLNR approval</li> <li>Provide the following electronic file found on this <a href="http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm">web page to the sign fabricator:</a></li> </ul> <p><b>Color Key</b></p> <ul style="list-style-type: none"> <li>3M Black</li> <li>3M Yellow Engineer Grade</li> <li>3M Red Engineer Grade</li> <li>3M White Engineer Grade</li> </ul>


FLNR FSR Standard Sign Design	Sign Use and Application	Catalogue Item #:
Road Entry Sign Type 2		Fi-008-4
<p>A ⇒ </p> <p>B ⇒</p> <p>C ⇒</p> <p>Substrate: Aluminum(0.081)          No. Sides: Single Sided Size:          120 cm X 60 cm          Font: ClearviewHwy (1-B, 2-B)          Reflectivity: ASTM Type 1          Anti-graffiti: 3M 1160 UV          Border: inset 1 cm / width 1.25 cm          Corner Radius: 38mm          Hole Diameter: 12mm dia          Hole Mount: two post, provide hole location at time of order</p> <p><b>● Color Key</b></p> <p>■ 3M Black          ■ 3M Red Engineer Grade          □ 3M White Engineer Grade</p>	<p><b>Road Entry Advisory Sign – Type 2:</b></p> <ul style="list-style-type: none"> <li>Used in conjunction with FSR name sign</li> <li>provides guidance for road radio call protocols at beginning of road or where call protocol may vary</li> <li>Use sign Type 2 where existing signage clearly shows the road name and radio channel. Using Type 2 reduces costs and duplication</li> </ul> <p><b>Sign information is to be consistent with approved District Calling Protocol</b></p> <p><u><b>Must</b></u> contain:</p> <ul style="list-style-type: none"> <li>call content and order</li> <li>local channel name &amp; frequency (MHz) <u>or</u> RR channel #              (note: do not post RR frequency (MHz) or tone)</li> </ul> <p>Sample up/down call language:</p> <ul style="list-style-type: none"> <li>as for Road Entry Sign Type 1</li> </ul> <p>Note that modifications are <b>intentionally in red</b> to highlight the difference</p>	<p><b>Special instructions:</b></p> <ul style="list-style-type: none"> <li>Provide the following when ordering:             <ol style="list-style-type: none"> <li>radio call content and order for the road</li> <li>radio call protocol for the “up” direction</li> <li>radio call protocol for the “down” direction</li> </ol> </li> <li>specify hole locations for mounting if different than shown Screen print only</li> <li>Proofs to be provided by supplier for FLNR approval</li> <li>Provide the following electronic file found on this web page to the sign fabricator:  <a href="http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm">http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm</a></li> </ul>

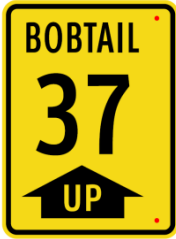

FLNR FSR Standard Sign Design	Sign Use and Application	Catalogue Item #:
Standard Must Call Type 1		Fi-008-5
<div> <div> <div>A ⇒</div> <div>B ⇒</div> <div>C ⇒</div> </div>  </div> <p>Substrate: Aluminum (0.081)  No. Sides: Single Sided  Size: 45 cm X 60 cm  Font: ClearviewHwy (2-B)  Reflectivity: ASTM Type 1  Anti-graffiti: Optional  Border: inset 1 cm / width 1.25 cm  Corner Radius: 38mm  Hole Diameter: 12mm dia  Hole Mount: Center Mount</p> <p><b>Color Key</b></p> <p>■ 3M Black  □ 3M White Engineer Grade</p>	<p><u>Must Call</u> – Type 1:</p> <ul style="list-style-type: none"> <li>To be used at identified <u>Must</u> Call locations</li> </ul> <p><u>Must</u> contain:</p> <ul style="list-style-type: none"> <li>Road name</li> <li>Km location</li> <li>Direction (up/down)</li> <li>No RR channel # or channel name</li> </ul>	<p><b>Special instructions:</b></p> <ul style="list-style-type: none"> <li>Provide the following when ordering: <ul style="list-style-type: none"> <li>A. road name used in call protocol</li> <li>B. kilometre location for “<u>must</u> call”</li> <li>C. specify one of - “up” or “down”</li> </ul> </li> <li>Anti-graffiti: specify 3M 1160 UV or Not Required</li> <li>Screen print only</li> <li>Proofs to be provided by supplier for FLNR approval</li> <li>Complete and provide a standard electronic order form to the sign fabricator from the following web page:  <a href="http://www.for.gov.bc.ca/htb/engineering/sign_standards.htm">http://www.for.gov.bc.ca/htb/engineering/sign_standards.htm</a></li> </ul>



FLNR FSR Standard Sign Design	Sign Use and Application	Catalogue Item #:
Standard Must Call Type 2		Fi-008-6
<div> <p>A ⇨</p> <p>B ⇨</p> <p>C ⇨</p> <p>D ⇨</p> </div>  <p>Substrate: Aluminum (0.081)          No. Sides: Single Sided          Size: 45 cm X 60 cm          Font: ClearviewHwy (2-B)          Reflectivity: ASTM Type 1          Anti-graffiti: Optional          Border: inset 1 cm / width 1.25 cm          Corner Radius: 38mm          Hole Diameter: 12mm dia          Hole Mount: Center Mount</p> <p><b>● Color Key</b></p> <p>■ 3M Black</p> <p>■ 3M Yellow Engineer Grade</p> <p>□ 3M White Engineer Grade</p>	<p><b>Standard <u>Must</u> Call – Type 2:</b></p> <ul style="list-style-type: none"> <li>To be used when entering onto a branch road off of the mainline where the calling protocol has not changed from the mainline</li> </ul> <p><b><u>Must</u> contain:</b></p> <ul style="list-style-type: none"> <li>Road name</li> <li>Km location</li> <li>Direction (up/down)</li> <li>local channel name &amp; frequency (MHz) <u>or</u> RR channel # (note: do not post RR frequency (MHz) or tone)</li> </ul>	<p><b>Special instructions:</b></p> <ul style="list-style-type: none"> <li>Provide the following when ordering:             <ol style="list-style-type: none"> <li>road name used in call protocol</li> <li>kilometre location for “<u>must</u> call”</li> <li>specify one of - “up” or “down”</li> <li>local channel name &amp; frequency (MHz) <u>or</u> RR channel # (note: do not post RR frequency (MHz) or tone)</li> </ol> </li> <li>Anti-graffiti: specify 3M 1160 UV or Not Required</li> <li>Screen print only</li> <li>Proofs to be provided by supplier for FLNR approval</li> <li>Complete and provide a standard electronic order form to the sign fabricator from the following web page:  <a href="http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm">http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm</a> </li> </ul>




FLNR FSR Standard Sign Design	Sign Use and Application	Catalogue Item #:
Standard Junction Must Call Type 1		Fi-008-7
<div> A ⇨ B ⇨ C ⇨ D ⇨ </div>  <p>Substrate: Aluminum (0.081)  No. Sides: Single Sided  Size: 45 cm X 60 cm  Font: ClearviewHwy (2-B, 4-B, 1-B)  Reflectivity: ASTM Type 1  Anti-graffiti: optional  Border: inset 1 cm / width 1.25 cm  Corner Radius: 38mm  Hole Diameter: 12mm dia  Hole Mount: Center Mount</p> <p><b>Color Key</b></p> <ul style="list-style-type: none"> <li>3M Black</li> <li>3M Yellow Engineer Grade</li> <li>3M White Engineer Grade</li> </ul>	<p><b>Standard Junction <u>Must</u> Call – Type 1:</b></p> <ul style="list-style-type: none"> <li>To be used for road junctions when entering onto a main road</li> <li>Radio channel may be included on the sign as per, Standard Junction Type 1 (Fi-008-6) or on a separate channel tab (Fi-008-12) with Standard Junction Type 2 (Fi-008-8)</li> </ul> <p><b><u>Must</u></b> contain:</p> <ul style="list-style-type: none"> <li>“On to the” Road name</li> <li>“at” Km location</li> <li>local channel name &amp; frequency (MHz) <u>or</u> RR channel # (note: do not post RR frequency (MHz) or tone)</li> </ul>	<p><b>Special instructions:</b></p> <ul style="list-style-type: none"> <li>Provide the following when ordering: <ul style="list-style-type: none"> <li>A. road name used in call protocol</li> <li>B. kilometre location for “<b><u>must</u></b> call”</li> <li>C. direction arrow on the left (“UP” or “DOWN”)</li> <li>D. local channel name &amp; frequency (MHz) <u>or</u> RR channel # (note: do not post RR frequency (MHz) or tone)</li> </ul> </li> <li>Anti-graffiti: specify 3M 1160 UV or Not Required</li> <li>Screen print only</li> <li>Proofs to be provided by supplier for FLNR approval</li> <li>Complete and provide a standard electronic order form to the sign fabricator from the following web page:  <a href="http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm">http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm</a> </li> </ul>








FLNR FSR Standard Sign Design	Sign Use and Application	Catalogue Item #:
Standard Junction Must Call Type 2		Fi-008-8
<div> A ⇨ B ⇨ C ⇨ </div>  <p>Substrate: Aluminum (0.081)  No. Sides: Single Sided  Size: 45 cm X 60 cm  Font: ClearviewHwy (2-B)  Reflectivity: ASTM Type 1  Anti-graffiti: Optional  Border: inset 1 cm / width 1.25 cm  Corner Radius: 38mm  Hole Diameter: 12mm dia  Hole Mount: Center Mount</p> <p><b>Color Key</b></p> <p>■ 3M Black  □ 3M White Engineer Grade</p>	<p><b>Standard Junction <u>Must</u> Call – Type 2:</b></p> <ul style="list-style-type: none"> <li>To be used for road junctions when entering onto a main road</li> <li>It is recommended that the radio channel be identified when using the Standard Junction <u>Must</u> Call Sign to avoid driver confusion regarding correct channel</li> <li>Radio channel may be included on the sign as per Standard Junction Type 1 (Fi-008-7) or on a separate channel tab as per Standard Junction Type 2 (Fi-008-08)</li> </ul> <p><b><u>Must</u> Contain:</b></p> <ul style="list-style-type: none"> <li>“On to the” Road name</li> <li>“at” Km location</li> <li>No RR channel # or channel name</li> </ul>	<p><b>Special instructions:</b></p> <ul style="list-style-type: none"> <li>Provide the following when ordering: <ul style="list-style-type: none"> <li>A. road name used in call protocol</li> <li>B. kilometre location for “<u>must</u> call”</li> </ul> </li> <li>Anti-graffiti: specify 3M 1160 UV or Not Required</li> <li>Screen print only</li> <li>Proofs to be provided by supplier for FLNR approval</li> <li>Complete and provide a standard electronic order form to the sign fabricator from the following web page:  <a href="http://www.for.gov.bc.ca/htth/engineering/sign_standards.htm">http://www.for.gov.bc.ca/htth/engineering/sign_standards.htm</a> </li> </ul>


FLNR FSR Standard Sign Design	Sign Use and Application	Catalogue Item #:
Kilometre Board Type 1		Fi-008-9
<div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;"> <p>Side A</p> <p>A ⇨</p>  </div> <div style="text-align: center;"> <p>Side B</p> <p>B ⇨</p>  </div> </div> <p>Substrate: Aluminum (0.081)          No. Sides: Double Sided          Size: 45 cm X 60 cm          Font: ClearviewHwy (1-B, 2-B)          Reflectivity: ASTM Type 1          Anti-graffiti: Optional          Border: inset 1 cm / width 1.25 cm          Corner Radius: 38mm          Hole Diameter: 12mm dia          Hole Mount: Side Mount</p> <p><b>Color Key</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: black; margin-right: 5px;"></span> 3M Black</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: yellow; margin-right: 5px;"></span> 3M Yellow Engineer Grade</li> </ul>	<p><b>Kilometre board – Type 1</b></p> <p>Kilometre Board type and size may can be determined by traffic volume and speed as well as road characteristics</p> <p>Kilometre Boards are to be posted every 1 km unless traffic patterns dictate otherwise</p> <p><b><u>Must</u></b> Contain:</p> <ul style="list-style-type: none"> <li>Rd name</li> <li>Km location</li> <li>Direction (up/down)</li> </ul>	<p><b>Special instructions:</b></p> <ul style="list-style-type: none"> <li>Provide the following when ordering:             <ul style="list-style-type: none"> <li>A. road name used in call protocol</li> <li>B. kilometrelocation</li> </ul> </li> <li>Anti-graffiti: specify 3M 1160 UV or Not Required</li> <li>Screen printonly</li> <li>Proofs to be provided by supplier for FLNR approval</li> <li>Complete and provide a standard electronic order form to the sign fabricator from the following web page:  <a href="http://www.for.gov.bc.ca/htth/engineering/sign_standards.htm">http://www.for.gov.bc.ca/htth/engineering/sign_standards.htm</a> </li> </ul>

FLNR FSR Standard Sign Design	Sign Use and Application	Catalogue Item #:
Kilometre Board Type 2		Fi-008-10
<div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;"> <p>Side A</p> <p>A →</p>  </div> <div style="text-align: center;"> <p>Side B</p> <p>B →</p>  </div> </div> <p>Substrate: Aluminum (0.081)</p> <p>No. Sides: Double Sided</p> <p>Size: 45 cm X 60 cm</p> <p>Font: ClearviewHwy (1-B, 2-B)</p> <p>Reflectivity: ASTM Type 1</p> <p>Anti-graffiti: 3M 1160 UV</p> <p>Border: inset 1 cm / width 1.25 cm</p> <p>Corner Radius: 38mm</p> <p>Hole Diameter: 12mm dia</p> <p>Hole Mount: Side Mount</p> <p><b>● Color Key</b></p> <p>■ 3M Black</p> <p>■ 3M Yellow Engineer Grade</p>	<p><b>Kilometer board – Type 2</b></p> <p>Kilometre Board type and size may can be determined by traffic volume and speed as well as road characteristics</p> <p>Kilometre Boards are to be posted every 1 km unless traffic patterns dictate otherwise</p> <p><b><u>Must</u></b> Contain:</p> <ul style="list-style-type: none"> <li>• Rd name</li> <li>• Km location</li> <li>• No direction(up/down)</li> </ul>	<p><b>Special instructions:</b></p> <ul style="list-style-type: none"> <li>• Provide the following when ordering: <ul style="list-style-type: none"> <li>A. road name used in call protocol</li> <li>B. kilometrelocation</li> </ul> </li> <li>• Anti-graffiti: specify 3M 1160 UV or Not Required</li> <li>• Screen printonly</li> <li>• Proofs to be provided by supplier for FLNR approval</li> <li>• Complete and provide a standard electronic order form to the sign fabricator from the following web page: <a href="http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm">http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm</a> </li> </ul>

FLNR FSR Standard Sign Design	Sign Use and Application	Catalogue Item #:
Kilometre Board Type 3		Fi-008-11
<p>B ⇨ </p> <p>Substrate: Aluminum (0.081)          No. Sides: Double Sided          Size: 30 cm X 30 cm or 45 cm X 45 cm          Font: ClearviewHwy (4-B)          Reflectivity: ASTM Type 1          Anti-graffiti: 3M 1160 UV          Border: inset 1 cm / width 1.25 cm          Corner Radius: 38mm          Hole Diameter: 12mm dia          Hole Mount: Side Mount</p> <p><b>Color Key</b></p> <p> 3M Black   3M Yellow Engineer Grade</p>	<p><b>Kilometer board – Type 3</b></p> <p>Kilometre Board type and size may can be determined by traffic volume and speed as well as road characteristics</p> <p>Kilometre Boards are to be posted every 1 km unless traffic patterns dictate otherwise</p> <p><b><u>Must</u></b> Contain:</p> <ul style="list-style-type: none"> <li>Km location only</li> </ul>	<p><b>Special instructions:</b></p> <ul style="list-style-type: none"> <li>Provide the following when ordering:             <ul style="list-style-type: none"> <li>A dimension (30x30cm or 45x45cm)</li> <li>B kilometre location</li> </ul> </li> <li>Anti-graffiti: specify 3M 1160 UV or Not Required</li> <li>Screen print only</li> <li>Proofs to be provided by supplier for FLNR approval</li> <li>Complete and provide a standard electronic order form to the sign fabricator from the following web page:  <a href="http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm">http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm</a></li> </ul>

FLNR FSR Standard Sign Design	Sign Use and Application	Catalogue Item #:
Kilometre Board Type 4		Fi-008-15
<p>A ⇌</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>Side A</p>  </div> <div style="text-align: center;"> <p>Side B</p>  </div> </div> <p>Substrate: Aluminum (0.081)          No. Sides: Double Sided          Size: 45 cm X 60 cm          Font: ClearviewHwy (1-B, 2-B)          Reflectivity: ASTM Type 1          Anti-graffiti: 3M 1160 UV          Border: inset 1 cm / width 1.25 cm          Corner Radius: 38mm          Hole Diameter: 12mm dia          Hole Mount: Side Mount</p> <p><b>Color Key</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: black; margin-right: 5px;"></span> 3M Black</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: yellow; margin-right: 5px;"></span> 3M Yellow Engineer Grade</li> </ul>	<p><b>Kilometre board – Type 4</b></p> <p>Kilometre Board type and size may can be determined by traffic volume and speed as well as road characteristics</p> <p>Kilometre Boards are to be posted every 1 km unless traffic patterns dictate otherwise</p> <p><b><u>Must</u></b> Contain:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Km location</li> <li><input type="checkbox"/> Direction (up/down)</li> </ul>	<p><b>Special instructions:</b></p> <ul style="list-style-type: none"> <li>Provide the following when ordering:             <ul style="list-style-type: none"> <li>A. kilometrelocation</li> </ul> </li> <li>Anti-graffiti: specify 3M 1160 UV or Not Required</li> <li>Holes for mounting on left or right edge</li> <li>Screen printonly</li> <li>Proofs to be provided by supplier for FLNR approval</li> <li>Provide the following electronic file found on this web page to the sign fabricator:  <a href="http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm">http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm</a> </li> </ul>

FLNR FSR Standard Sign Design	Sign Use and Application	Catalogue Item #:
Radio Channel Tab Type 1 & 2		Fi-008-12 & Fi-008-13
<p>  </p> <p>           Substrate: Aluminum (0.081)            No. Sides: Single Sided            Size: 45 cm X 30 cm            Font: ClearviewHwy (2-B; 2-B, 3-B)            Reflectivity: ASTM Type 1            Anti-graffiti: Optional            Border: inset 1 cm / width 1.25 cm            Corner Radius: 38mm            Hole Diameter: 12mm dia            Hole Mount: Center Mount         </p> <p> <b>Color Key</b>   3M Black   3M Yellow Engineer Grade         </p>	<p><b>Road Channel :</b></p> <ul style="list-style-type: none"> <li>To be used to identify road radio channel</li> <li>Can be used in conjunction with other signage</li> </ul> <p><b>Must</b> Contain:</p> <ul style="list-style-type: none"> <li><b>Type 1 (Catalogue No. Fi-008-12)</b> <ul style="list-style-type: none"> <li>Where no RR Channel but named industrial channel and frequency (MHz)</li> <li>Include both channel name and frequency (MHz)</li> <li>Three lines of text</li> </ul> </li> <li><b>Type 2 (Catalogue No. Fi-008-13)</b> <ul style="list-style-type: none"> <li>Where Industry Canada RR radio channel</li> <li>Only show RR #</li> <li>RR frequency (MHz) and tone not posted</li> <li>Two lines of text</li> </ul> </li> </ul>	<p><b>Special instructions:</b></p> <ul style="list-style-type: none"> <li>Provide the following when ordering:             <ul style="list-style-type: none"> <li><b>Type 1</b> (Catalogue No. Fi-008-12):                 <ul style="list-style-type: none"> <li>A local channel name</li> <li>B frequency (MHz)</li> </ul> </li> </ul> </li> <li><b>or</b></li> <li><b>Type 2</b> (Catalogue No. Fi-008-13):             <ul style="list-style-type: none"> <li>B. RR channel # (note: do not post RR frequency (MHz) or tone)</li> </ul> </li> <li>Anti-graffiti: specify 3M 1160 UV or Not Required</li> <li>Screen print only</li> <li>Proofs to be provided by supplier for FLNR approval</li> <li>Complete and provide a standard electronic order form to the sign fabricator from the following web page:  <a href="http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm">http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm</a> </li> </ul>

FLNR FSR Standard Sign Design	Sign Use and Application	Catalogue Item #:
Caution		Fi-008-14
<p>A ⇨</p>  <p>Substrate: Aluminum (0.081)          No. Sides: Single Sided          Size: 60 cm X 45 cm          Font: ClearviewHwy (2-B)          Reflectivity: ASTM Type 1          Anti-graffiti: Optional          Border: inset 1 cm / width 1.25 cm          Corner Radius: 38mm          Hole Diameter: 12mm dia          Hole Mount: Center Mount</p> <p>● <b>Color Key</b></p> <p>■ 3M Black          ■ 3M Red Engineer Grade          □ 3M White Engineer Grade</p>	<p><b>Caution Sign:</b></p> <ul style="list-style-type: none"> <li>To be used to identify known critical hazard(s)</li> <li>Use only when no MoT standard sign available  <a href="http://www.th.gov.bc.ca/publications/engineering/geometsigns.htm">http://www.th.gov.bc.ca/publications/engineering/geometsigns.htm</a></li> </ul> <p>Sample wording examples:</p> <ul style="list-style-type: none"> <li>Active Logging</li> <li>Powerline Clearance 10 m</li> </ul>	<p><b>Special instructions:</b></p> <ul style="list-style-type: none"> <li>Provide the following when ordering:             <ul style="list-style-type: none"> <li>A. Specify wording for the caution</li> </ul> </li> <li>Anti-graffiti: specify 3M 1160 UV or Not Required</li> <li>Screen print only</li> <li>Proofs to be provided by supplier for FLNR approval</li> <li>Complete and provide a standard electronic order form to the sign fabricator from the following web page:  <a href="http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm">http://www.for.gov.bc.ca/hth/engineering/sign_standards.htm</a></li> </ul>

## Appendix 1.2: Shared Use Road Maintenance Policy:



File: 10765-01

### **Advisory Bulletin No. 25/06/08 – Shared Use Road Maintenance Policy (For internal and external communication)**

#### **Introduction:**

The purpose of this bulletin is to improve the operational understanding and application of the Ministry of Forests and Range (MFR) Shared Use Road Maintenance policy. The policy, introduced on July 26, 2006 by way of a memorandum signed by the Deputy Minister, MFR, establishes a clear process for the sharing of road maintenance costs between a holder of a Timber Sale License (TSL) and a major licensee who have legal obligations as the Maintainer of a road or roads, in accordance with their Road Use Permits (RUP) or Road Permits (RP).

#### **Policy:**

The current policy (Shared Road Maintenance/Cost-Sharing Process Information Package dated July 6, 2006):

- Provides clear direction regarding the determination and collection of appropriate maintenance costs.
- Describes a clear set of maintenance standards, critical for the protection of the environment and structural integrity of the road prism and which supports the safe use of the roads by industrial users.
- Includes a Standard Road Maintenance Agreement (SRMA) template that must be signed by the two parties involved in the maintenance of forest roads under a RP or a RUP.
- Provides for reasonable shared cost calculation of maintenance under the SRMA which specifies a transparent costing methodology (i.e., applies maintenance allowance dollars, based on the Interior or Coast Appraisal Manuals tabular rates, prorated to the shared portion of the road only). Consistent with both Appraisal Manuals and associated recognized costs, the length of TSL road (on-block) to be maintained is also included as a portion of "T" which is the total length of forest road maintained from the TSL as referred to in the SRMA.
- Is sufficiently flexible to accommodate alternative local agreements under the umbrella of existing or emerging Road User Committees that are successfully working.
- Provides a detailed process to follow in various situations involving multiple users as related to the sharing of costs and implementation of maintenance standards.



### Summary of the SRMA Process:

A TSL holder who is the user of a road that is subject of an existing RP or a RUP may encounter the following situations:

1. There's at least one major licensee holder of a RUP or RP, with the major licensee being designated as the Maintainer of the road:  
For situations of a TSL holder utilizing a single extraction route, or multiple road routes as the case may be, prior to advertising a TSL, the Timber Sale Manager (TSM) is required to ascertain whether the Maintainer wishes to invoke the SRMA provisions which will allow for recovery of partial road maintenance costs from the TSL holder. If so, the requirement to sign a SRMA (or multiple SRMAs if multiple routes could be potentially utilized) must be built into the TSL documentation. District managers must also ensure that the appropriate road maintenance standards are amended into the Maintainer's RP or RUP, for the road portion that will be the subject of the SRMA.

The SRMA itself commits the TSL holder to paying the Maintainer based on one of the following rates:

- 100% of the Coast or Interior Appraisal Manual cost estimate<sup>1</sup> for the percentage of the shared road when the Maintainer will carry out all the required surface maintenance work, or
- 25% of the Coast or Interior Appraisal Manual cost estimate for the percentage of the shared road when the TSL holder will do the maintenance work. In addition, the TSL holder agrees to indemnify the Maintainer against any potential liabilities that may arise as a result of the TSL holder's maintenance activities on the respective portion of the road during term of the SRMA. Only one Maintainer can be responsible for any section of a road at one time. In situations where there are different Maintainers responsible for maintaining specific segments of road used for transporting timber from a TSL, the TSL holder will pay each Maintainer its corresponding share in accordance with the applicable SRMA.

Where there is only one recipient/purchaser of the timber, that purchaser will be authorized by copy of a SRMA to hold back the agreed upon maintenance amount and remit it to the Maintainer every 30 days. This period is considered and measured as cumulative delivery of timber to the purchaser that amounts to 30 days. Otherwise, payment will be made directly to the Maintainer by the TSL holder every 30 days.

Periodicity of payment is every 30 days based on the volume transported on the shared portion of the road within this passed period. In those instances where timber is boomed or towed and scaling is deferred, the periodicity of payment is every 30 cumulative days of road use.

2. In the event that there is a Road User Committee in existence for the road section(s) serving a TSL with clear and acceptable terms and conditions for delivery of and payment for road maintenance, there will be no need to modify the existing arrangements. The TSL document will provide for a commitment of the

<sup>1</sup>References: 4.6 of the Interior Appraisal Manual and s.5.4 of the Coast Appraisal Manual.

holder to agree to the terms and conditions of the Road User Committee. No changes would be made to the Maintainer's permits.

A TSL holder must not use a road that has a damaged surface or sub-grade and must notify the Maintainer of any situations requiring maintenance work. The maintenance of the road surface may be inspected by Compliance and Enforcement staff to ensure conformance with the contractual standards as stipulated in the applicable RUP.

TSMs may decide to access TSL deposits in order to satisfy shortfall in maintenance payments.

Any individual or entity that is qualified to bid on TSLs is advised to check with their local TSO regarding road use charges prior to submitting a sealed tender. In some cases, the road maintenance costs to the successful TSL bidder will be known prior to tender opening. In these instances, prospective bidders are advised to consider such costs prior to submitting a sealed tender.

### **Attachments:**

The SRMA template and the cost sharing process information package are attached to this document as Appendix 1 and 2 respectively.

### **Contact**

Further details and direction regarding this matter are available from Wayne Hagel, Policy and Standards Specialist, Resource, Tenures and Engineering Branch at 250-387-6565 or [Wayne.Hagel@gov.bc.ca](mailto:Wayne.Hagel@gov.bc.ca).

Ministry of Forests and  
Range

DEPUTY MINISTER

## MEMORANDUM

File: 11200-00

JUL 26 2006

To:

All Regional Executive Directors  
All District Managers  
All Timber Sales Managers  
Director, BC Timber Sales Branch  
Director, Compliance and Enforcement Branch

From: Doug Konkin  
Deputy Minister

**Re: Shared Use Road Maintenance/Cost-Sharing Process**

Please be advised that, effective immediately, procedures for the shared forest road maintenance and cost-sharing process are to be adopted by ministry offices. These procedures shall apply to any new Timber Sale Licence (TSL) in situations where a TSL holder will be operating on forest roads (road permit/Forest Service road) maintained by a major licensee. Enclosed is the detailed information package, which includes procedures, road maintenance standards, and Standard Road Maintenance Agreement document. This documentation will also be available on the RTEB website at:  
[http://www.for.gov.bc.ca/hth/engineering/pol\\_pro\\_mld.htm](http://www.for.gov.bc.ca/hth/engineering/pol_pro_mld.htm).

This initiative has been finalized through the joint agency/industry group known as the Forest Engineering Steering Committee (FESC) with input from ministry personnel, including the Provincial Engineering Policy Committee.

It is believed that implementation of these procedures will assist in improved road maintenance practices, and be a factor in making forest roads safer for travel for forest workers. It is also expected that potential disputes between the road maintainer and TSL holders will be reduced.

Successful implementation of these procedures will require co-operation and work of BCTS, districts, and Compliance and Enforcement as follows:

All Regional Executive Directors  
All District Managers  
All Timber Sales Managers  
Director, BC Timber Sales Branch  
Director, Compliance and Enforcement Branch

- 1) BCTS will need to revise their Business Area procedures and licence documents, where appropriate, to:
  - address consultations with major licensees around roads maintained by those licensees;
  - complete the Standard Road Maintenance Agreement as required; and
  - ensure that the agreement is provided to the buyer of the TSL timber, or that the TSL holder pays the maintainer directly.
- 2) Districts will need to work cooperatively with major licensees and BCTS to incorporate the road maintenance standards into applicable road permits and road use permits.
- 3) Compliance and Enforcement staff will need to reinforce their commitment to road safety, and provide suitable levels of staff support to review road maintenance issues under this process.

If you have any questions, please contact Wayne Hagel, Policy and Standards Specialist, RTEB, directly at (250) 387-6565 or [Wayne.Hagel@gov.bc.ca](mailto:Wayne.Hagel@gov.bc.ca).



Doug Konkin  
Deputy Minister

Enclosures

## **SHARED ROAD MAINTENANCE/COST-SHARING PROCESS**

### **Information Package**

#### **A. BACKGROUND**

During the transition between the Forest Practices Code and the *Forest and Range Practices Act* (FRPA), it was determined by government that with the downsizing of staff, many decisions previously mediated/arbitrated by MOFR staff would be left to the proponents to resolve on their own. The current statutory framework provides for Commercial Arbitration as the fallback when two parties cannot reach agreement, as was the case in a recent decision involving shared road use and reasonable contributions to road maintenance costs. Based on feedback from industrial users, both large and small, the cost of such arbitration usually outweighs any potential cost recovery.

Over the last several years, there has been growing evidence of non-agreement between major licensees and Timber Sale Licence (TSL) Holders, as well as difficulties with collection of moneys owed for shared maintenance. This poor track record related to shared road use has come to the attention of the Forest Practices Board, politicians, and MOFR executive, field and headquarters staff. The joint agency/industry roads policy group known as the Forest Engineering Steering Committee (FESC) has been working with the ministry to find a workable solution to this problem. The FESC evaluated a number of options, particularly with a view to minimizing the amount of both ministry and company staff.

The following process is the result of considerable discussion and negotiation among the various stakeholders, and the process is provided as a best practice geared to resolve the majority of situations that may crop up around the province. There will undoubtedly be situations that cannot be addressed by this model, and may need further local attention to resolve each case.

#### **B. SAFETY FOCUS**

During the development of this package of shared use procedures, it became apparent to Forestry TruckSafe, as a part of the Forest Safety Council, that improved road maintenance was a key component in reducing fatalities and injuries to forest workers operating logging trucks. A results-based compendium of maintenance standards was recognized as a major step towards improving truck safety on our forest road network. These Road Surface Maintenance Standards are also included in this package.

#### **C. GUIDING PRINCIPLES**

1. The intent of this process is to better assure:
  - a) a reasonable cost of shared maintenance;
  - b) agreement to pay shared maintenance costs; and

- c) delivery of a level of road surface maintenance that will provide for industrial safety and protect the structural integrity of the road prism.
- 2. The major licensee, referred to for purposes of this process as the “Maintainer”, is responsible for upgrading a road where necessary to restore the surface to an acceptable industrial use standard. However, where the road has been and would otherwise be maintained to a wilderness level of maintenance, the cost for that work is to be borne either by
  - a) the BCTS Business Area entering directly into an agreement with the Maintainer, or
  - b) the TSL Holder carrying out the upgrading as part of their licence responsibilities when the Maintainer has opted to have the TSL Holder carry out the maintenance work by agreement.
- 3. If there are currently local agreements or arrangements that work, there is no intent to modify those arrangements. There may be a road user committee in place, with clear and acceptable terms and conditions for delivery of and payment for road maintenance, or an individual Maintainer may be delivering a suitable level of maintenance and currently reaching agreement with and collecting payments from secondary industrial users.
- 4. To apply this process to a road or road system to be used by one or more TSL Holders, firstly the Maintainer must confirm to the BCTS Business Area that it wishes to avail itself of the cost collection process provided for the particular timber sale. Then, the requirement to sign the Standard Road Maintenance Agreement is built into the timber sale license, and the road maintenance standards are incorporated into the specific major licensee road permits or road use permits and applied to those road sections covered by the Standard Road Maintenance Agreement.
- 5. For those FSRs where this process will apply, no additional deposits shall be taken on TSL Holder road use permits to satisfy potential maintenance obligations.
- 6. Should the Maintainer choose not to utilize this cost collection process, the only clause that would be added to a timber sale license document is one that commits the TSL Holder to agree to the terms and conditions of a road user committee, should one be operating on the roads serving the TSL. No changes would be made to the major licensee’s permits.

#### **D. ROAD SURFACE MAINTENANCE STANDARDS**

The Road Surface Maintenance Standards, incorporated into this document in the detailed procedures and included in the Maintenance Agreement Package, provide some guidance for the regulatory requirements to ensure an industrial level of safety and to protect the structural integrity of the road prism. Specifically related to the issue of shared use and maintenance, the standards provide an agreed-upon level of maintenance that will be provided for the secondary user for their given cost share.

## **E. MAINTENANCE COSTS AND COLLECTION OF FUNDS**

This Process, reflected in the Standard Road Maintenance Agreement template, provides for the costing of road maintenance in a consistent manner using the Coast and Interior Appraisal Manual tables as the basis. The cost is based on dollars per cubic metre of harvest. Often, the road network serving a specific timber sale may be comprised of a number of forest roads maintained by one or more Maintainers. The network may include roads under road permit as well as Forest Service roads under road use permit. The tabular cost of maintenance is apportioned to the various roads used to transport the TSL timber, based on the length of each road or road section pro-rated over the total length of forest roads serving the sale. As such, the total dollar amount for road maintenance may be distributed to more than one Maintainer, and may reflect the TSL Holder's own road maintenance operations for those roads under road permit or road use permit to that TSL Holder.

Where it is determined by the BCTS Business Area that the timber from the timber sale will be sold to one purchaser, whether it is a mill or a log broker, the Standard Road Maintenance Agreement will direct that purchaser to hold back the agreed-upon maintenance dollars and remit them to the Maintainer. Where the logs from a timber sale will be dispersed such that the eventual recipient of the wood is unknown, the Standard Road Maintenance Agreement will commit the TSL Holder to pay the Maintainer directly every 30 days the maintenance amount owing based on the scaled timber moved over the road during that period. Because the requirement to sign the Standard Road Maintenance Agreement and meet its terms and conditions will be a license requirement, failure to pay the owed maintenance dollars may result in the Timber Sales Manager utilizing the license deposit at the conclusion of the sale to satisfy the obligation.

## **F. DETAILED PROCEDURES:**

### ***Prior to Advertising a Timber Sale:***

If there are any road permit roads or Forest Service roads being maintained by a Maintainer that will access a new TSL, the Business Area will advise the Maintainer of the pending sale advertising, and ask the Maintainer whether or not they wish to avail themselves of the cost collection package.

The Maintainer must respond in writing within 5 working days as to their desire to utilize the cost collection process or not. Should the Maintainer fail to meet the time deadline, the default response will be **not** to use the process.

### ***Preparing the TSL package:***

a) if the Maintainer **will not be** utilizing the process:

- If there is no road user committee in place for the roads serving the TSL, no additional clauses will be added to the Timber Sale License. Any cost-sharing

agreements will be concluded outside of this process, and there will be no license or permit tie-in to any such agreements.

- If there is a road user committee in place for the roads serving the TSL, the BCTS Business Area will embed the following clause into the Timber Sale License:

“The Licensee must reach agreement with the \_\_\_\_\_ 'Road User Association' for payment for the use of roads accessing the License area, and must abide by the maintenance fee structure determined by that association. The Licensee must forward the signed agreement to the Timber Sales Manager prior to commencing harvesting.”

b) If the Maintainer *will be* utilizing the cost collection process:

- The BCTS Business Area will complete the Standard Road Maintenance Agreement and provide it in the timber sale package for the TSL Holder to sign and obtain the signature of the Maintainer. That Agreement will provide the maintenance cost per cubic metre of scaled volume off the Licence, and will also provide the distributed cost based on the individual and total lengths of forest road used to transport the TSL timber.
- The BCTS Business Area will incorporate the following clause in the TSL:

“The Licensee must enter into a Standard Road Maintenance Agreement (FS1287) in a form approved by the district manager, with the holders of any road permits and the maintainers of any Forest Service roads for roads that will be required for the transport of logs from the Licence area.”

The Licensee must forward the signed Standard Road Maintenance Agreement to the Timber Sales Manager prior to commencing harvesting.

The Licensee must pay the dollar amount specified in the Standard Road Maintenance Agreement to the road permit holder or maintainer, in the manner specified in that agreement. Failure to meet the requirements of the Standard Road Maintenance Agreement may be construed by the Ministry Official as a breach of this Licence.

#### ***Amending major licensee road permits and road use permits:***

Following consultation with the BCTS Business Area, the district will amend the specific road permit(s) and road use permit(s) that are currently issued to the Maintainer (referred to as the “Permittee” for purposes of road permits and road use permits), to add the following clauses (1 and 2) in Schedule A in each document:

1. The Permittee agrees that the following road maintenance standards will apply, and must be met by the Permittee during the life of the Standard Road Maintenance



Agreement, for the following roads and road sections (*enter those roads/sections that will be covered under a Standard Road Maintenance Agreement*):

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### **Road Surface Maintenance Standards**

2. The Permittee must maintain access and carry out repairs to restore access for any industrial use on the road during the period that the road is being used under the Standard Maintenance Agreement. Items of the Road Surface Maintenance Standards must be addressed in a timely manner to provide a suitable level of safety and quality of access for industrial users when a road is actively being used for industrial purposes.

#### **Drainage systems**

Ensure that road surface and slope drainage systems, including ditches, culverts and road crowning, insloping and outsloping, are functional.

#### **Brushing**

This work consists of cutting all vegetative growth, including trees and other vegetation on roadway surfaces and roadsides.

Brushing is required when one of the following conditions occur:

- a) Sight distance is impeded or reduced to the point that the limited sight distance is not safe for the road alignment.
- b) Where snow removal is an issue, brushing must be sufficient to accommodate snow placement beyond the road shoulder without impeding sight distance.
- c) Usable road width is reduced to the point that vehicles cannot safely pass each other at road widenings or turnouts.

Any dangerous trees that may reach the road surface must be felled in accordance with WorkSafe BC requirements.

#### **Road surface grading**

This work is to be done on roads other than those with ballast rock surfaces, and consists of utilizing a grader to perform surface grading to the road to a condition that will facilitate industrial use and provide proper road surface drainage and to prevent water pooling on the road. Grading includes shaping the crown or slope of the road surface and removing grader berms in accordance with this specification. Compaction may be required on those sections that will not stabilize by normal grading activities.

In addition, the Permittee must do the following:

- a) Perform surface grading during operational use of the road as often as needed to provide a road surface that self drains and minimizes road surface erosion.
- b) Grade and shape the existing road surface and shoulders, including turnouts, to produce a surface commensurate with road alignment (considering factors such as: smoothness, uniformity, crowning or cross sloping, etc.).
- c) Place or replace surface aggregate where necessary to achieve the objectives in (1) and (2) above.
- d) Unless otherwise specified, thoroughly loosen surfacing material by cutting, scarification or other methods to address the depth of potholes, rutting or washboarding, without causing contamination of the surfacing with the subgrade material or with unsuitable ditch materials.
- e) Grade only when moisture content is suitable, which may require the addition of water.

### **Turnouts**

Turnouts must be either intervisible or of a sufficient number given the traffic volumes and the use of radios on the road. They must be sized to accommodate the vehicles that are in regular use on the road.

### **Sign Maintenance**

This work consists of cleaning, replacing, and reconditioning signs, posts, and markers that currently exist or are the Permittee's responsibility to install. These include but are not limited to radio frequency call signs, information signs, kilometre markers, traffic control signs and bridge delineators.

### **Winter maintenance**

This section provides for winter maintenance of roads to facilitate logging operations and safe use.

The Permittee must do the following:

- a) Perform work in a manner to preserve and protect roads, including bridges and other structures.
- b) As part of ongoing winter log haul operations, remove snow from all or part of the travelled way, including sufficient turnouts, when operations become inefficient, and/or the road would be otherwise unsafe for industrial use.
- c) Do not undercut cut slopes.
- d) Do not blade gravel or other surfacing material off the road.
- e) Restrict snow removal to the usable road surface having roadbed support, including turnouts. Reshape over-width plowing as necessary to define the usable width.

- f) Wing back or breach snow banks to facilitate drainage at a sufficient number of locations to reduce water flow along road surfaces during periods of melt.
- g) Keep roadbed drainage ditches, drainage dips, and culverts functional during periods of melt.
- h) Add sand to the bladed road surface as needed to provide proper traction for industrial vehicles where chains will not be suitable or sufficient.
- i) With district manager approval, close roads to wheeled vehicles at times when use would be unsafe or when damage to the road could occur.

### **Completion of shared use**

When the shared use of a forest service road(s) under a Standard Road Maintenance Agreement has concluded, and the responsibility for maintenance is to be transferred to another user or back to the Ministry of Forests and Range, the road must be left in a condition that conforms with these maintenance standards. This may require that the Permittee return to the area after breakup or snowmelt to complete the necessary maintenance work.

## **G. FOLLOWUP AND ENFORCEMENT BY MINISTRY OF FORESTS AND RANGE STAFF ON ROADS UNDER ROAD MAINTENANCE AGREEMENT:**

During the life of the TSL, normally responding to complaints from the Maintainer, the BCTS Business Area will investigate any apparent breach of the Agreement by the TSL Holder in terms of payment for the maintenance work. Should the breach continue, the TSM may, at the conclusion of the sale, utilize the TSL license deposit to satisfy the shortfall in maintenance payments.

During the life of the sale, normally responding to problems found during routine monitoring by the BCTS Business Area or District staff, or as a result of complaints from a TSL Holder, Compliance & Enforcement staff may investigate the state of the road surface maintenance and take any necessary actions to ensure that the Maintainer complies with the terms of the Standard Road Maintenance Agreement.

Under section 63 (2) of the *Forest Practices Code of BC Act*, a person responsible for maintaining a road must maintain the road in accordance with a number of documents, two of which are a road permit and a road use permit. Accordingly, if the standards become part of a road permit or road use permit, failure to meet the standards may result in an offence or an administrative remedy, both enforced by Compliance and Enforcement.

Currently, this provision does not reside in FRPA. However, in both the Forest Road Regulation and the Forest Planning and Practices Regulation, roads must be maintained to:

- protect the structural integrity of the road prism and clearing width, and
- ensure that the road can be used safely by industrial users.

Therefore, while enforcement of the permit is not available to Compliance and Enforcement under FRPA, they may use the road surface maintenance standards as an interpretive guide reflecting the expected level of maintenance to accomplish the regulatory requirements. However, site-specific circumstances will govern.



## STANDARD ROAD MAINTENANCE AGREEMENT



Road Permit/Forest Service Road Name(s)/Number(s) and length(s) _____ _____ to which this agreement applies, and shown on the attached map (optional) Major Licensee Name (Maintainer) _____ TSL Holder Name _____ TSL # _____
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- For the purposes of Section 22.3 of the *Forest and Range Practices Act* (FRPA), this serves as a written notice and is an agreement for the payment of a reasonable contribution to the expense of maintaining the road(s) described above.
- The Maintainer agrees to provide a level of road maintenance as described in the "Surface Maintenance Standards" below for the roads described above.
- The TSL Holder agrees, for all timber grades scaled from the timber sale license described above, to pay the Maintainer \$\_\_\_\_\_/m<sup>3</sup> for the use of the road(s) described above, based on the following maintenance option and Formula \*(the Maintainer selects one):

- ☐ the Maintainer will carry out all of the required surface maintenance on behalf of the TSL Holder [100% of the appraisal manual price/m<sup>3</sup> distributed in accordance with the Formula\*]
- ☐ the TSL Holder will carry out the required surface maintenance work on the road(s) and indemnifies the Maintainer against any potential liabilities with respect to the maintenance of the road during the period that the TSL Holder is carrying out the maintenance work [25% of the appraisal manual price/m<sup>3</sup> distributed in accordance with the Formula\*]

\*Formula for distributing maintenance dollars to this road:  
 $(A/T) \times M$  where, as determined by the Timber Sales Manager:

A = number of km of Forest Service road and road permit road covered by this agreement  
 T = total number of km of Forest Service roads and road permit roads used for transporting timber from this TSL  
 M = price per cubic metre for road management/maintenance derived from the appropriate portions of either the *Interior Appraisal Manual* or the *Coast Appraisal Manual*.

- The TSL Holder agrees to pay the amount calculated under paragraph 3 in the following manner [TSM selects the option below based on the disposition of the timber]
- ☐ **OPTION A (where the timber is dispersed and not trackable):** directly to the Maintainer every 30 days; or

- ☐ **OPTION B (where the timber is sold and tracked to one or more buyers):** by copy of this Agreement, authorizing the buyer of the timber from the TSL to hold back this amount from the purchase price of the timber and forward this amount to the Maintainer directly every 30 days.
5. The TSL Holder must cease all industrial use of any road or sections of road to which this Agreement applies that have any of the following conditions due to use of the road:
- A. Rutting to the point that there is mixing of subgrade material with surfacing material, which can occur during thawing of the road or during periods of road saturation
  - B. Damage to the subgrade
  - C. Surfacing material is eroding due to flowing water on the road.
6. In addition, the TSL Holder must notify the Maintainer of any situations observed to be having a negative impact on the roads or users of the roads.

_____ Maintainer Signature	_____ Date
_____ TSL Holder Signature	_____ Date

## 2. Road Layout

### 2.1 Introduction

Access is a primary consideration in planning forest development. Although the principles for determining road locations apply to both main and secondary Forest Service Roads (FSRs), secondary roads are more site-specific to the harvesting system and the equipment used. For this reason, secondary roads are the focus of this chapter. Decisions made at the route selection stage may have significant effects on road construction and maintenance costs, user safety, and other resources. Select and locate routes to meet the objectives of higher-level plans within the constraints of any approved operational plans, or permits. Road layout is a process of route selection based on pre-field investigation and field reconnaissance to determine a site-specific road location. The level of detail and the type of information required for road layout depends on the required road design standards, the complexity of terrain, the size and complexity of stream crossings, and the need to consider other resource values.

Road layout includes pre-field and field reconnaissance works that address safety and resource issues directly or lead to suitable applications at the survey, design and construction stages. Practices include:

- field determination of any signs of landslide prone terrain;
- professional terrain and fan stability assessments;
- riparian classification of streams near the road;
- applying qualified personnel to the project;
- selecting the optimum route;
- preparing a field reconnaissance report that addresses: road survey instructions, seepage, locations of springs and licensed waterworks in community watersheds, resource features, wildlife habitat features, and road alignment controls where no geometric road design will take place;
- flagging and traversing the proposed road centre-line;
- field check of the proposed road location by professionals and FLNR staff; and
- sign-off of the approved location by FLNR professional

This chapter presents the ministry's mandatory procedures and best practices related to pre-field and field investigation, and to the associated outputs. It is intended to provide the reader with enough detail to be able to understand the processes and expected mandatory procedures, as well as ensuring that the road meets the regulatory requirements related to safety and protection of other resources.

## 2.2 Policy

The location of a proposed Forest Service Road will optimize operational needs, maximize safety, and minimize cost, and environmental impacts.

## 2.3 Mandatory Procedures and Best Practices

The *Forest and Range Practices Act* (FRPA) and the Forest Planning and Practices Regulation (FPPR) require Timber Operations and Pricing Division/BCTS to construct a Forest Service road in a manner that achieves certain resource protection objectives or meets specific criteria. In doing so, a key component of a road's development is the layout of the road.

To address safety, resource protection and mitigation measures related to road layout, provide appropriate levels of expertise and resources to pre-construction of a road, and suitable checks and balances to ensure that the work is proceeding according to plan.

For each regulatory requirement, ensure that:

- suitable levels of data collection are applied;
- professional input is obtained as required;
- reconnaissance information is appropriate in terms of quality and quantity; and
- assurance that the necessary steps were taken and issues addressed (see [Project Tracking Checklist](#)).

Following is a table that summarizes in approximate chronological order the mandatory procedures and best practices with respect to the layout of Forest Service roads.

**Table 2-1 Road Layout**

Results to be achieved:

- FSP results/strategies are achieved or carried out for visual quality or cultural heritage resources (FRPA s. [21\(1\)](#))
- do not cause landslides or gully processes that would have a material adverse effect on forest resources (FPPR s. [37,38](#))
- maintain natural surface drainage patterns (FPPR s. [39](#))
- no construction of a road in a riparian management area (FPPR s. [50](#))
- no fan destabilization that would have a material adverse effect on forest resources (FPPR s. [54](#))
- no road construction within a specified distance from a spring in a community watershed, or within 100 m upslope of a licensed waterworks in a community watershed (FPPR s. [60, 62](#))
- comply with any general wildlife measures, or do not damage or render ineffective any resource feature or wildlife habitat feature (FPPR s. [69, 70](#))
- road is safe for industrial use (FPPR s. [72](#))

Legislation supported: FRPA section [21\(1\)](#), FPPR sections [37, 38, 39, 50, 54, 60, 62, 69, 70, 72](#)



B1.	Ensure that the person conducting field reconnaissance has established skill sets. [see <a href="#">Field</a> <a href="#">Section 2.5.1</a> ]
B2.	Mark the centreline of all proposed routes with intervisible flagging tape, and include cumulative chainages and control points on the flagging tape. [see <a href="#">Field</a> <a href="#">Section 2.5.1</a> ]

Legislation supported: FRPA section <a href="#">21 (1)</a> : visual and heritage resources results/strategies achieved	
B3.	Ensure that appropriately qualified forest visuals professionals and archaeological professionals carry out office and field reviews as necessary to ensure that the road layout achieves the visual and cultural objectives. [see <a href="#">Use of Appropriate Professionals</a> <a href="#">Section 2.5.6</a> ]
B4.	Consider the visual impacts of the road and the road corridor on the surrounding landscape. Where visual quality objectives (VQOs) have been established or visual impact issues can be foreseen, consider alternate route locations to lessen the visual impact of road [see <a href="#">Visual Impact</a> <a href="#">Section 2.4.3</a> ].

Legislation supported: FPPR sections <a href="#">39</a> : maintaining natural surface drainage patterns	
B5.	Ensure that the field reconnaissance report includes information about all continuous and intermittent drainage flow channels, springs, seeps, and wet areas [see <a href="#">drainage</a> <a href="#">Section 2.6</a> ]

Legislation supported: FPPR section <a href="#">50</a> : no construction in a riparian management area except as provided	
B6.	Ensure that the field reconnaissance report identifies the riparian areas of the streams near the road. [see <a href="#">riparian</a> <a href="#">Section 2.6</a> ].
B7.	Ensure that the layout places the road beyond the riparian management areas for each stream, except as provided in section 50 (1) of FPPR [see <a href="#">Riparian</a> <a href="#">Section 2.5.3</a> ].
B8.	Ensure that the field reconnaissance report identifies the fish stream crossings, so that suitable crossing structures can be designed and built. [see <a href="#">stream crossings</a> <a href="#">Section 2.6</a> ].

Legislation supported: FPPR section <a href="#">54</a> : no fan destabilization	
B9.	Where a proposed road will cross an alluvial or colluvial fan, ensure that an appropriately qualified professional carries out a fan stability assessment to determine the potential impact on forest resources from debris flows, debris floods or water floods. [ see <a href="#">fan destabilization</a> <a href="#">Section 2.5.1</a> ]

Legislation supported: FPPR sections <a href="#">60</a> , <a href="#">62</a> : no construction near licensed waterworks or springs in a community watershed	
B10.	Ensure that road layout and field reconnaissance report identify licensed waterworks and springs in community watersheds [see <a href="#">locations</a> <a href="#">Section 2.6</a> ], and, unless there is an exception in accordance with FPPR, the layout places the road centre-line so as not to damage a waterworks and to achieve at least 100m distance from any such waterworks or springs in community watersheds.

Legislation supported: FPPR sections <a href="#">69</a> , <a href="#">70</a> : wildlife measures, resource features and wildlife habitat features	
B11.	Ensure that the field reconnaissance report determines potential impacts on other resources, so as to locate roads in such a manner as to address general wildlife measures, resource features or wildlife habitat measures. [see <a href="#">applications</a> <a href="#">Section 2.5.1</a> ]

Legislation supported: FPPR section <a href="#">72</a> : roads and structures are safe for industrial users	
B12.	Where no geometric road design will be required, ensure that the field reconnaissance report provides suitable horizontal and vertical road alignment criteria in a road layout and design schedule. [see <a href="#">maximum Section 2.6</a> ]
M1.	A terrain stability assessment <b><i>must</i></b> be conducted by a qualified professional to determine whether measures are required to reduce the likelihood of a landslide occurring, or to reduce the likelihood of a landslide affecting forest resources, in the following situations: <ul style="list-style-type: none"> <li>• terrain stability mapping indicates that the road is located on terrain that is unstable or potentially unstable;</li> <li>• the mapping referred to in paragraph (a) has not been done, and the road is located on terrain with slopes greater than 60%; or</li> <li>• the road is located on terrain where there are indicators of slope instability.</li> </ul> [see <a href="#">terrain stability Section 2.5.1</a> ]
B13.	Ensure that the professional specialists who have been retained to do the work are in fact qualified to do this work. [see <a href="#">Use of Appropriate Professionals Section 2.5.6</a> ]
B14.	Ensure that each reconnaissance report addresses terrain conditions and road sections that are in unstable or potentially unstable terrain. [see <a href="#">Field Reconnaissance Report Section 2.6</a> ]
Legislation supported: FRPA sections <a href="#">21 (1)</a> , FPPR sections <a href="#">37</a> , <a href="#">38</a> , <a href="#">39</a> , <a href="#">50</a> , <a href="#">54</a> , <a href="#">60</a> , <a href="#">62</a> , <a href="#">69</a> , <a href="#">70</a> , <a href="#">72</a>	
B15.	Ensure that the necessary steps in the road layout process were undertaken and issues addressed [see <a href="#">Project Tracking Checklist</a> ]

## 2.4 Pre-Field Investigation

### 2.4.1 Route Selection

Allocate adequate time and resources to route selection. The route selection stage begins with the collecting and analyzing of all available information for the development area, focusing on the route corridor.

The first step in determining a road location is the pre-field investigation, which includes:

- carrying out a thorough map and air photo review; and
- preparing a working map of the area that shows study area boundaries, existing access, major drainages, land alienations, and other key planning elements.

### 2.4.2 Maps and Air Photos

Maps and air photos are a major source of information for examining terrain features and collecting information about the study area. Use the following types of maps at 1:5,000 or 1:10,000 scale for pre-field preparation, particularly for difficult or broken terrain:

- contour maps;

- Terrain Resource Information Management (TRIM) maps;
- forest cover maps; and
- soil and landform maps, terrain and stability maps, and ortho imagery.

Use the most recent series of air photos in conjunction with the available maps, to interpret physical features, drainage, and forest cover. Photo scales at 1:15,000 and 1:20,000 enable detail to be examined, although 1:60,000 photos are helpful for general landform orientation.

Complete an in-depth review of the maps and air photos to identify features and control points along potential route (“recce”) locations, including:

- stream crossings where location is critical;
- rock bluffs, benches, passes, saddles, and other dominant terrain features;
- potential switchback locations;
- harvesting systems and potential location of landings;
- potential disposal sites for excavation spoil or debris;
- alienated lands, including powerline, gas pipeline, or railway crossings;
- current access to and junction with existing roads;
- log dumps, mill yards, or other destinations;
- avalanche chutes;
- talus slides;
- swamps and wet areas;
- forest cover and stand condition; and
- potential environmentally sensitive areas.

### 2.4.3 Visual Impact

Consider the visual impacts of the road and the road corridor on the surrounding landscape. Where visual quality objectives (VQOs) have been established or visual impact issues can be foreseen, consider alternate route locations to lessen the visual impact of road. However, consider the impact of any increased costs to do so in evaluating the route alternatives. The [Visual Impact Assessment Guidebook](#) provides details for consideration in the layout of forest roads.

### 2.4.4 The Working Map

The working map provides a visual summary of all information gathered during the pre-field investigation. Once assembled, it provides a picture of:

- an outline of the study boundaries;
- the location, volume, and species of timber to be accessed;

- alienations that may apply to the access development, such as Indian Reserves or private property and utilities;
- location of administrative, environmental, special interest, and land status concerns, including Visual Quality Objectives (VQOs); and
- specifications that may affect the access itself, such as grade, alignment, haul requirements, or the needs of other users.

In developing working maps, carry out the following steps:

- Establish control points (including those to be used as photo ties) that may affect physical access or define where the road reconnaissance needs to be.
- Establish a minimum of one photo tie per kilometer.
- Use the maps and air photos to locate the reconnaissance routes that most effectively and economically connect the control points and meet the general specifications for road grade and travel speed.
- Mark the control points and proposed route locations on the air photos for verification during field reconnaissance.
- If 1:5,000 or 1:10,000 topographic mapping is available, check the grades along the proposed route options. Position roads away from water bodies and wetlands. Avoid areas of potential open-slope instability, potential surface soil erosion, and gully instability. Locate roads on benches, ridge tops, and flatter slopes to minimize erosion. Avoid erosion hazards such as:
  - heavy groundwater seepage;
  - soft clay or sensitive silt soil strata;
  - concave slopes;
  - steeply dipping rock layers; and
  - areas where there is a hazard of high mass wasting or erosion, including downslope sensitive areas.
- Select stream crossings at locations where channel and bank disturbance will be minimized. Keep the number of stream crossings to a minimum.

### 2.4.5 Land Alienations

Check the land status of an area as a prerequisite for road layout, to identify alienated lands and other potential conflicts that may require right-of-way (R/W) acquisition.

Alienations and interests or conflicts that may require R/W acquisition generally fall into one of the following categories:

- fee simple land;
- provincial government leasehold/tenure/interest;
- reserve by Ministerial Order/OIC; or

- federal reserve.

Where applicable, notify land owners of the intent to enter. However, avoid any discussion concerning possible land acquisition (and, in particular, expropriation). Limit discussions to the topic of access being required for reconnaissance purposes only. Also, advise a landowner that, should the ministry require legal access across the property, then a Forest Land Acquisitions Project Manager would contact the landowner to begin negotiations. If a landowner refuses ministry staff entry onto the property, contact FLNR Forest Land Acquisitions for further advice on how to proceed or how to negotiate the short-term access.

Do not assume that the occupant of a site is the landowner. Obtain information on the name of current landowners from the FLNR Forest Land Acquisitions in Victoria.

#### **2.4.6 Government Interests**

Based on potential conflicts that become evident during the road layout process, consider any concerns from the following government agencies, both provincial and federal, about the area and information to be included in plans for development of access for the timber resource:

- [Ministry of Environment](#) (provincial);
- [Environment Canada](#) (federal);
- [Ministry of Transportation and Infrastructure](#) (provincial)
- [Transport Canada](#) (federal; [Navigable Waters Protection Act](#));
- [Ministry of Energy and Mines](#) (provincial; placer leases and mining claims);
- [Oil and Gas Commission](#) (provincial); and
- [Ministry of Agriculture](#) (provincial; Agricultural Land Reserve).

### **2.5 Field Reconnaissance**

The process of field reconnaissance has three primary objectives:

1. investigate potential route corridors considering all of the elements, including reviews of optional locations and the constraints of the harvesting system that would contribute to the final location of the road;
2. gather information for subsequent use by the road survey and design contractor, and to assess the need for any additional information or assessments; and
3. flag the reconnaissance line of the preferred road location using field traverse Survey Level 1 standards as required. See [3.4.2: Survey Level 1: Field Traverse](#).

### 2.5.1 Field Reconnaissance Procedures

Ensure that the person conducting field reconnaissance has established skill sets. Refer to [Engineering Equipment and Services \(EES\) Directory](#).

Carry out the following reconnaissance steps:

1. Walk the proposed routes.
2. Mark the centreline of all proposed routes with intervisible flagging tape, using hand instruments for direction and grade control. Maintain horizontal control with a hand-held compass and a hip chain; and maintain vertical control with clinometer readings. Handheld GPS units may be used to establish the centreline where road grades are not an issue and the operator ensures that sufficient satellite coverage is available. Measure side slopes with a clinometer, and record average readings for consistent topographic sections.
3. Note the grades between control points. Keep road gradients within specifications.
4. Mark cumulative chainages and TP numbers on the flagging tape with felt pen. Mark curves with flagging by approximating the best alignment.
5. Mark control points used as photo ties on the ribbon line, noting the air photo tie number and the air photo numbers.
6. Where a location survey is not required for the project because of the easy terrain, reference all control points and flag the right-of-way boundaries.
7. Record side slopes between control points.
8. Provide detailed notes on soils and topographic features, including:
  - stream crossings where channel and bank disturbances can be prevented or mitigated, locations that require site plans, and data required for minor stream crossings;
  - forest cover (species composition, timber quality, and volume per hectare);
  - recommended slash and debris disposal methods and additional clearing widths required for the slash and debris disposal;
  - soil types based on visual observations of exposed cuts, shallow hand-dug test holes and probing, and the location of these soils on maps or aerial photos;
  - maximum road grades and minimum curve radii;
  - location and extent of bedrock, if rippable, and the potential as ballast;
  - location and extent of gravel sources and the potential for use as

- subgrade and surfacing materials;
  - endhaul sections and potential waste areas;
  - recommended construction methods and potentially appropriate alternatives; and
  - recommended survey level or levels appropriate for the terrain. See [Chapter 3.4.2: Survey Levels](#);
9. Note harvest opportunities and access requirements.

As part of any field reconnaissance, confirm or evaluate the need for any additional information or assessments, including:

- terrain stability field assessments for roads;  
A terrain stability assessment ***must*** be conducted by a qualified professional to determine whether measures are required to reduce the likelihood of a landslide occurring, or to reduce the likelihood of a landslide affecting forest resources, in the following situations:
  - (a) terrain stability mapping indicates that the road is located on terrain that is unstable or potentially unstable;
  - (b) the mapping referred to in paragraph (a) has not been done, and the road is located on terrain with slopes greater than 60%; or
  - (c) the road is located on terrain where there are indicators of slope instability.

Ensure that the professional carries out the assessment in accordance with the APEGBC [Guidelines for Terrain Stability Assessments in the Forest Sector](#).

- riparian classification of streams, wetlands, and lakes;
- identification of fish streams;
- visual impact assessments;
- applications of general wildlife measures, and protection of resource features and wildlife habitat features;
- fan destabilization and a gully process (for coastal BC) (see fans and gully);
- archaeological impact assessments; and
- soil erosion field assessments.

### 2.5.2 Specific Concerns

Consider the following items during reconnaissance:

1. **Vertical alignment:** The grades that result in the best combination of haul and construction costs should be selected. See [Chapter 3 Table 3-2: Summary of alignment controls for forestroads](#).
2. **Horizontal alignment:** The speed limits for various degrees of curvature are given in [Chapter 3 Table 3-3: Curve Widenings](#).
3. **Junctions:** A high level of safety ***must*** be maintained in selecting a site for a junction. The following factors should be incorporated as much as possible:
  - adequate sight distance in both directions in accordance with the normal travel speed (up to 65 km/h, 100 m; and 65–80 km/h, 150 m);
  - near-level ground conditions (2% plus or minus);
  - right angle T-junctions rather than Y-junctions; and
  - only gradual change in horizontal or vertical alignment.
4. **Soils:** For locating roads, landforms can be excellent guides to desirable areas or to areas to avoid. Alluvial terrains, lacustrine deposits, water melt channels, colluvial deposits, alluvial fans eskers, and kames are strong indicators of the types of soils to be found below the surface. Easily accessible gravels, found in alluvial fans or kames, are an economical source of surfacing material. Glacial moraines, which contain relatively unsorted material, are a good source of subgrade material. Other glacial deposits that can provide subgrade or surfacing materials are basal tills and drumlins.
5. **Riparian Management Areas:** Ensure that riparian classifications are identified for streams near the road location, and that the road layout places the road beyond the riparian management area for each stream, except as provided in section [50 \(1\) of FPPR](#).

Plan on obtaining any large fragmented rock required for road ballast or rip rap from rock outcrops (quarries) or talus slopes. Avoid very fine-grained soils of lacustrine origin, particularly for sidehill construction.

Illustrations of the landforms mentioned here are found in [Terrain Classification System for British Columbia](#).

### 2.5.3 Drainage Structures

Some of the most important control points reviewed during a field investigation are those used to locate bridges and culverts.

#### Bridge Location

Locate a bridge site to provide an acceptable horizontal and vertical alignment for the road, considering:

- stream width;



- upstream and downstream watercourse alignment;
- streambank stability;
- whether streambanks are fairly even in height on both sides;
- availability of local materials for construction;
- access to both sides of watercourse during construction phase;
- potential for ice and debris buildup; and
- potential for streambank erosion.

Ideally, locate the crossing of a waterway at right angles to the centreline of the waterway and include approach tangents of a minimum 15 m in length. Limit the maximum grade on a bridge deck to 4%, but preferably less.

### Major Culvert Location

In planning for major culverts, use much of the same location criteria as used for bridges. Refer to the [Fish-stream Crossing Guidebook](#).

## 2.5.4 Harvesting Requirements

As the field investigation proceeds, consider the harvesting systems that will affect on block roads.. For detailed information on total chance plans and mainline roads, see FPI Innovations ( FERIC) Handbooks No. 4: [Timber Development Planning for the British Columbia Interior: The Total Chance Concept](#), and No 9: [Forest Harvesting and Renewal Planning for the British Columbia Interior: An Extension of the Total Chance Concept](#), which cover planning considerations and logging methods for various types of terrain.

## 2.5.5 Use of Appropriate Professionals

To adequately manage and conserve forest resources, ensure that qualified professional specialists are consulted where appropriate. Site-specific conditions will dictate what the critical impacts and risks will be, but in general specialists might include those in the fields of terrain stability, stream morphology, structural engineering, aquatic and marine habitat, archeology, wildlife, botany, visual impacts, and forestry. Ensure that the professional specialists who have been retained to do the work are in fact qualified to do this work. See [Engineering Equipment and Services \(EES\) Directory](#) for those categories related to road engineering, and for these particular categories, consult with the ministry engineering professionals and have them:

- assess a consultant's qualifications prior to retaining the consultant under a service contract; and
- assist with service contract language.

## 2.6 *Field Reconnaissance Report*

Regardless of the complexity of the project, incorporate critical factors that will influence the final road location in a field reconnaissance report.

Depending on the site, prepare a reconnaissance report that ranges in size and detail from a map showing route locations, a one-page summary and field notes to a multiple page document outlining in detail the various options for route locations. The determining factor is the level of comfort with the quality of information, given the risks and potential impacts of the project. In general, ensure that each reconnaissance report includes a map showing route locations and addresses the following:

- the need, if any, for any additional information or assessments to be carried out by the appropriate professionals;
- terrain conditions and road sections that are in unstable or potentially unstable terrain;
- road sections with side slopes over 60% or where slope instability indicators are found;
- control points and topographic features (e.g. , rock bluffs, swamps, avalanche paths, landslides, and debris slides), including those that may be used as photo ties;
- the sections of road that encroach on public utilities;
- the sections of road that are adjacent to or cross private property, Crown leases, or mineral and placer claims or leases (where possible, alienated lands should be avoided);
- all continuous and intermittent drainage flow channels, springs, seeps, and wet areas;
- riparian areas;
- stream crossings where channel and bank disturbances can be prevented or mitigated;
- locations of springs and licensed waterworks in community watersheds;
- locations that require site plans;
- minor stream crossings;
- forest cover (species composition, timber quality, and volume per hectare);
- potential landing locations;
- soil type, based on visual observations of exposed cuts, shallow hand-dug test holes, and probing, and the location of these soils on maps or aerial photos;
- maximum road grades and minimum curve radii;
- location and extent of bedrock, if rippable, and the potential as ballast;

- location and extent of gravel sources and the potential for use as subgrade and surfacing materials;
- endhaul sections and potential waste areas;
- recommended construction methods and potentially appropriate alternatives;
- recommended survey level or levels appropriate for the terrain; and
- harvesting system requirements.

## **2.7 Resources and Suggestions for Further Reading**

Technical solutions to field problems or recommended processes can generally be found in publications such as:

BC Ministry of Forests. 1999. [Mapping and assessing terrain stability guidebook](#). For. Prac. Br., B.C. Min. For. Victoria, B.C.

\_\_\_\_\_. 1992. Forest inventory manual: forest classification, sampling and environmentally sensitive areas. Vol. 2. Inventory. Br., B.C. Min. For. Victoria, B.C. 161 p.

BC Ministry of Sustainable Resource Management. 1996. [Terrain stability mapping in British Columbia](#). For. Prac. Br., B.C. Min. For. Victoria, B.C.

Braedon, R.E. 1990. [Forest harvesting and renewal planning for the British Columbia interior: an extension of the total-chance concept](#). FERIC handbook No.9. For. Eng. Research Inst. Can. (FERIC). Vancouver, BC. 49 p.

Braedon, R.E. 1983. [Timber development planning for the British Columbia interior: the total chance concept](#). FERIC handbook No.4. For. Eng. Research Inst. Can. (FERIC). Vancouver, BC. 73 p.

Chatwin, S.C., D.E. Howes, J.W. Schwab, and D.N. Swanston. 1994. [A guide for management of landslide-prone terrain in the Pacific Northwest](#). 2nd ed. B.C. Min. For., Victoria, BC. Land Manage. Handb. No. 18. 220 p.

Holmes, D.C.. 1989. Manual for roads and transportation. British Columbia Institute of Technology (BCIT). Burnaby, BC

and various other technical bulletins and handbooks commonly used by the forest industry and the BC Ministry of Forests, Lands and Natural Resource Operations.

## Appendices

### Appendix 2.1: Project Tracking Checklist

<i>Project Tracking Checklist</i>		
Use this checklist to prepare a paper trail of key outputs prepared by consultants and sign-offs by FLNR.		
Element Being Reviewed & Results Achieved		Date of FLNR sign-off
<b>ROAD LAYOUT</b>		
Ensured that the centre line was flagged with appropriate chainages and control points indicated	YES NO N/A	_____
Did an appropriately qualified person carry out the field reconnaissance? If YES, <b>Person's Name and Company:</b> _____	YES NO N/A	_____
Ensured that a field reconnaissance report (including design specifications) was prepared	YES NO	_____
Ensured that road locations were: <ul style="list-style-type: none"> <li>&gt;100m from springs or licensed waterworks in community watersheds and outside of riparian management areas, or if NO:</li> <li>such locations were in accordance with the regulatory exemptions</li> </ul>	YES NO N/A  YES NO N/A	_____
Ensured that road locations (check one) <ul style="list-style-type: none"> <li>address general wildlife measures,</li> <li>do not damage or render ineffective any resource feature or wildlife habitat</li> </ul>	YES NO N/A  YES NO N/A	_____
Carried out a road layout field review, and ensured that professional measures based on assessments were incorporated into the road layout.	YES NO	_____
Determined that a visual assessment was required	YES NO N/A	_____
Did an appropriately qualified licensed professional carry out a visual assessment? If YES,		_____

<b>Professional's Name and Company:</b> _____ _____	YES NO N/A	_____	_____
Determined that an archaeological impact (cultural heritage) assessment was required  Did an appropriately qualified licensed professional carry out an archaeological impact assessment? If YES, <b>Professional's Name and Company:</b> _____	YES NO N/A  YES NO N/A	_____  _____	_____  _____
Determined that a terrain stability assessment was required  Did an appropriately qualified licensed professional carry out a terrain stability assessment? If YES, <b>Professional's Name and Company:</b> _____	YES NO N/A  YES NO N/A	_____  _____	_____  _____
Determined that a fan stability/gully assessment was required  Did a n appropriately qualified licensed professional carry out a fan stability/gully assessment? If YES, <b>Professional's Name and Company:</b> _____	YES NO N/A  YES NO N/A	_____  _____	_____  _____
<u>Statement of Road Layout Conformance signed off (P.Eng, RPF, RFT)</u>	YES NO	_____	_____

## Appendix 2.2: Statement of Road Layout Conformance

TO BE COMPLETED BY QUALIFIED REGISTERED PROFESSIONAL **AFTER** COMPLETION OF THE  
ROAD LAYOUT AND THE ROAD DESIGN

Road Name	Project #	Forest District/Business Area
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I am a (check one) ☐ Registered Forest Technician, ☐ Professional Engineer or ☐ Professional Forester, registered with the appropriate professional association in British Columbia, and I have undertaken professional responsibility as the Coordinating Professional for all field and office reviews required with respect to the layout and design of this road. I have taken steps as regulated under the Provincial Statute for my profession and required by good practice in order to sign and seal this Schedule.

### Road Layout:

In my professional opinion:

- The road layout has incorporated the necessary professional assessments, carried out by appropriately qualified professionals;
- The road layout is in general conformance with the reconnaissance report; and
- appropriate field reviews have been carried out to confirm the above.

Signature (and seal as appropriate) of Professional	
Name of Professional (please print)	DATE SIGNED YYYY M M DD

## 3. Road Survey and Design

### 3.1 Introduction

Route reconnaissance is usually the first on the ground location work used to define the general position of a road. Based on the reconnaissance and reconnaissance summary, further investigations and surveys may be required, including field traverses and surveys to an established standard or Survey Level. The level is determined primarily by the complexity of the terrain and end results required. Once the survey has been completed, the road design can be carried out.

Road design varies in complexity and can be as simple as providing basic road dimensions and grades required to a more detailed design to establish excavation and fill volumes, grades and alignments. In most cases, road design is usually an office process utilizing computers and road design software. Again, depending on the complexity and end results required, further road survey work may be required to establish the road location.

Road survey and design includes applying the appropriate level of survey to achieve the required accuracy of field measurements, and preparing a geometric road design (including plans, profiles, cross-sections and mass graphs) based on the survey measurements, data and assessments, to tie the location of the road to the land base. Practices include:

- carrying out a location survey;
- incorporating professional assessments from the road site plan, including any strategies or objectives that are necessary;
- marking locations of cross drain culverts;
- locating roads outside of riparian management areas;
- consideration of sediment transport and deposition;
- locating roads appropriate distances from licensed waterworks in community watersheds;
- suitable clearing widths to address topographic and operational needs; and
- sign-off of approved design by appropriate professional

This chapter presents the ministry's standards related to road location survey and road design practices, and to the associated output. It is intended to provide the reader with enough detail to be able to understand the mandatory procedures, as well as carrying out appropriate best practices to address the applicable regulatory requirements.

### 3.2 Policy

For any FSR, the road will be:

- surveyed with appropriate detail and accuracy for the terrain and complexity of the layout; and
- designed in a manner that:
  - is commensurate with the level of survey and expected use, cost and potential impacts on other resources by the road construction; and
  - incorporates the results of any required assessments.

### 3.3 **Mandatory Procedures and Best Practices**

The Forest Planning and Practices Regulation (FPPR) requires the government to construct a Forest Service road in a manner that achieves certain resource protection objectives or meets specific criteria. One component of a road's development that addresses such objectives or criteria is its survey and design.

To address safety, and resource protection and mitigation measures related to road layout, it is necessary to provide appropriate levels of expertise and resources to pre-construction of a road, and suitable checks and balances to ensure that the work is proceeding according to plan.

Following is a table that summarizes in approximate chronological order the mandatory procedures and best practices with respect to the survey and design of Forest Service roads.

**Table 3-1 Road Survey and Design**

Results to be achieved:	
<ul style="list-style-type: none"> <li>• compliance with the road site plan (FRPA s. <a href="#">10</a>)</li> <li>• do not cause landslides or gully processes that would have a material adverse effect on forest resources (FPPR s. <a href="#">37,38</a>)</li> <li>• maintain natural surface drainage patterns (FPPR s. <a href="#">39</a>)</li> <li>• no construction of a road in a riparian management area (FPPR s. <a href="#">50</a>)</li> <li>• no fan destabilization that would have a material adverse effect on forest resources (FPPR s. <a href="#">54</a>)</li> <li>• protection of fish passage (FPPR s. <a href="#">56</a>)</li> <li>• no deposition or transport of deleterious materials into licensed waterworks drinking water (FPPR s. <a href="#">59</a>)</li> <li>• no road construction within a specified distance from a spring in a community watershed, or within 100 m upslope of a licensed water intake or spring in a community watershed (FPPR s. <a href="#">60, 62</a>)</li> <li>• road is safe for industrial use (FPPR s. <a href="#">72</a>)</li> </ul>	
Legislation supported: FPPR sections <a href="#">37, 38, 57, 59, 69, 70, 72</a> ; do not cause landslides or gully processes that will have a material adverse effect on forest resources	
B1.	Ensure that at least a location survey level 3 is carried out for roads crossing landslide prone terrain. [see <a href="#">Survey Level 3 Section 3.4.2</a> ]
M1.	A geometric road design <b>must</b> be carried out for all roads that will cross areas with a moderate or high likelihood of landslides. [see <a href="#">Geometric Road Design Requirements Section 3.8</a> ]
B2.	Ensure a geometric road design is carried out for all roads that will cross areas on side slopes greater than



50%. [see [Geometric Road Design Section 4.7](#)]

- B3. Ensure that the road design incorporates any measures prepared by an appropriately qualified professional to protect user safety, fish, fish habitat, water quality, wildlife, wildlife habitat features, visual and heritage resources. [see [Incorporate Section 3.6.1](#)]

Legislation supported: FPPR section 39: maintain surface drainage patterns

- B4. Ensure that locations of proposed cross drain culverts are marked on the road plans, subject to on-site modification. [see [Cross Drain Section 3.7](#)]

Legislation supported: FPPR section 50: no construction in riparian management areas, except as provided

- B5. Ensure that the road is designed in the location identified by the layout, and where no exception has been provided in accordance with FPPR, the design places the road beyond the riparian management areas for each stream. [see [riparian Section 3.6.1](#)]

Legislation supported: FPPR sections 38 and 54: no gully process or fan destabilization on the Coast

- B6. Ensure that a road design on the Coast incorporates any protective measures prepared by an appropriately qualified professional as part of a gully process or fan stability assessment. [see [ensure Section 3.6.1](#)]

Legislation supported: FPPR section 56: protection of fish passage

- B7. Ensure that any crossing design does not result in a material adverse effect on fish passage in a fish stream [see [fish stream Section 3.7](#)]

Legislation supported: FPPR sections 59, 60, 62: no construction near (1) licensed waterworks in community watersheds or (2) springs that are a source of water for licensed waterworks in community watersheds

- B8. Ensure that the road design places the road at least 100m distance from any (1) licensed waterworks in community watersheds or (2) springs that are a source of water for licensed waterworks in community watersheds.

Legislation supported: FPPR section 72: roads and structures are safe for industrial users

- B9. Ensure that the design incorporate professional design measures related to landslides [see [Slope Stability Section 3.6.2](#)]

- B10. Ensure that the road design incorporates horizontal and vertical road alignments that provide for equipment use and for user safety. [see [Road Alignment Section 3.6.2](#)]

- B11. Ensure that a geotechnical report is prepared for retaining structures associated with the road, and that it evaluates and addresses possible (1) foundation and construction difficulties, (2) effects on existing adjacent structures or slope stability, and (3) methods of overcoming any identified difficulties during the construction stage, or other requirements. [see [Geotechnical Report Section 3.10.4](#)]

- B12. During the conceptual design phase and well in advance of any detailed design work or procurement of materials, ensure that a ministry engineer is given an opportunity to review and comment on the suitability of a retaining structure proposed for construction on an FSR by the ministry. [see [Concept Review Phase Section 3.10.5](#)]

- M2.** A Professional Engineer registered with the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) *must* prepare designs and take responsibility for retaining structures (associated with the road prism) that are greater than 1.5 m high. [see [Structure Design Responsibility Section 3.10.1](#)]

<b>M3.</b>	A ministry engineer <b><i>must</i></b> review all detailed designs of retaining structures for conformance with ministry standards and other site specific requirements, and accept the designs prior to the construction phase on FSRs. [see <a href="#">Review and Acceptance of Detailed Designs Section 3.10.5</a> ]
<b>M4.</b>	The CRP <b><i>must</i></b> coordinate and ensure field reviews are carried out during the construction of a retaining structure on an FSR, and <b><i>must</i></b> gather all relevant information and prepare record drawings and sign, seal and date a Structure Assurance Statement for submission to the ministry. For retaining structures greater than 1.5 m high, the CRP <b><i>must</i></b> be a Professional Engineer. [see <a href="#">Final Reviews, Record Drawings, and Assurance Statement Section 3.10.6</a> ]
Legislation supported: FPPR section 78: minimize clearing width	
B13.	Ensure that clearing widths marked on the road plans provide for the minimum clearing width considering operational requirements, safety, drainage, stability and topography [see <a href="#">Clearing Width Section 3.6.2</a> ]
Legislation supported: FPPR sections 37, 38, 39, 50, 54, 56, 57, 59, 60, 62, 69, 70, 72	
<b>M5.</b>	The survey and design outputs <b><i>must</i></b> be reviewed and accepted by a Qualified Registered Professional, usually the BCTS/District engineering technician [see <a href="#">Survey and Design Outputs Section 3.9</a> ]
B14.	Ensure that a Qualified Registered Professional completes the Statement of Road Survey and Design Responsibility [see <a href="#">Statement Appendix 2.2</a> ], and that the necessary steps in the road survey and design processes were undertaken and issues addressed [see <a href="#">Project Tracking Checklist Appendix 2.1</a> ]

### 3.4 Road Location Survey

In forestry road applications, there are two general types of surveys: a field traverse and a location survey. To determine which survey type and level is required, consider the physical characteristics of the terrain, the design complexity, and the desired road prism geometry.

The two terms most commonly associated with survey and design are P-line (the Preliminary Line) and L-line (the Location Line). Despite a common assumption, the P-Line is not the original, flagged reconnaissance line, but a traversed survey based on the results of the reconnaissance. The P- line is established in the field and shown as a plotted line on a drawing to provide the horizontal and vertical control for the roadway centreline.

The L-line, is the designed roadway centreline shown on a drawing with tangent Point of Intersection (PI), Beginning of Curve (BC), and End of Curve (EC) chainages. The L-line is often established in the field as offsets to the P-line based on the road centreline design. Where close control of cut and fill slopes are required, the L-line is established after grubbing and stripping operations by setting gradestakes.

#### 3.4.1 Types of Survey

##### Field Traverse

Carry out a field traverse for road layout and design to collect data and measurements for the road location. A field traverse is also sometimes referred to as Survey Level 1, see Survey Levels following. This level of survey is

appropriate only for roads with no geometric road design, such that the road layout is tied down and can be mapped and reproduced in the field.

### **Location Survey**

Carry out a location survey to obtain information and measurements necessary for a detailed design, or to obtain information when geometric road designs are required. Compared with a field traverse, a location survey is carried out at a higher level of survey (i.e., Survey Level 2, 3, or 4) to capture more information at a level suitable for detailed drawings.

If as-built surveys are required for volume determination or to check conformance to the design, use a location survey level that is suitable for accurately re-establishing the road centreline location.

If construction surveys are required, use a location survey level that is suitable for accurately re-establishing the construction control points.

The accuracy achieved with any survey level depends, in part, on the type and condition of survey equipment used the competence of the crew, and the field methods used. Global Positioning System (GPS) receivers, like other survey equipment, are acceptable when they can achieve the required horizontal and vertical accuracy for the appropriate survey level.

Stream crossings require special consideration. Site information requirements for bridge and culvert planning and design are provided later in 3.6.2: [Road Design Criteria](#) and [Chapter 4.7: Site Data](#) and [Survey Requirements for Bridges and Major Culverts](#) and [Site Survey for Stream Crossings](#).

### **3.4.2 Survey Levels**

This section outlines practices for field traverses and location surveys. Although considerable gains have been made in survey instrumentation technology, use of the technology does not preclude the need to follow standard survey practices as outlined in the Manual for Roads and Transportation (BCIT 1984).

Use Global Positioning System units only where the specified accuracy can be achieved to establish GPS waypoints and tracks necessary to accurately locate the road centreline and stream culvert crossings.

Use the following criteria to determine the appropriate survey level for a field traverse (Survey Level 1) or location survey (Survey Levels 2, 3, or 4). Note the equipment may be appropriate for the level but, more importantly, the skill of the surveyor is paramount in achieving the accuracy required. Geo-reference any survey that is carried out on an FSR.

### Survey Level 1 (for field traverses)

Where a low likelihood of landslides, and for situations where geometric road design, construction surveys, and as-built surveys are not required. Equipment may include hand compass, recreational GPS and hip chain.

**Horizontal accuracy:** turning points are to be established to a relative accuracy of 1:100.

**Vertical accuracy:** within equipment precision for slope corrections.

### Survey Level 2 (for location surveys on stable terrain)

**Application:** for location surveys on stable terrain with a low likelihood of landslides and for situations where a geometric road design, construction surveys, or as-built surveys are desired. Equipment may include hand compass, clinometer and steel or fiberglass chain.

**Horizontal accuracy:** turning points are to be established to a relative accuracy of 1:300.

**Vertical accuracy:**  $= 1.0 * \sqrt{\text{total distance in kilometres}}$ , expressed in metres. For example, the vertical accuracy for a 1 km road is 1 m. For a 2 km road, the vertical accuracy is 1.41 m.

### Survey Level 3 (for location surveys within areas of moderate or high likelihood of landslides)

**Application:** for location surveys, construction surveys, geometric road design, and as-built surveys in areas of moderate to high likelihood of landslides, as determined by a terrain stability field assessment. This is also the appropriate level of survey for material volume determination and detailed-engineered estimates. May also be used for bridge and major culvert planning and design, but greater vertical accuracy might be necessary. Equipment may include staff compass, rod and steel chain.

**Horizontal accuracy:** Turning points are to be established to a relative accuracy of 1:1,000.

**Vertical accuracy:**  $= 0.5 * \sqrt{\text{total distance in kilometres}}$ , expressed in metres. For example, the vertical accuracy for a 1 km road is 0.5 m. For a 2 km road, the vertical accuracy is 0.71 m.

### Survey Level 4 (for high-order survey requirements)

**Application:** A high-order survey for location surveys, construction surveys, construction contracting on a cost-per-unit basis, check surveys, placement of permanent bridges, as-built surveys through Crown leases, mineral and placer claims, and leases, private property, and surveys to re-establish private property

lines. Equipment may include transits, rod and steel chain, or total station instruments.

Horizontal accuracy: Turning hubs are to be established to a relative accuracy of 1:5,000.

**Vertical accuracy:**  $= 0.3 * \sqrt{\text{total distance in kilometres}}$ , expressed in metres. For example, the vertical accuracy for a 1 km road is 0.3 m. For a 2 km road, the vertical accuracy is 0.42m.

### 3.5 Survey Procedures

#### 3.5.1 Survey Level 1

Where a geometric road design is not required (e.g., where a proposed road will not cross areas with a moderate or high likelihood of landslides as determined by a terrain stability field assessment), carry out the following as part of a field traverse:

1. Clearly identify the beginning and end of the road.
2. Clearly flag the proposed centreline of the road.
3. Using an appropriate method (such as aluminum plaques and tree blazes), mark and record control points, noting the control point number, station, bearing, and horizontal distance from the proposed centreline.
4. Measure the bearing, slope gradient, and distance between the TPs and mark the cumulative changes and/or point number in the field.
5. Geo-reference the end points by double occupying the stations.
6. Record notes describing forest cover, vegetative types, soil types, rock, groundwater seepage, streams, and other related factors.

#### 3.5.2 Survey Level 2 and Level 3

##### Traverse

Carry out the following where a geometric road design is required:

1. Clearly identify the beginning and end of the road.
2. Establish intervisible stations (called turning points [TPs] if done with a compass, or traverse hubs [THs] if done with a transit) along the preliminary centreline (P-line). Use manufactured stakes or local material (blazed saplings) driven into the ground.

3. Measure the bearing, slope gradient, and distance between TPs and mark the cumulative chainages and/or point number in the field. Take both foreshots and backshots to verify the readings and to protect against booking errors.
4. Measure the slope gradient and distance to additional grade breaks between TPs as intermediate fore shots to facilitate taking cross-sections at those locations.
5. Using an appropriate method (such as aluminum plaques and tree blazes), mark and record control points, reference points, and benchmarks. Note the number, station, bearing, and horizontal distance from the P-line.
6. Geo-reference the end points by double occupying the stations.
7. Record notes describing forest cover, vegetative types, soil types, rock, groundwater seepage, streams, and other related factors that were not identified on the reconnaissance report.
8. Obtain enough information to ensure that road junctions can be designed and constructed. This includes capturing a minimum of 50 m of the existing road in the traverse (horizontal and vertical alignments and side slopes) to ensure that the road junction is adequately designed. Switchbacks located on steep slopes also require detailed data for proper design and construction.
9. The final design road location centreline (L-line) should be close to the P-line and generally within 3 m of the P-line if the road will cross areas with a moderate to high likelihood of landslides as determined by a terrain stability field assessment, or if bedrock is present, or switchbacks are encountered.

### **Cross-Sections**

Carry out the following:

1. Take cross-sections at all TPs and intermediate foreshots perpendicular to the back tangent or bisecting the interior angle of two tangents. Ensure that the recorded information is compatible with computer design software requirements.
2. Ensure that cross-sections are not more than 15 m apart in rock or 30 m apart in other material. A longer spacing will not provide sufficient cross-sections for the accurate earth volume calculations required for geometric design. Exceptions to this guideline may be considered for Level 2 surveys conducted in uniform terrain.
3. Extend cross-sections at least 15 m horizontally on either side of the location line or farther to accommodate the road prism and in areas considered for waste disposal.
4. Measure and record slope breaks (over 10%) on the cross-section profile to the nearest 0.1 m in distance and nearest 1% in slope gradient.

5. Take additional cross-sections to record features that may affect the road prism on each side of the proposed centreline. Examples of such features are rock outcrops, flat topography (benches), lakeshores, fences, streams, back channels, and existing roads.

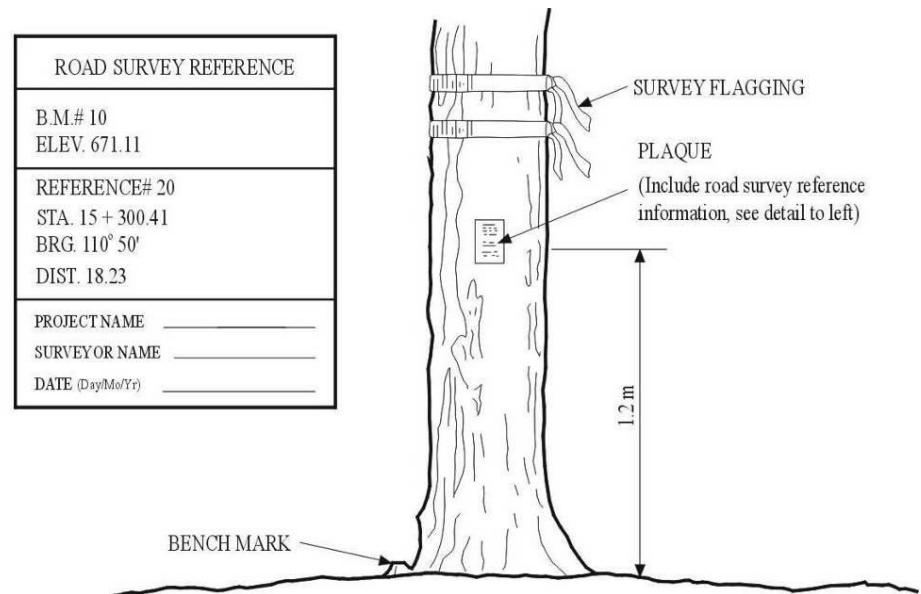
### Referencing and Benchmarks

Use a reference tree or other fixed object (e.g., bedrock outcrop) for the horizontal control, and use a benchmark for the vertical control of the road traverse. Both are important for re-establishing the designed location line (L-line), as well as for construction surveys and those surveys necessary to complete as-built documentation.

Carry out the following:

1. Reference the beginning and end of the location line traverse. When switching from one survey level to another, reference this point in accordance with the higher survey level accuracy.
2. Establish references at least every 300 m and at control points established during the field traverse.
3. Use two trees to establish references outside the proposed upslope clearing limit. Set the angle from the TP to the two reference trees between  $60^\circ$  and  $120^\circ$  from the centreline tangent. Make horizontal measurements to the centre of the reference marker (plaque). (The use of two reference trees improves the accuracy of relocating the traverse station and provides for a back-up if one tree is destroyed.) Use the same level of survey accuracy to establish references and benchmarks.
4. Record the diameter at breast height (dbh) and species of the reference trees so that they can easily be found.
5. Establish benchmarks outside the clearing width no more than 1 km apart, at major structures and at existing references for control points established during the field traverse.

Figure 3-1 shows typical benchmark and road survey reference information (source: Forest Road Engineering Guidebook).

**Figure 3-1 Typical benchmarks and reference**

### 3.5.3 Survey Level 4 (for high-order survey requirements)

As noted earlier, this high-order survey is also suitable for alienated lands such as private property (Note: coordinate this with FLNR Forest Land Acquisitions, Victoria).

Carry out the following:

1. Before starting work on alienated lands, contact the owners and explain the nature of the work. The owner may be able to provide the location of corner pins and other useful information.
2. When working on alienated lands, keep the clearing (tree falling, line slashing, etc.) and marking of lines to a minimum.
3. Record the following information and tie it to the location line traverse:
  - all existing legal markers;
  - improvements and utilities that may be affected by the right-of-way;
  - fences and buildings; and
  - parts of the existing road, if applicable, including the top of cut, toe of fill, grade, and ditchline.
4. If possible, close traverses onto at least two legal posts to ensure accuracy and to establish correct orientation of the survey with respect to the legal lot or lots.



5. Geo-reference the end points by double occupying the stations.

### **Survey on Private Property, Crown Leases, and Mineral and Placer Claims and Leases**

For such road location surveys, carry out the following:

- Notify, in writing, owners of private property and holders of leases and claims before conducting survey work.
- Carry out a P-line survey to a relative precision of 1:5,000 horizontally and a vertical accuracy of +0.3 m per 1 km of traverse.
- Keep the clearing and marking of lines to a minimum.
- Locate all existing legal markers and tie them into the traverse.
- Tie in all improvements to the P-line, including those for buildings, fences, and existing roads.

### **Ties to Existing Property Boundaries**

Traverse tie the location survey to existing property markers or other evidence of legal boundaries that may be near the location survey. Complete sufficient investigations to establish the location of the property line and determine whether the road right-of-way will encroach on the property line. If possible, relocate the centreline and right-of-way if there is an encroachment.

### **Site Survey for Stream Crossings**

A sketch is generally sufficient for non-fish and non-major stream culverts, showing the culvert and the foundation locations with enough detail so the locations can be accurately re-established in the field. [Appendix 3.3](#), Basic Drainage Site Report Requirements, describes works and standards for data collection, site planning, and plan details.

To establish site survey specifications for all bridges and for the planned installation of any culvert 2,000 mm or greater in diameter, or with peak flow greater than 6 m<sup>3</sup>/s., see [Chapter 4: Design and Construction of Bridges and Major Culverts](#).

## **3.6 Geometric Road Design**

The purpose of road design is to produce specifications for road construction by determining the optimum road geometry that will accommodate the design vehicle configuration for load and alignment, traffic volume and provide for user safety, while minimizing the cost of construction, transportation, maintenance, and deactivation during the expected life of the road.

Road design is an art that takes the survey information and essentially connects the field data to produce the desired road profile showing the grade, alignment, designed cross sections, excavation and embankment volumes, location and size

of drainage structures, turnouts, and surfacing requirements. The optimum road design reduces impacts on other resources by minimizing clearing widths and excavations, and specifying proper drainage structures. Also consider the equipment anticipated for use during construction, since the equipment type impacts material movement distances and balance points. Incorporate construction techniques such as rolling grades, full and partial benching, end haul, road width, cut and fill slope angles, and horizontal and vertical control angles with consideration given to climatic, terrain and soil conditions.

Geometric road design (see 3.8: [Geometric Road Design Requirements](#)) includes plans, profiles, cross-sections, and mass haul diagrams showing the optimum balance of waste, borrow, and endhaul volumes. Generate the designs from the route selection process and the location survey. From the location survey information, design a road centreline (L-Line) for vertical and horizontal alignment, calculate earthwork quantities, and produce a mass haul diagram to show the optimum placement of excavated material. See [Appendix 3.2](#): Standard Drawings.

### 3.6.1 Design Planning Considerations

In order to meet the ever-increasing demand for access, be apprised of any multi-user needs: for example, oil and gas exploration, mining, power project, recreational, and public uses. These factors may influence the design widths, alignment, and grades beyond those required for forest access during harvesting. Use additional and/or larger turnouts if heavy traffic is anticipated or there is potential for high recreational use of the road. Restrict utilities to only one side of the road to ensure that the road right-of-way has room to expand and be upgraded in the future.

Road maintenance can also be a significant factor to be recognized during road design. For example, access to retaining and catchment walls and spillways may be required once the road is built and, if the structures are inaccessible, this may increase the chance of being overlooked during inspections which may increase the cost of maintenance.

Allow adequate room for equipment operation including snow removal and logging equipment. Large equipment or operations often require additional road width and in the case of snow removal, for example, a place to relocate snow and ice away from the roadway without damaging surrounding forest resources caused by trapping and diverting meltwater on sensitive slopes and not damaging signs, fences, and bridge guardrails.

When designing a road prism that includes excavation into side slopes or the placement of loads on the fill slopes, consider the nature of the soil and ground conditions, so that slope stability can be maintained. In addition to the immediate factors related to the slope, consider the road in the context of the overall area.

Ensure that the road is designed in the location identified by the layout and, where no exception has been provided in accordance with FPPR, the design places the road beyond the riparian management areas for each stream.

Incorporate other information in the design, including prescriptions and assessments that relate to the road location and design. These may include professional designs such as retaining walls, designs for stream crossings, bridge design and alignments, designs included in or based on terrain stability assessments, and specialized designs in rock cuts. For example, if a proposed road will cross areas with a moderate or high likelihood of landslides as determined by a TSFA, incorporate measures to maintain slope stability into the geometric road design. Also, ensure that a road design on the Coast incorporates any protective measures prepared by an appropriately qualified professional as part of a gully process or fan stability assessment.

As a result, be aware of the intended use of the road, the timing of such use, construction techniques and other surrounding design considerations as well as the following road design criteria.

### **3.6.2 Road Design Criteria**

Consider the following factors in the road design:

#### **Clearing Width**

Keep the clearing widths as narrow as possible, to minimize impacts on other resources, but wide enough to accommodate:

- the road prism;
- user safety;
- decking of right of way timber;
- turnouts;
- subgrade drainage;
- subgrade stability;
- waste areas and endhaul areas;
- pits and quarries;
- landings;
- slash disposal;
- equipment operation;
- snow removal;
- fencing and other structures; and
- standing timber root protection, especially on cut banks.

Move to a disposal site organic debris, rock, or other excess material that cannot be placed in the road prism and within the clearing width because of terrain stability or other factors. Ensure such areas are of suitable size to accommodate the estimated volume of waste material and identify the areas in the road design.

Calculate clearing widths on a station-by-station basis as part of a geometric road design. In situations where geometric road design is not required, use other methods as shown on page 179 in the [Forest Road Engineering Guidebook](#).

## Road Alignment

Road design incorporates horizontal and vertical road alignments that provide for equipment use and for user safety. This involves establishing:

- appropriate travel speeds;
- appropriate maximum road grades;
- suitable stopping and sight distances;
- junctions with existing roads;
- road widths;
- turnouts; and
- appropriate traffic control devices.

Designed travel speeds often vary along forest roads due to terrain conditions or changing road standards. The cycle time or distance from the logging area to the dump or processing area may be an important economic factor to consider in establishing an overall design speed. In other cases, topography and terrain may dictate alignment, with little impact from other factors. In general, base the safe vehicle speed for a road on:

- horizontal and vertical alignment of the road;
- vehicle size and configuration;
- road width; and
- sight distance and traffic volume.

Use the information in [Table 3-2](#): Summary of alignment controls for forest roads to determine appropriate travel speeds and stopping and sight distance requirements along the road.

**Table 3-2 Summary of alignment controls for forest roads**

Stabilized Road Width (m)	Design Speed (km/h)	Minimum Stopping Sight Distance <sup>a</sup> (m)	Minimum Passing Sight Distance for 2-Lane Roads (m)	Minimum Radius of Curve (m)	Suggested Maximum Road Gradient <sup>b, c</sup>				
					Favourable		Adverse		Switch-backs Favourable
					S	P <sup>d</sup>	S	P <sup>e</sup>	
4	20	40		15	16 %	20% for distance <100 m	9%	12% for distance <100 m	8%
5 - 6	30	65		35	12 %	14% for distance <150 m	8%	10% for distance <100 m	8%
	40	95		65					
8+	50	135	340	100	8%	10% for distance <200 m	6%	8% for distance <100 m	6%
	60	175	420	140					
	70	220	480	190					
	80	270	560	250					

**Notes Table 3-2:**

These are suggested alignment controls for average conditions on forest roads. Variations can be expected, depending on, for example, site conditions and time of use.

<sup>a</sup> For two-lane and single-lane one-way roads, multiply the minimum stopping sight distance by 0.5.

<sup>b</sup> There are no absolute rules for establishing maximum road gradient. Maximum grades cannot generally be established without an analysis to determine the most economical grade for the site-specific conditions encountered. The maximum grade selected for design purposes may also depend on other factors such as: topography and environmental considerations; the

resistance to erosion of the road surface material and the soil in the adjacent drainage ditches; the life expectancy and standard of road; periods of use (seasonal or all-weather use); and road surfacing material as it relates to traction, types of vehicles and traffic, and traffic volume.

Apply other grade restrictions in special situations. For example:

- On horizontal curves sharper than 80 m radius, reduce the adverse maximum grade by 0.5% for every 10 m reduction in radius.
- As required at bridge approaches, and at highway and railway crossings.

<sup>c</sup> S = sustained grade; P = short pitch

<sup>d</sup> Design maximum short-pitch favourable grades so that they are followed or preceded by a section of slack grade. The average grade over this segment of the road should be less than the specified sustained maximum.

<sup>e</sup> Design maximum short-pitch adverse grades as momentum grades.

## Maximum Road Grades

Ensure that the following design conditions are considered in developing maximum road grades:

- road surface;
- anticipated vehicle types;
- vehicle speed;
- length of pitch;
- curve radius; and
- specific terrain hazards to negotiate.

## Subgrade Widths

Forest roads widths are categorized as either single or double lane roads based on subgrade width. Roads less than 8 metres in subgrade width are classified as single lane roads. Double lane roads do not require turnouts. Where road surfacing is not used, the stabilized road width is the width of the road subgrade.

## Curve Widenings

Design minimum subgrade widths for roads on curves or design widenings in accordance with the following table and the following notes:

**Table 3-3 Curve Widenings**

<b>Radius of Curve</b> in metres (m)	<b>Minimum Subgrade Width</b> in metres (m)
180	4.3
90	5.3
60	5.8
45	6.0
35	6.5
25	7.5
20	8.0
15	9.0

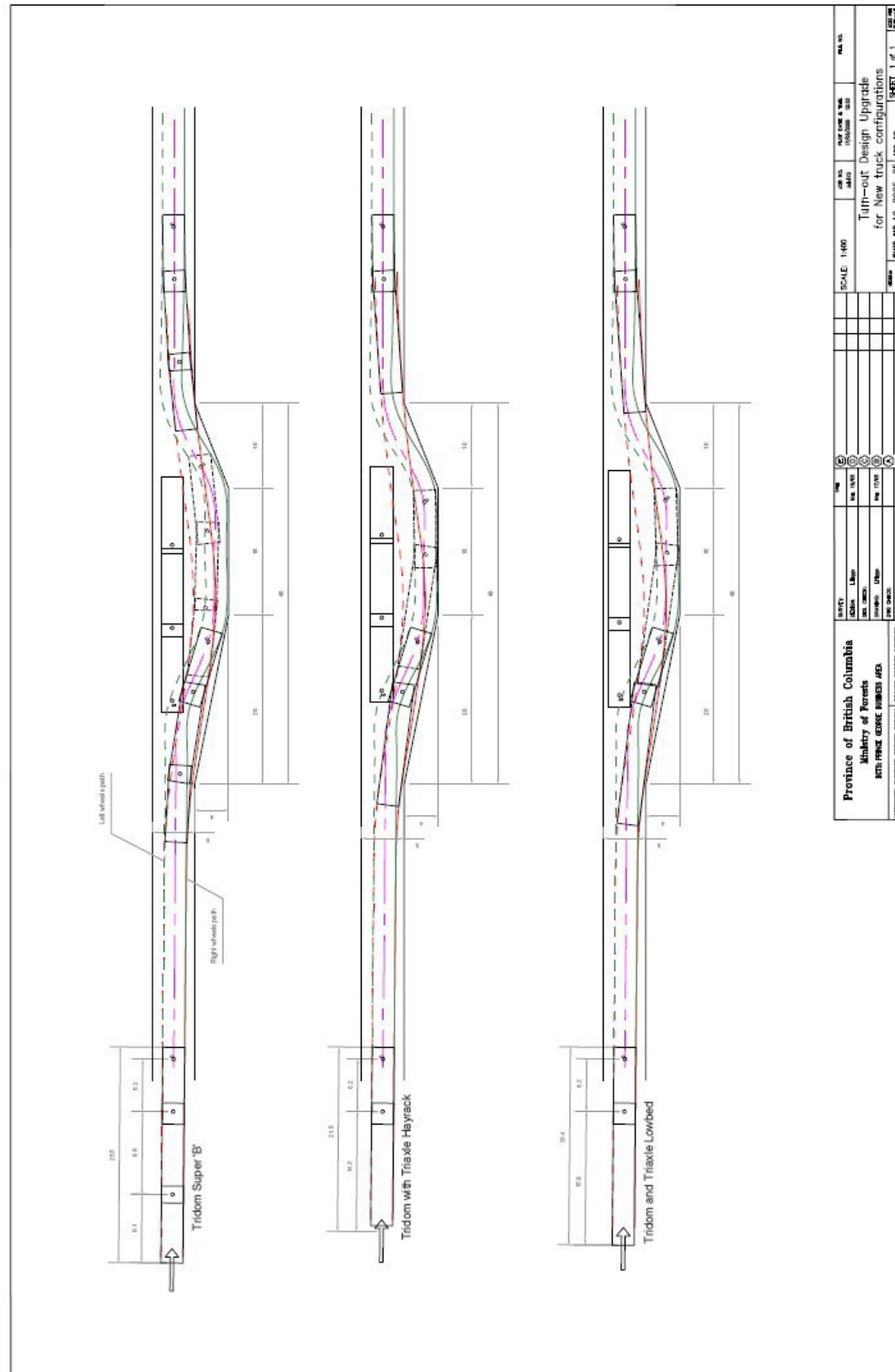
Double-lane all blind curves or provide adequate traffic control devices. Allow extra width to accommodate for side tracking of truck-trailer units. Note that the subgrade widths in the table do not make accommodation for the overhang of long logs or any slippage of the truck or trailer because of poor road conditions.

Apply the widening to the inside of the curve unless the curve has a 60 m long taper section on each end. For widening on the inside, provide a minimum 20 m section on each end of the curve. Apply the full widening at the beginning of the curve (B.C.) and end of the curve (E.C.).

### Turnouts

A turnout is a short auxiliary lane of sufficient width to provide space for safe passage of industrial vehicles. They are used on single lane roads and located in suitable numbers to accommodate user safety. Design them such that the running surface of the turnout is 4m in width, in addition to the stabilized road width. Make the overall turnout length a minimum 30m, including a 7.5m taper at each end. Increase the turnout length to accommodate longer truck configurations, where the turnout length may increase to as much as 50m. Figure 3-2 illustrates examples of turnout configurations.

### Figure 3-2 Illustrated examples of turnout configurations





## Slope Stability Considerations

If a proposed road will cross areas with a moderate or high likelihood of landslides, a conventional cut and fill road construction technique may not be an adequate type of measure to maintain slope stability, and alternative measures incorporated into the geometric road design may be needed to prevent road-induced slope failures and landslides.

Examples of types of measures include:

- road relocation;
- site specific road construction techniques;
- methods to cross gullies and fishstreams;
- cut and fill slope angles;
- location and design of waste areas and endhaul areas;
- drainage control or installation of subsurface drainage; and
- road maintenance (including upgrading and modification), and deactivation strategies.

Examples of different road construction techniques that may be used in conjunction with appropriate deactivation measures, include:

- bench construction with no endhaul;
- oversteepened fills for single season use of the road;
- use of wood for fill support for short term roads;
- oversteepened cuts with modified drainage control to manage minor sloughing;
- bench construction with endhaul and replacement of finer material with coarse rock fill;
- full bench construction with 100% endhaul;
- retaining wall structures to support cut or fill slopes; and
- engineered fills that incorporate special requirements for compaction of the fill and reinforcement of the fill with geosynthetics.

## Fill Slope and Cut Slope Angles

Design stable cut slopes, road fills, borrow pits, quarries, and waste areas in a manner that will not contribute directly or indirectly to slope failures or landslides over the expected design life. [Table 3-4](#) provides general guidelines for cut and fill slope angles for use in forest road design.

**Table 3-4 General guidelines for cut and fill slope angles for use in forest road design**

	<b>Cut Slope</b>		<b>Fill Slopes</b>	
	<b>Examples of Material Types<sup>a</sup></b>	<b>Suggested Cut Slope Angles<sup>b</sup> for Cut Bank Height &lt; 6 m<sup>c</sup></b>	<b>Examples of Material Types<sup>a</sup></b>	<b>Suggested Fill Slope Angles<sup>b</sup></b>
Coarse-grained Soils <sup>d</sup>	Road cuts in loose to compact SANDS or SANDS and GRAVELS (not cement and non-cohesive)	1½ H : 1 V	Road fills composed predominantly of SANDS, or SANDS and GRAVELS, or drained mixtures of coarse-grained and fine-grained soils	1½ H : 1 V
Fine-grained Soils	Road cuts in loose SILTS, or soft cohesive soils such as SILTY CLAYS or CLAYS (not consolidated and not cemented)	1½ H : 1 V for lower cuts to 2 H : 1 V for higher cuts	Road fills composed predominantly of SILTS or CLAYS <sup>e</sup>	2 H : 1 V
	Road cuts in hard cohesive soils such as SILTY CLAYS or CLAYS (consolidated)	1 H : 1 V or flatter		
Dense Glacial Till / Cemented Sands and Gravels	Road cuts in dense to very dense GLACIAL TILL (i.e., basal till), or cemented SANDS or SANDS and GRAVELS	¾ H : 1 V or flatter	See above for coarse-grained soils	See above for coarse-grained soils
Rock <sup>f</sup>	Road cuts in strong, good quality ROCK mass with no significant weaknesses	¼ H : 1 V to vertical	Road fill composed predominantly of individually placed and locked together (not dumped) good quality angular blasted or ripped ROCK	1 H : 1 V

	Cut Slope		Fill Slopes	
	Road cuts in other ROCK types should be flatter to include any weaknesses from the effects of structural discontinuities in the rock mass, and other factors such as the strength of the rock material, and the spacing, aperture, roughness, filling, weathering, and orientation of discontinuities	$\frac{1}{4} H : 1 V$ to $1\frac{1}{4} H : 1 V$	Road fill composed predominantly of dumped angular ROCK or placed rounded ROCK	$\frac{1}{4} H : 1 V$ to $1\frac{1}{2} H : 1 V$

Notes Table 3-4:

<sup>a</sup> Not all material types in the soil groups are represented in the table.

<sup>b</sup> For the design of roads located in domestic watersheds, on sensitive terrain, or in other areas where transport of sediment or landslides may adversely affect resources, it may be necessary to use flatter cut and fill slope angles to reduce the hazard of erosion or failure of cut and fill slopes. During construction of roads, it may be necessary to build flatter slopes where the road prism exhibits signs of distress, such as, for example:

- (1) cracks or scarps within original ground above the top of cut slopes, in the road surface, or within the fill slope on the downslope side of the road; and
- (2) significant zones of ground water seepage such that localized failure of cut or fill slopes are expected. Alternatively, installation of retaining wall structures may be needed to reduce excavation, contain bank material, or prevent slope failure. The significance of observed seepage zones might dictate application of other special measures to reduce the likelihood of slope failure during construction and over the operating life of the road.

<sup>c</sup> Consider the need to obtain advice from a qualified registered professional for cut heights greater than 6 m. The advantages of steeper cuts may include: less area occupied by road; less excavated material; less sidecast; and shorter slope lengths exposed to erosion processes. The disadvantages of steeper cuts may include: increased difficulty to establish vegetation; increased chance of slope ravelling, tension crack development and slope failure; and increased road maintenance costs. The disadvantages of steeper cut slopes can be reduced if high banks are avoided.

<sup>d</sup> Erosion control may be particularly problematic for slopes composed of sand, silty sands, or silts. Consider the need for erosion protection measures for cut slopes, fill slopes, and ditches, such as revegetation, soil bioengineering and biotechnical slope stabilization techniques, riprap, or other special slope treatments.

<sup>e</sup> If significant compaction of the road fills can be achieved, then fill slopes (of limited height) may be placed steeper than  $2 H : 1 V$ .

<sup>f</sup> If potential problems are anticipated for rock slopes either during design, construction, maintenance, or deactivation, consult with a geotechnical engineer or other rock slope specialist. It may be necessary to address the need for special rock slope stabilization measures (e.g., rockfall catch ditch, wire mesh slope protection, shotcrete, rock bolts).

## Fill Slopes

The stability of a fill slope depends on several variables, including the forces that tend to cause instability (gravitational and water pressure forces), and the forces that tend to oppose instability (e.g., shear strength resistance of the soil or rock materials expressed as an internal friction angle or cohesion). The stability of fill slope can be increased by incorporating various design and construction techniques.

Design fill slopes at or less than the “angle of repose.” The term “angle of repose” should be used in the context of loose, cohesionless soils only (e.g., non-plastic silt, sand, sand and gravel). Flatter side slopes in all types of soil will reduce the gravitational forces that tend to cause slope instability. For a fill slope in cohesionless material, the angle of repose is about the same as the minimum value of that material’s angle of internal friction. Steeper fill slopes are more likely to cause a road-induced slope failure or landslide than flatter fill slopes.

Compact the fill materials to increase the density and shearing resistance of the soil. The angle of internal friction depends primarily on the relative density (loose versus dense), the particle shape (round versus angular), and the gradation (uniformly graded versus well graded). For relatively loose cohesionless soils, the minimum value of the angle of internal friction will range from about 27 degrees (2H : 1V) for rounded uniform soil grains to 37 degrees (1½H : 1V) for angular, well-graded soil grains. For relatively dense cohesionless soils, the maximum value of the angle of internal friction will range from about 35 degrees (1.5H : 1V) for rounded uniform soil grains to 45 degrees (1H : 1V) for angular, well-graded soil grains.

**Note:** Fill slopes that are constructed at or less than the angle of repose (minimum angle of internal friction) will not necessarily remain stable if partial or full saturation of the fill occurs. Such saturation can result from surface and subsurface water flows during spring melt or after heavy periods of rainfall.

Expect that poorly drained fill materials will be prone to a greater likelihood of slope failure or sloughing than well-drained fill materials. Additionally, the slopes of poorly drained fills at locations of significant zones of ground water seepage may experience larger and greater frequency of slope failures or sloughing problems. The significance of observed seepage zones might dictate the application of special drainage measures to reduce the likelihood of slope failure during construction and the intensity of maintenance activities over the operating life of the road. As a general rule, without special drainage measures, design the side slopes of poorly drained fills (e.g., fills composed of silty soils) at angles that are flatter than the angle of repose to minimize the likelihood of slope failures.

## Cut Slopes

In the design of cut slopes, consider and address factors such as:

- the desired performance of the cutslopes;
- types of cut slope materials;
- overall terrain stability;
- engineering properties of soils;
- seepage conditions; and
- maintenance.

In general, cut slopes will remain stable at slightly steeper angles than fill slopes constructed from like soil materials. The reason for this is the undisturbed soil materials in a cut are often in a denser state than similar type materials placed in a fill; and may contain sources of cohesive strength that further increases the shearing resistance of the soil.

Cut slopes designed at too flat an angle can be uneconomical in steep ground because of the large volumes of excavation. Steeper cut slopes may be more economical to construct in terms of reduced volumes of excavation. However, they can also be more costly from an operational standpoint because they require more maintenance due to sloughing and slumping.

For most forest roads, design cut slope angles to favour steeper angles to:

- reduce the length of cut slopes;
- minimize visible site disturbance; and
- reduce excavation costs;

provided that a somewhat higher level of road maintenance and likelihood of slope destabilization is acceptable for the site.

In the latter case, prepare and implement a maintenance schedule that addresses the erosional processes acting on the exposed cut slope face (such as splash, sheet, rill, and gully erosion) and reduces the threat to:

- drainage systems (as a result of cut bank slope failure redirecting ditchwater flows onto potentially unstable fill or natural slopes);
- user safety; and
- risk of damage to the environment.

Consider designing flatter cut and fill slopes, or using retaining wall structures to support cut slopes or fill slopes, in cases where slope stability problems are expected to be difficult to manage with maintenance measures alone.

### **3.6.3 Swell and Shrinkage of Materials**

The volume of natural in-place material usually expands (swells) or contracts (shrinks) after it is excavated and reworked. Figure 3-3 illustrates how the volume of a material can change during excavation, handling, placement, and compaction

in a fill. Soil and rock volumes can be expressed in different ways, depending on whether they are measured in the **bank**, or measured in **loose** or **compacted** conditions.

**Bank volume** (sometimes referred to as **excavation volume**) is the volume of material in its natural, or in-place, condition.

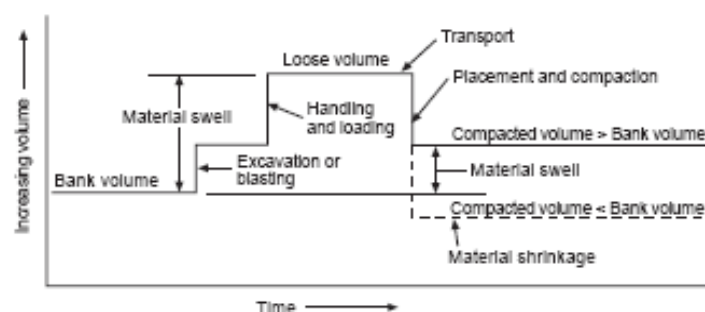
**Loose volume** (sometimes referred to as **trucked volume**) is the volume of material in a loose, broken, blasted, or otherwise disturbed state that has been excavated and stockpiled or loaded into trucks and hauled (handled). As shown in Figure 3-3, both soil and rock increase in volume (swell) when they are excavated and handled. This occurs because air voids are created in the material during these processes.

**Compacted volume** (sometimes referred to as **embankment volume**) is the measured volume of material after it has been placed in a fill and compacted. As shown in Figure 3-3, when loose material is placed and compacted, a reduction in volume occurs. The amount of this decrease may be greater or less than the increase in volume due to excavation, depending on several factors explained below. If the compacted volume is greater than the bank volume, the volume increase is called **swell**. If the compacted volume is less than the bank volume, the volume reduction is called **shrinkage**.

The amount of swell and shrinkage depends on several factors, including:

- soil or rock type;
- natural in-place density;
- moisture content of the loose material at the time of placement and compaction; and
- compactive effort applied to the fill material.

**Figure 3-3 Example of material volume variation with time for various stages of road construction (not to scale)**



### 3.6.4 Example Correction Factors

If the objectives of road design are to optimize the balance of excavated, fill, waste, and endhaul volumes and to minimize volume movements, adjust material volumes to compensate for swell and shrinkage. [Table 3-5](#) shows example correction factors for various material types, to convert compacted volume to bank volume for use in road design.

In road design, material volumes are most commonly reported in volumes equivalent to bank volumes, because road construction projects are usually estimated, contracted, and paid based on bank volumes. In this system:

- Cut and fill volumes are both reported as the volumes they would occupy in the bank.
- The cut volume is the bank volume calculated from the road cross-sections, and therefore no adjustment is required.
- To convert the compacted fill volume back to the bank volume, apply a correction factor for swell and shrinkage. The correction factor is  $<1$  to compensate for swell and  $>1$  to compensate for shrinkage. If no net swell or shrinkage occurred during excavation, handling, placement, and compaction, the correction factor is 1.0.

The correction factors in Table 3-5 do not include any effects due to wastage or loss of material. Consider the need to separately account for other potential material losses that might affect achieving a balanced cut and fill design. Typical important sources of material loss, among others, can include material lost (spilled) in transport from cut to fill and subsidence, compression, or displacement of the prepared subgrade or original ground surface caused by the weight of the overlying embankment.

**Table 3-5 Correction factors to convert compacted volume to bank volume for various materials**

	<b>Swell or Shrinkage</b>	<b>Material When It Was IN THE BANK</b>
0.75 to 0.85	Swell	<b>Solid rock.</b> Assumes drilling and blasting is required, resulting in large fragments and high voids
0.9 to 1.0	Swell	<b>Dense soil or rippable rock.</b> In the case of dense soil (e.g., glacial till) or rippable rock, typical compaction during conventional forest road construction will result in swell.
1.0 to 1.15	Shrinkage	<b>Compact to loose soil.</b> Lower correction factors are more appropriate for coarse-grained soils (e.g., sand, sandy gravel, or mixtures of gravel, sand, silt, and clay). Higher correction factors are more appropriate for fine-grained soils (e.g., silt and clay). It is more possible to achieve shrinkage during conventional forest road construction if the soil in the bank was in a loose condition.

	Swell or Shrinkage	Material When It Was IN THE BANK
		For example, a correction factor of 1.0 (i.e., no shrinkage) may be appropriate for compact sands and gravels, whereas a correction factor of 1.15 may be appropriate for very loose silts.

Notes Table 3-5:

1. The “example correction factors” are applicable to forest road design purposes only. They assume compaction typically achieved during conventional forest road construction, and different correction factors could apply for engineered fills, placed and compacted to achieve the highest material density possible. Because of the variability of natural materials and their conditions in the bank, the potential for material loss during handling, and the range of road construction methods, correction factors are best determined from experience and local knowledge.
2. The example correction factors are based on swell or shrinkage effects due to an increase or decrease in the density of the soil or rock materials, and do not include any effects of potential wastage or loss of material from other sources.

### Example

**Bank volume** = compacted volume x correction factor.

**Example:** If the compacted volume of shot rock is 12 m<sup>3</sup> measured from drawings, how much bank volume needs to be drilled, blasted, and excavated to achieve this volume? Assume a correction factor of 0.75.

**Solution:** Bank volume = 12 m<sup>3</sup> x 0.75 = 9 m<sup>3</sup>

Surfacing often depends on the material available within an economic haul distance and intended season of use. Rock ballast roads may require minimal surfacing material while other roads require extensive surfacing for year round use. Consider the surfacing depth during the road design process. The depth of surfacing is dependent on the stabilization of the subgrade and the ability to carry design loads.

## 3.7 Culvert Design

Culvert drainage design encompasses the selection of culvert materials, backfill requirements, scour protection, roadway alignment and adequate sizing to pass the expected flows. The information contained in this chapter is focused on design considerations, site selection, and design flows relevant to non-major stream crossing culverts.

In [Appendix 3.5](#), log culvert design is addressed and in [Appendix 3.6](#), ford design is covered. If the site is a fish stream or a potential fish stream, consult the [Fish-stream Crossing Guidebook](#) for site and design requirements.



## Design Considerations

Design stream culverts to pass the highest peak flow of the stream that can be reasonably be expected based on the anticipated length of time the culvert will remain on the site. For culverts anticipated to remain on site less than three (3) years, design for a peak flow return period of 10 years and all others for the 100 year peak flow return period. Note that there is no consideration of replacing the structure after these periods.

Determine the culvert length (measured along the invert) from the distance between the toes of the embankment, plus 1 m in gravelly soils or 2 m in silty soils.

## Cross Drain Culverts

Cross drain culverts are used to carry ditchwater from one side of the road to the other and spaced at intervals necessary to minimize erosion of the roadside ditchline.

Use the distances in [Table 3-6](#) as a guide to the maximum spacing for cross-drain culverts between established watercourses.

**Table 3-6 Guidelines for maximum culvert spacing for forest roads**

Erosion hazard:	slight	moderate	high
<b>More than 50% by soil type:</b>	hardpan, rock, coarse gravels	Fine gravels	sands, silts, clays
Road gradient			
0-3%	350 m	300 m	200 m
3-6%	300 m	200 m	150 m
6-9%	250 m	150 m	100 m
9-12%	200	100	75
12%+	150 m	100 m	100 m + rock line the ditch

Reduce the spacing between culverts as required to prevent excessive accumulation of water in the ditches, particularly at road junctions, along road segments with steep uphill side slopes, and along areas of seepage or piping in cuts.

Determine the composition of the slope on which the culvert will discharge. If extensive erosion or mass-wasting may occur, change the location to suit the situation.

Skew cross-drainage culverts to the road centreline by  $3^\circ$  for each 1% road gradient that the road exceeds 3% (to a maximum of  $45^\circ$ ).

### **Culverts on Non-Fish-Bearing Streams**

For stream culverts not classified as major culverts or those installed on non-fish-bearing streams, record a minimum amount of information during the road location survey to assist in sizing such a stream culvert for the maximum design flow. In deeply incised channels, ensure that the culvert width is at least the same as the stream channel width. Prepare site plans where conditions are such that there are complex horizontal and vertical or other control issues requiring higher level design and installation procedures.

In planning the layout of the structure:

- Choose an appropriate location, along a stream reach with uniform or uniformly varying flow close to the proposed crossing, to measure a cross-section. Sketch the cross-section of the stream gully, showing evidence of the high water level, present water level, and the depth of the stream across the bottom. Extend the cross-section back from the stream an appropriate distance to show the terrain that affects the proposed crossing and road alignment.
- Note any visual evidence of high water.
- Measure and record the average gradient of the stream at the crossing and at the cross-section if the two are taken at different locations.
- Record the soil type, soil profile, parent material, and substrate material at the crossing and describe the stream bottom.
- Describe the stream channel (debris loading, bank stability, crossing location on a fan, bedload problem, etc.).

### **Factors Affecting Runoff**

The runoff and behaviour of a stream depends on many factors, most of which are not readily available or calculable, such as:

- rainfall (cloudbursts; hourly and daily maxima);
- snowpack depth, distribution, and snowmelt;
- contributory watershed area, shape, and slope;
- topography and aspect;
- ground cover;
- soil and subsoil;

- weather conditions;
- harvesting and road or other upslopedevelopment;
- drainage pattern (stream order, branchiness; lakes and swamps); and
- stream channel shape, length, cross-section, slope, and “roughness.”

Because topography, soil, and climate combine in infinite variety, design drainage structures individually from available data for each site. In addition, consult those individuals who have long experience in maintaining drainage structures in the area.

### High Water Estimation Method for Stream Culverts

Limit application of this method for determining the  $Q_{100}$  from site information to non-major stream culverts. It is not appropriate for use as the sole method for “professional” designs.

This method assumes that the high water width represents the mean annual flood cross-sectional flow area for the stream ( $Q_2$ ); and that the  $Q_{100}$  cross-sectional flow area is three times this. It also assumes that the discharge is not sensitive to influences from pipe slope, roughness, or other factors.

The high water width is defined as the horizontal distance between the stream banks on opposite sides of the stream, measured at right angles to the general orientation of the banks. The point on each bank from which width is measured is usually indicated by a definite change in vegetation and sediment texture. Above this border, the soils and terrestrial plants appear undisturbed by recent stream erosion. Below this border, the banks typically show signs of both scouring and sediment deposition. Determine the high water width from recent visible high water mark indicators, which would approximate the mean annual flood cross-section. This point is not necessarily the top of bank, particularly in the case of an incised stream.

- Locate a relatively uniform stream reach in close proximity to the proposed culvert location. Note that this not an averaging process that would be used for determining the stream channel width for the purpose of assessing stream habitat impacts. A uniform stream reach would have a consistent cross-section, bed materials, and channel slope. It would also be relatively straight.
- Estimate the visible high water stream width and cross-sectional area.
  - a) Measure (in metres) the high water width at a relatively uniform reach of the stream, representative of the mean annual flood ( $W_1$ ) and at the stream bottom ( $W_2$ ). See Figure 3-4: High water width cross-sectional area.
  - b) Measure the depth of the stream at several spots across the opening to obtain the average depth ( $D$ ) in metres.
  - c) Calculate the cross-sectional area of the stream,  $A = (W_1 + W_2)/2 \times D$ .
- Calculate the area of the required culvert opening,  $A_c = A \times 3.0$ .

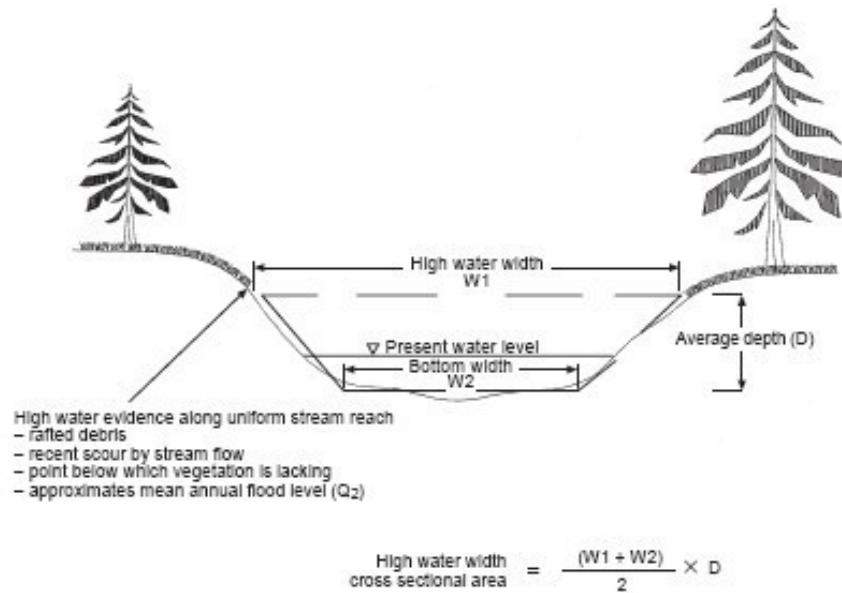
- Size the pipe (see [Table 3-7](#)), using the smallest pipe area that exceeds the required area, or select an opening size for a log culvert that will be greater than  $A_c$ .

Cross check the high water width method if field or other evidence of an approximate 10-year flood is available. In this case, the area of the  $Q_{10}$  flood can be multiplied by 2 to estimate the minimum culvert area for the  $Q_{100}$  flood.

#### Example:

If                       $W1 = 1.2 \text{ m}$   
                           $W2 = 0.8 \text{ m}$   
                           $D = 0.5 \text{ m}$   
                          stream cross-sectional area  $A = 0.5 \text{ m}^2$   
 Then                    $A_c = 0.5 \times 3.0 = 1.5 \text{ m}^2$   
 Therefore            (from Table 3-7), the required pipe culvert size = 1400 mm.

**Figure 3-4 High water width cross-sectional area**



**Table 3-7 Round pipe culvert area ( $A_c$ ) versus pipe diameter**

$A_c (\text{m}^2)$	Pipe diameter (mm)
1.0.13	400
0.20	500
0.28	600
0.50	800

$A_c (m^2)$	Pipe diameter (mm)
0.64	900
0.79	1000
1.13	1200
1.54	1400
2.01	1600
2.54	1800

### Road Junctions

Ensure that a junctioning road has a minimum vertical curve with a K value of 1, and a minimum horizontal curve radius of 20 m or widening for sidetracking of vehicles. Where possible, design roads that junction other roads at right angles whenever possible to allow traffic to turn both ways and provide adequate site distance for oncoming traffic based on the road design speeds. On steeper slopes where a perpendicular junction cannot be obtained, ensure that the junction is designed so that the existing road width is not reduced.

For showing junctions and railway and utility crossings, use the [Appendix 3.2: Standard Drawings](#), subject to any variations required by the appropriate agency.

### Other Structures

The design of bridges, major culverts, cattleguards, retaining walls and other specialized structures that fall within the practice of a professional engineer are covered in Chapter 4 Design and Construction of Bridges and Major Culverts. Incorporate these designs into the road design.

## 3.8 Geometric Road Design Requirements

A geometric road design ***must*** be carried out for all roads that will cross areas with a moderate or high likelihood of landslides. In those areas of potentially unstable terrain, incorporate measures to maintain slope stability into the geometric road design. These measures rarely allow for the most optimum balance of waste, borrow, and endhaul volumes.

Carry out a geometric road design on side slopes greater than 50%, to facilitate construction or minimize impacts on other forest resources. It is recognized that when encountering short sections (i.e. <100 metres) of stable terrain along a corridor where a geometric road design would **not** otherwise be required, it may be impractical to mobilize a survey crew just for those short sections. In such

situations, information from the field reconnaissance report would be utilized *Link to B12 (chapter 2)*

In geometric road design, select specifications for road width, cut and fill slope angles, and horizontal and vertical control angles to match the required road standard. Design a road centreline location (L-Line) based on information from the location survey and reconnaissance report. Calculate earthwork volumes or quantities.

In addition to the design requirements previously mentioned, ensure that a geometric road design provides:

- plans and profiles (see [Appendix 3.2](#): Standard Drawings for recommended content and layout);
- cross-sections with road prism templates;
- mass diagrams with balance lines;
- appropriate expansion and shrinkage factors for the material types;
- a schedule of quantities and units of measure for clearing, grubbing, excavating (other material and rock), and graveling;
- planned movement and placement of materials (balancing of design);
- the location and size of required drainage structures such as culverts and bridges;
- the location and size of retaining walls or specialized roadway structures;
- clearing widths (generally tabular in variable widths);
- construction equipment considered in the design for material movements;
- estimated material costs;
- location survey alignment and designed centreline (L-Line) offsets, and clearing width offsets shown on the site plan;
- slope stake information (note that this information is only a guide and slope/grade stakes should be calculated and placed based on design or re-design cuts and fills at centreline);
- measures required for reducing potential impacts on other resource values;
- site-specific design and construction notes and prescriptions on, for example, the location of endhaul sections, borrow pits, waste and slash disposal areas, and full bench cut areas, and any other information that the designer considers useful to the road builder;
- measures to maintain slope stability if the road will cross areas with a moderate or high likelihood of landslides as determined by a TSFA; and
- information that the designer considers useful to the road builder or owner.

Whenever possible, allow for the use of waste or spoil material in ways that reduce endhauling requirements. For example, some material types may be used for the road subgrade, base course, turnouts, curve widenings, and embankment (fill). If these options are not available, or if the excess material consists of overburden and debris, then identify spoil sites as close to the construction area as possible. Abandoned quarries, gravel pits, and roads are some possibilities for spoil sites. Alternatively, evaluate stable areas in gentle or benched terrain for use as spoil sites.

### 3.9 Survey and Design Outputs

The output of survey and design is a series of drawings, design data and construction specifications, profile, cross sections and mass haul. The plotting data, plan profile information in Appendix 3, page 171 of the [Forest Road Engineering Guidebook](#) lists the basic information from a field survey and road design. Depending on the level of survey and road design requirements, the information may vary somewhat. For example, with a geometric design, mass haul diagrams would be present. The survey and design outputs ***must*** be reviewed and accepted by a Qualified Registered Professional, usually the BCTS/District engineering technician. The intent is to ensure that a quality assurance review for acceptance, by a qualified ministry staff person, is carried out as a mandatory procedure. The intent is to avoid receipt of deliverables on the sole basis of it being signed and sealed by a registered professional, to avoid the practice of "blind" reliance. There is no intent for a ministry staff person to assume professional responsibility, nor would it be considered taking professional responsibility, for a survey and design (or any other) product, through the contract review and acceptance process.

### 3.10 Design Requirements for Road Retaining Structures

The FPPR requires BCTS and Timber Operations and Pricing Division to construct or maintain an FSR in a manner that ensures the road and the bridges, culverts, fords and other structures associated with the road are structurally sound and safe for use by industrial users.

Retaining structures associated with the **road prism** may be required at some locations to stabilize cut and fill slopes exceeding the natural angle of repose. They can be an important component of the road infrastructure to (1) optimize road layout and design and reduce overall construction costs, and (2) ensure slope stability and a stable road prism over the life of the road. To address safety and resource protection, retaining structures installed on FSRs will be suitably planned in layout and design of a road, and properly designed and built to ensure structural integrity, durability and serviceability.

This section describes the design requirements for conceptual and detailed design of retaining structures **greater than 1.5 m high**, installed within or adjacent to the road prism to stabilize road cuts and fills or natural slopes. This section also describes the associated ministry acceptance / approval

processes for such structures. Similar requirements and processes should be considered for retaining structures 1.5 m high and less.

The types of retaining structures captured by these design requirements include:

- conventional retaining walls that do not incorporate geosynthetic reinforcement, such as inter locking concrete block walls, gabion walls, steel bin walls, log cribs, and cast-in-place concrete cantilever walls;
- reinforced soil retaining walls using mechanically stabilized earth (MSE)<sup>1</sup> or geosynthetic reinforced soil (GRS)<sup>2</sup> design methodologies;
- reinforced slope retention systems using MSE or GRS design methodologies.

### 3.10.1 General

#### Structure Design Responsibility

A Professional Engineer registered with the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) ***must*** prepare designs and take responsibility for retaining structures that are **greater than 1.5 m high**.

#### Conceptual Design

During conceptual design and prior to detailed design, and based on a site visit, the design engineer will recommend a retaining structure type, and also facing materials for MSE and GRS retaining structures, to the ministry engineer for review. Selection of appropriate retaining structure type is typically based on an assessment of the design loading, depth to adequate foundation support, presence of deleterious environmental factors, physical constraints of the site, cross-sectional geometry of the road and natural slopes, foundation settlement potential, desired aesthetics, constructability, maintenance, and cost. Recommended retaining structure types (including facing materials for MSE and GRS retaining structures) will meet the performance, durability, and serviceability requirements established for the project by the ministry engineer.

#### Detailed Design

Analysis and design calculations of retaining structures will conform to best engineering practices as outlined below:

- define project requirements, considerations, constraints, performance, durability and serviceability criteria; determine design methodology (analytical and design procedures), and confirm design service life;

<sup>1</sup>MSE technology uses a tied-back approach to the design of the geosynthetics and typically uses a wider spacing of the geosynthetic reinforcement compared to GRS technology.

<sup>2</sup>GRS technology consists of closely spaced layers of geosynthetic reinforcement and compacted fill materials to produce a composite reinforced soil mass.



- define structure geometry, design loads, lateral earth and water pressures, and effects of surcharge loads;
- assess external stability, and internal stability (if applicable), and facing material stability (if applicable);
- check global stability;
- produce design and construction drawings to show road site and general layout, retaining structure profile, existing and finished grades, cross-sections and details, materials specifications, connection details, guardrails or barriers (if applicable), construction guidelines, maintenance requirements;
- make reference to any supporting documentation.

### Design Variations

Variations from the design requirements described herein may be acceptable in certain special situations. All such variations will be documented and require approval from the ministry engineer prior to use.

## 3.10.2 General Design Requirements

### Design Service Life

The design service life is potentially affected by the long-term effects of people, machinery, component material deterioration, seepage, flowing water, and other potentially deleterious environmental factors. Design retaining structures for a service life based on consideration of the potential long-term effects of material deterioration on each of the material components comprising the structure.

Design drawings will clearly specify (1) whether the structure is permanent or temporary, and (2) the design service life of the structure.

- **Permanent** retaining structures installed on roads to stabilize road cuts and fills or natural slopes will have a minimum design service life of 45 years (same design service life as permanent bridges for FSRs) or longer service life as otherwise specified by the ministry engineer. Permanent retaining structures will be comprised of durable materials, and will not incorporate any components having a lesser service life than the specified design requirement service life.
- **Temporary** retaining structures installed on roads to stabilize road cuts and fills or natural slopes will have a minimum design service life of 15 years unless a lower design requirement service life is specified by the ministry engineer after consideration of operational objectives and durability of material types contemplated for structure components. The installation of temporary retaining structures on permanent term FSRs should only be permitted if sound justification (supported by cost effectiveness analysis) is provided and approval is given by the ministry engineer. The design of

temporary retaining structures will not incorporate any components having a lesser service life than the specified design requirement service life.

### **Design Lateral Forces**

In addition to lateral earth pressures from level or sloping backfill, the design of retaining structures will consider the effects of water pressure, surcharge loading (uniform area loads, point or line loads), compaction-induced pressures, frost-induced loads, and other forces acting behind the structures as appropriate.

### ***Vehicle Live Load Surcharge***

As a minimum requirement, any in-service vehicle live load surcharge for engineering design of retaining structures will be based on a specific standard bridge design vehicle available from the following website:

<http://www.for.gov.bc.ca/hth/engineering/FRBDC.htm>.

Alternatively, to meet specific operational access needs, it may be required to design for a vehicle live load surcharge that is possibly greater than a ministry standard bridge design vehicle to allow for safe passage of heavy equipment or non-standard vehicles (in a normal transport configuration) that can reasonably be expected to regularly use the FSR, now or in the future. In this case, obtain relevant manufacturers' equipment / vehicle data for design.

### **Design Methodology**

Retaining structure systems installed steeper than 70 degrees will be designed as retaining walls.

Unless otherwise specified herein or approved by the ministry engineer, the design engineer will analyze the applied loads and induced stresses using the design methodologies provided in the reference documents below:

For both conventional retaining structure design (with no geosynthetic reinforcement) and MSE retaining structure design:

- Canadian Foundation Engineering Manual, ***or***
- AASHTO Standard Specifications for Highway Bridges, Seventeenth Edition 2002, Section 5 "Retaining Walls."

For GRS retaining structure design:

- Canadian Foundation Engineering Manual (chapter sections as applicable), ***and***
- Chapter 4 of US Department of Transportation, Federal Highway Administration (FHWA), Publication No. FHWA-HRT-11-026 (*Geosynthetic Reinforced Soil Integrated Bridge System Interim Implementation Guide*).

<http://www.fhwa.dot.gov/publications/research/infrastructure/structures/11026/11026.pdf>

## Design Factors of Safety

Use the following minimum factors of safety for external stability calculations:

### *Minimum factors of safety for external stability*

Condition	Minimum Factor of Safety
Bearing Capacity	2.5
Sliding	1.5
Overturning	2.0
Global Stability	1.5

On some forestry road applications, it may not be feasible to achieve some of these factors of safety, especially the global factor of safety on cut slope retention on steep slopes. For design, where a factor of safety is lower than shown in the above table, the design engineer will document the risks and benefits associated with a lower value and provide a recommendation to the ministry engineer for review and decision.

### *Minimum factors of safety for internal stability (MSE and GRS designs)*

For MSE and GRS retaining structures, apply the minimum factors of safety for internal stability calculations of allowable reinforcement strength (or strength of the GRS composite mass) provided in the following guidelines or standards, unless the design engineer provides a rationale for using alternative factors of safety acceptable to the ministry engineer:

For MSE retaining structures:

- Canadian Foundation Engineering Manual, or
- AASHTO Standard Specifications for Highway Bridges, Seventeenth Edition 2002, Section 5 “Retaining Walls.”

For GRS retaining structures:

- Chapter 4 of US Department of Transportation, Federal Highway Administration (FHWA), Publication No. FHWA-HRT-11-026 (*Geosynthetic Reinforced Soil Integrated Bridge System Interim Implementation Guide*).  
<http://www.fhwa.dot.gov/publications/research/infrastructure/structures/11026/11026.pdf>

### *Maximum vertical spacing of geosynthetic reinforcement for GRS retaining structures*

The maximum vertical spacing between horizontal layers of geosynthetic reinforcement used in GRS retaining structures will not exceed **300 mm**.

### 3.10.3 Factors to Consider in Selecting Facing Materials for MSE and GRS Retaining Structures

Prior to final design, the ministry engineer will approve the type of facing materials for all MSE and GRS retaining structures proposed for installation on FSRs. To address durability and serviceability, the selection of facing element for a retaining structure will consider various factors:

- design service life
- economic implications of the structure length and potential environmental impact
- road safety considerations and traffic barricade requirements
- life cycle cost considerations, future maintenance and serviceability
- drainage requirements of the backfill
- durability for given exposure
- tolerances to movement during and after construction settlement, deflection, and rotation
- exposure of uncovered geosynthetic materials to potentially deleterious environmental factors or the loss of geosynthetic strength due to the long-term effects of ultraviolet (UV) light
- likelihood of possible damage to facing elements from stream abrasion and scour hazards
- likelihood of possible damage from grading and snow removal operations and vandalism
- aesthetics
- anticipated potential future transfer of the FSR to other agencies possibly necessitating the installation of specific materials for facing elements
- availability of materials
- horizontal alignment restrictions and space limitations.

#### Facing Materials for Permanent MSE and GRS Retaining Structures

Permanent MSE and GRS retaining structures installed within or adjacent to the road prism to stabilize road cuts and fills or natural slopes along FSRs will have facing materials comprised of durable materials such as modular concrete panels or blocks, free draining rock fill (natural or imported cobbles, or broken rock), or other long-lasting material.

If prefabricated welded wire mesh forms are used in combination with stone fill or other durable facing materials, the design will ensure that the forms and all component connectors (including stiffeners and anchors) have adequate strength and are galvanized after fabrication, and that no backfill from the soil reinforced

zones will migrate and escape through any voids or gaps in the front facing. For rock fill facing, the design will ensure that the rock fill is adequately sized to prevent any loss of cobbles or broken rock through the grid openings in the welded wire mesh forms.

The use of uncovered geotextile fabric at the front of galvanized welded wire mesh forms as a standalone facing material is not recommended for permanent GRS retaining structures on FSRs due to concerns for (1) loss of geosynthetic strength from long-term degradation effects of weathering, UV light, abrasion and other environmental factors and (2) other possible sources of damage to the exposed fabric (e.g., vandalism or road maintenance operations) that may affect the functional service life of the facing.

Any variance to these criteria will be approved and documented by the ministry engineer.

### **Facing Materials for Temporary MSE and GRS Retaining Structures**

Temporary MSE and GRS retaining structures installed within or adjacent to the road prism to stabilize road cuts and fills or natural slopes along FSRs should (preferably) have facing materials comprised of durable materials as specified above for permanent retaining structures.

Alternatively, the facing can be comprised of alternative materials provided that they do not have a lesser service life than the specified design requirement service life and their use is appropriate for the type of retaining structure.

The use of uncovered geotextile fabric at the front of galvanized welded wire mesh forms as a standalone facing material can be considered for temporary GRS retaining structures on FSRs after consideration of the various selection factors listed above and only after consultation with the ministry engineer. For this application, a double layer of geotextile fabric is recommended provided the design engineer has determined (after consideration of the site specific UV potential) that this double layer system of geotextile fabric will provide suitable UV protection and address other factors listed above to meet project durability and serviceability requirements over the design requirement service life. Furthermore, the geotextile fabric product will be treated using carbon black (a UV absorber) meeting the following minimum specification to make the geotextile fabric less sensitive to UV light: minimum 70 percent strength retained after 500 hrs of UV exposure according to ASTM D4355-07 – “Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.”

Any variance to these criteria will be approved and documented by the ministry engineer.

### 3.10.4 Geotechnical Report, and Detailed Design Drawings and Specifications

#### Geotechnical Report

A geotechnical report will be prepared to assess and address possible (1) foundation and construction difficulties, (2) effects on existing adjacent structures or slope stability, and (3) methods of overcoming any identified difficulties during the construction stage, or other requirements. The report should include a recommendation of the preferred type of foundation, and methods of scour protection (if applicable for the site).

#### Detailed Design Drawings and Specifications

The design engineer will prepare detailed design drawings prior to construction of any retaining structures. The detailed design drawings will be signed, sealed, and dated by the design engineer taking responsibility for the design. Produce drawings at a scale and format that are usable in the construction process and include any explanatory notes, details, illustrations and specifications for the materials and construction. This content may include, but is not limited to, the following:

- site location, site plan, and general notes to specify:
  - site location coordinates;
  - name of FSR, forest district and region;
  - whether the retaining structure is temporary or permanent, and design service life of the structure;
  - design surcharge loading (uniform area loads, point or line loads), including the vehicle live load surcharge and the specific design vehicle or equipment configuration and loads used in the structure design;
  - design methodology and considerations, assumptions, constraints, any performance design criteria, and other project requirements;
- longitudinal views and existing ground profile, cross-sections, site location coordinates, construction working points and elevations, finished ground profile and elevations (if applicable);
- specifications for soil / rock materials, erosion protection of backfills, adequate foundation preparation, including scour protection (if applicable), and provisions for drainage of backfill materials and all soil reinforced zones (if applicable);
- material specifications for all components (including connection hardware), and including specification of corrosion protection of component materials to meet the design service life;

- facing material specifications and associated connection details, and geosynthetic layer layout, spacing and length in the case of MSE and GRS retaining structures;
- preparation of foundation areas, installation and assemblage of structure components, sizing and extent of riprap (if applicable), and other important requirements to ensure proper construction of the retaining structure;
- reference to design aids, specific constraints dictated by the ministry, or works of others which significantly impacted the resulting design.

All engineering reports and detailed design drawings and specifications, and engineered cost estimates related to the design of retaining structures (if applicable) will be signed, sealed, and dated by the design engineer.

It is the responsibility of the design engineer to ensure that appropriate quality assurance (QA) measures have been included in the design process. This may include engaging a qualified QA reviewer to check the design assumptions, calculations, notes and final design drawings consistent with the requirements of APEGBC Bylaw 14(b) available at: <https://www.apeg.bc.ca/getmedia/e0c7d14c-ed74-4872-9a58-0a4bb2cd59b7/APEGBC-Bylaws.pdf.aspx>

### 3.10.5 Ministry Review of Externally Prepared Designs

#### Concept Review Phase

During the conceptual design phase and well in advance of any detailed design work or procurement of materials, ministry staff will ensure that a ministry engineer is given an opportunity to review and comment on the suitability of a retaining structure proposed for construction on an FSR by the ministry. Failure to do this could delay acceptance of the detailed design drawings and/or project.

#### Review and Acceptance of Detailed Designs

Design engineers that prepare retaining structure designs for the ministry will consult with ministry professional engineering staff during the detailed design stage. A ministry engineer ***must*** review all detailed designs of retaining structures for conformance with ministry standards and other site specific requirements, and accept the designs prior to the construction phase on FSRs.

Accepted design drawings (for a retaining structure that will be constructed on an FSR) are to be stamped “For Construction.”

### 3.10.6 Coordinating Registered Professional (CRP)

#### Final Reviews, Record Drawings, and Assurance Statement

The Coordinating Registered Professional (CRP) ***must*** coordinate and ensure field reviews<sup>3</sup> are carried out during the construction of a retaining structure on an FSR. The CRP is responsible to ascertain whether the implementation or construction of the work substantially complies in all material respects with the engineering concepts or intent reflected in the engineering documents prepared for the work. The CRP ***must*** gather all relevant information and prepare record drawings<sup>4</sup> and sign, seal and date a Structure Assurance Statement for submission to the ministry.

For retaining structures **greater than 1.5 m high**, the CRP ***must*** be a Professional Engineer (preferably the design engineer who signed and sealed the construction drawings).

### 3.11 Resources and Suggestions for Further Reading

BC Ministry of Forests. 2002. [Fish-stream Crossing Guidebook](#). For. Prac. Br., B.C. Min. For. Victoria, B.C.

\_\_\_\_\_. 2002. [Forest road engineering guidebook](#). 2nd ed. For. Prac. Br., B.C. Min. For. Victoria, B.C.

Holmes, D.C.. 1989. Manual for roads and transportation. British Columbia Institute of Technology (BCIT). Burnaby, BC

The Geometric Design Guide for Canadian Roads, 2007. published by the Transportation Association of Canada (TAC) provides design standards that can be used for forest roads.

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<sup>3</sup>Field reviews means field reviews conducted at the project site [and / or at fabrication location(s)] of the implementation or construction of the engineering work by a Professional Engineer or his or her subordinate acting under his or her direct supervision, that the Professional Engineer in his or her professional discretion considers necessary to ascertain whether the implementation or construction of the work substantially complies in all material respects with the engineering concepts or intent reflected in the engineering documents prepared for the work.

<sup>4</sup>APEGBC discourages the use of the terms “as-built drawings” or “as-constructed drawings” as they imply that the drawings show exactly what was built or constructed. The terms may also suggest a level of certification or impose inappropriate liability. For this reason, APEGBC recommends and uses the term “record drawings.” Refer to APEGBC Quality Management Guidelines “Use of the APEGBC Seal” for more information: <http://www.apeg.bc.ca/pppractice/ppdocs.html#OMG>.








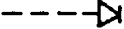



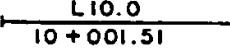
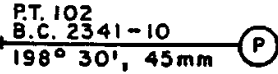
# Appendices

## Appendix 3.1: Drawing and Map Legends

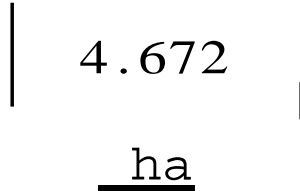
### 1. General

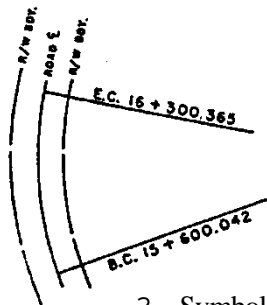
As a general rule, primarily in the interests of time and money, pencil fair drawings are an acceptable presentation. However, there may be occasions where inked final drawings are required. For that purpose, it will be noted that "template" information is shown.

### 2. Symbols for Road Location Line on Plans

Symbol	Colour	Item	Template
	Red	Surveyed Centreline	(Use 2.25 mm pen)
	Red	Paper Relocation Centreline	
	Red	P.I.	100 Caps
	Black	Turning Point	
	Black	Reference Point	80 Caps & Lower Case
	Black	Bench Mark	80 Caps & Lower Case
	Black	Forest Service Monument	
	Green	F.R. R/W Boundary	
	Black	Clearing Boundary	
	Black	km Marker (Location) line 0.5 marker	80 Caps
	Black	Photo Ties. Use 0.5 mm	80 Caps

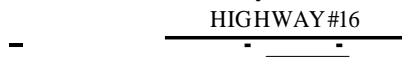
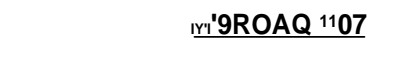
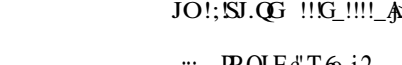
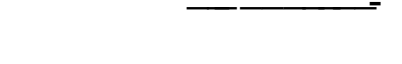
## 2. Symbols for Road Location Line on Plans (contd.)

Symbol	Colour	Item	Template
	Black	Right-of-Way Circle (40mm dia.)	200 Caps
		Right-of-way shown in alienated lots only	



B.C.'s & E.C.'s where possible to be shown close to the right-of-way boundary with template 80 Caps

## 3. Symbols for Roads and Trails

	Black	Public or Gazetted Roads. Paved-use 0.25mm pen	Size of letters used proportionate to width of highway
	Black	Gravel	Surveyed Non-Surveyed
	Black	Other Roads	SO Caps
	Green	F.S. - Gazetted	Surveyed and Unsurveyed
Road Permit No.	Black	Operational	



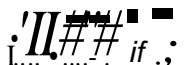


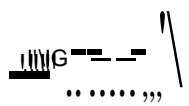

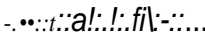





## 3. Symbols for Roads and Trails (cont.)

Symbol	Colour	Item	Template
	Black	Railroad Grade	
	Black	Railroad Grade Abandoned	
	Black	Bridges	
	F.S. - Green	Road Permit -Black	
	Black	Culverts (Type and Size)	
	Black	Trails	
Black Line or Colour	Dashed Orange	Recreation Trail	
	Dashed Green	Heritage Trail	

## 4. Symbols for Physical Features

Symbol	Colour	Item	Template
	Black	Contours, Elevation (show index contour heavy)	80 Caps
	Black	Local mound (above contour elevation)	
	Black	Depression (below contour elevation)	
	Black	Approximate or under-water contours	80 Caps
	Black	Form lines	80 Caps
	Black	Ridge line	80 Caps

## 4. Symbols for Physical Features (cont.)

Symbol	Colour	Item	Template
	Black	Lakes or ponds all year	Oblique caps & Lower case proportionate to feature
	Black	Lakes or ponds, intermittent	
	Black	Rock outcrops	
	Black	Slide	
	Black	Present water level (shoreline) - pencil shaded 0.5 mm or smaller to suit.	
	Black	High water level - light dash line	
	Black	Swamp	
	Black	Sand bar	
	Black	Streams (intermittent or underground)	
	Black	Streams (over 1.0m wide)	Where named, oblique caps and lowercase proportionate to size of feature.
	Black	Streams (under 1.0m wide)	Where named, oblique and lowercase proportionate to size of feature.
	Black	Timber boundary (small scale)	
	Black	Timber boundary (large scale)	

## 4. Symbols for Physical Features (cont.)

Symbol	Colour	Item	Template
@	Black	Treotype (sizetosuit)	
DECIDUOUS CONIFEROUS	Black	Drainorditch (label as to specific use)	
--+ O pen —			
•••• Covered (Tile)			

## 5. Legal Boundaries and Markers Found in the Field

In the following breakdown of legal marker and boundary symbols, it should be noted that the minimum requirement is two ties per legal plan or lot if at all possible. This is required to provide the correct orientation of the survey line through the legal parcel or parcels and to provide the necessary ties for gazetting purposes. Additional legal information may be noted as follows:

Symbol	Item
OTH	Traverse Hub
4TRJO.	Triangulation Station
O P	Wooden Post
Ⓡ P.CON.	Concrete Post
Ⓡ P.ROCK	Standard Rock Post
Ⓡ PP	Standard Pipe Post
•IP	Standard Iron-Bar Post
•AI	Standard Aluminum Bar Post

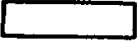









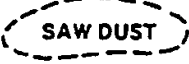



## 5. Legal Boundaries and Markers Found in the Field (cont.)

Symbol	Item
WT	Witness
BT	Bearing Tree
OPR	Wooden ReferencePost
C	Cairn
M	Mound
PIT	FourPits
T	Trench
0	Denotes old prefix to the foregoing symbol to denote post or tree found
MKD	Marked
STA	Station
BDY	Boundary
0 SP	Staking Post
0 LOC.P	Location Post(Mineral Act)

## 5. Legal Boundaries and Markers Found in the Field (cont.)

Symbol	Item
	Traverse to found Standard Pipe Post
	Any capped pin, monument, post or pipe post with an inscription that has been found and tied to the survey will be denoted by a double circle with a solid centre and are production of the inscription. Lead posts or
	iron pins will be denoted by a solid dot and LP or IP.
	The number (73) at the bottom of its inscription is the number assigned to the particular B.C.L.S. who established that monument.
	When the bearing and distance between legal markers as shown on the legal plan is confirmed by the survey, that line will be shown solid on the plan.
	At least two legal markers from one legal plan should be confirmed by the survey. When additional legal markers have been found and not tied to the survey, the lines joining these markers shall be shown as dashed lines on the plan.
	When legal markers are not found, the assumed location of the lot lines will be dashed according to legal plans or legal survey notes.

## 6. Symbols for Structures and Miscellaneous

Symbol	Colour	Item	Template
	Black	Building (permanent)	
	Black	Building (temporary)	
	Green	Lookouts	
	Black	Telephone Line	
	Black	Telephone Pole	
	Black	Power Line	
	Black	Power Pole	
	Black Black	Power and Telephone Lines with Poles located	
2 m Chain Link 	Black	Fences (Label as to type)	) )
	Black	Wharf or Pier	)
	Black	Sawdust Pile	) 80 Upper and Lower ) Case
	Green	Gravel Pit	)
	Black	Pipelines (Oil or Gas)	
	Black	Domestic Water	



## 6. Symbols for Structures and Miscellaneous (cont.)

Symbol	Colour	Item	Template
	Black	Pipelines	
	Black	Valve -Gate	
	Black	Valve - Air	
	Black	Reducer	
	Black	Risers	
	Black	Pipe - AL(W) - Aluminum Welded	
	Black	AL(ABL) -Aluminum with Aluminum Below Ground Couplers	
	Black	B.V.C - High Pressure Plastic	
	Black	(Polyvinyl chloride) Tower and guyline anchors	

## 7. North Arrow

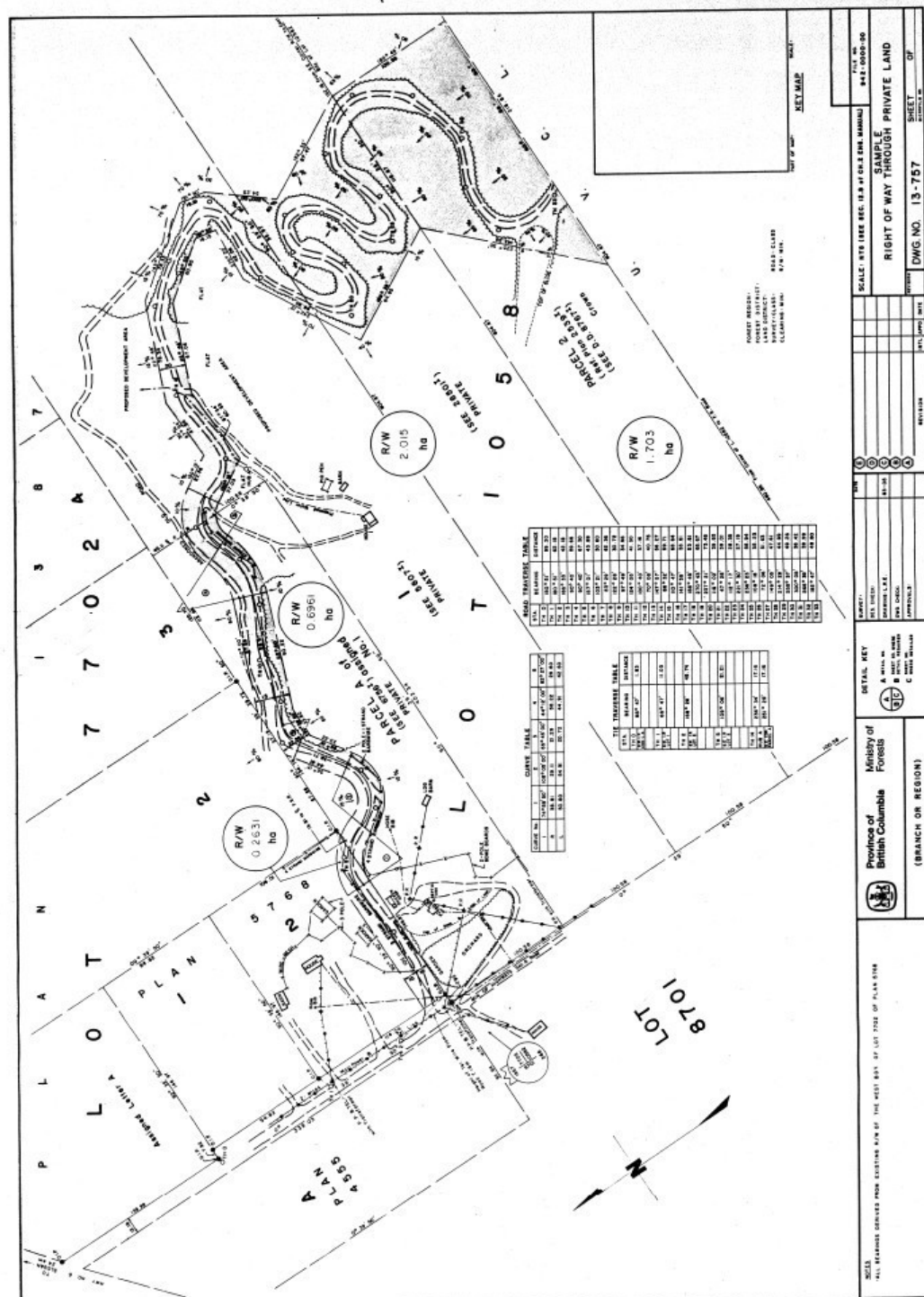
Compass readings will be accepted in areas where legal boundaries are not or cannot be defined. The drawings prepared in such areas will show the North arrow as well as the declination arrow, amount of declination, and the year.

In all other areas where a firm tie has been made to a legal boundary, the commencement bearing is the boundary bearing, and only the true North arrow need be shown on the related drawings.

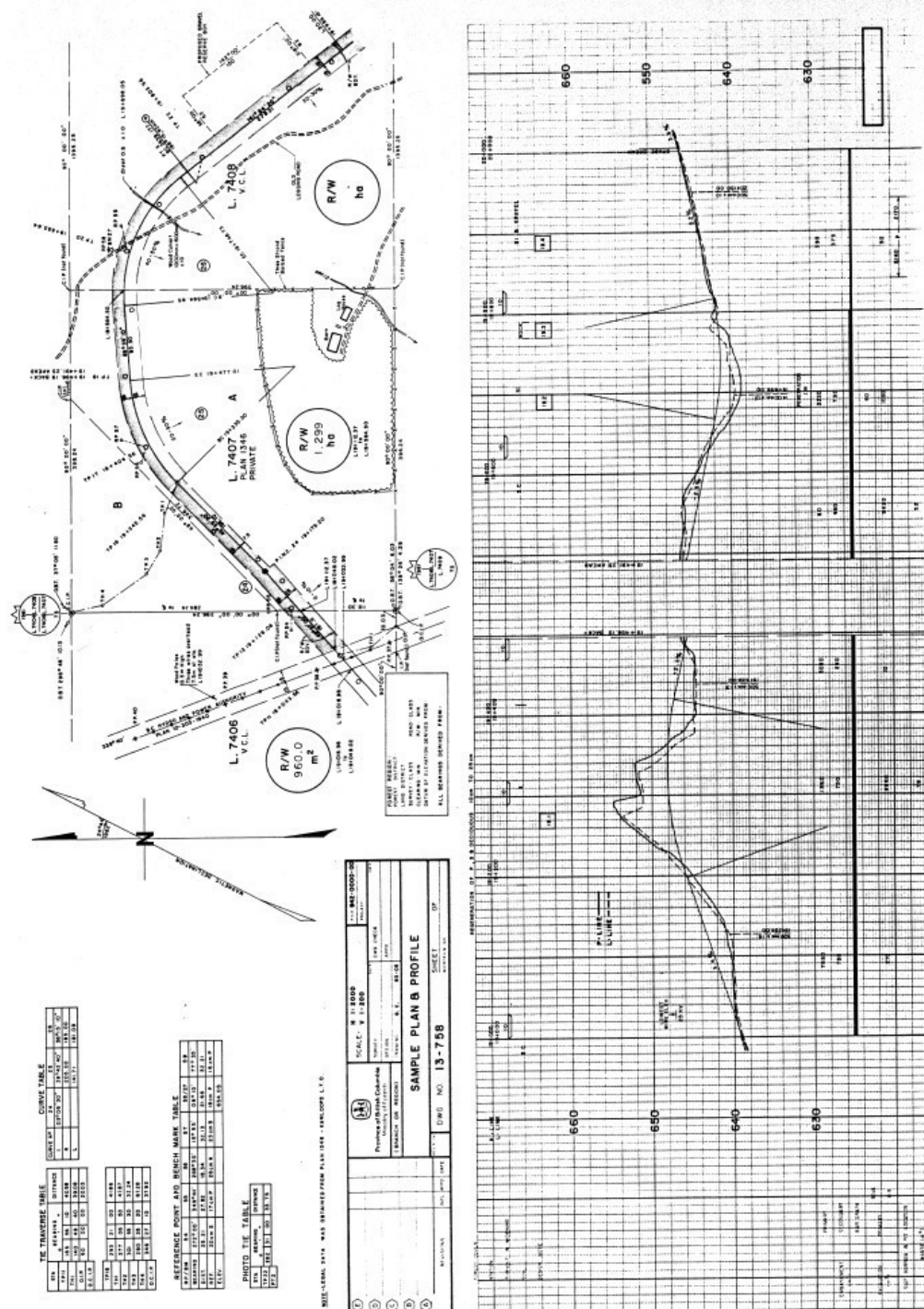
**Appendix 3.2: Standard Drawings**

Figure 3-5:	Dwg. No. 13-757	Sample Right-of-Way through Private Land
Figure 3-6:	Dwg. No. 13-758	Sample Plan and Profile
Figure 3-7:	Dwg. No. 13-759	Sample River Crossing Plan 1 of 2
Figure 3-8:	Dwg. No. 13-759	Sample River Crossing Profile & Cross-Section 2 of 2
Figure 3-9:	Dwg. No. 13-760	Sample Railway Crossing for Existing Road
Figure 3-10:	Dwg. No. 13-761	Sample Pipeline Crossing
Figure 3-11:	Dwg. No. 13-762	Sample Powerline Crossing
Figure 3-12:	Dwg. No. 13-763	Sample Structure of Compliance with Navigable Waters
Figure 3-13:	Dwg. No. 13-768	Sample Highway Junction

**Figure 3-5 Dwg. No. 13-757 Sample Right-of-Way through Private Land**



**Figure 3-6 Dwg. No. 13-758 Sample Plan and Profile**



**Figure 3-7 Dwg. No. 13-759 1 of 2 Sample River Crossing Plan**

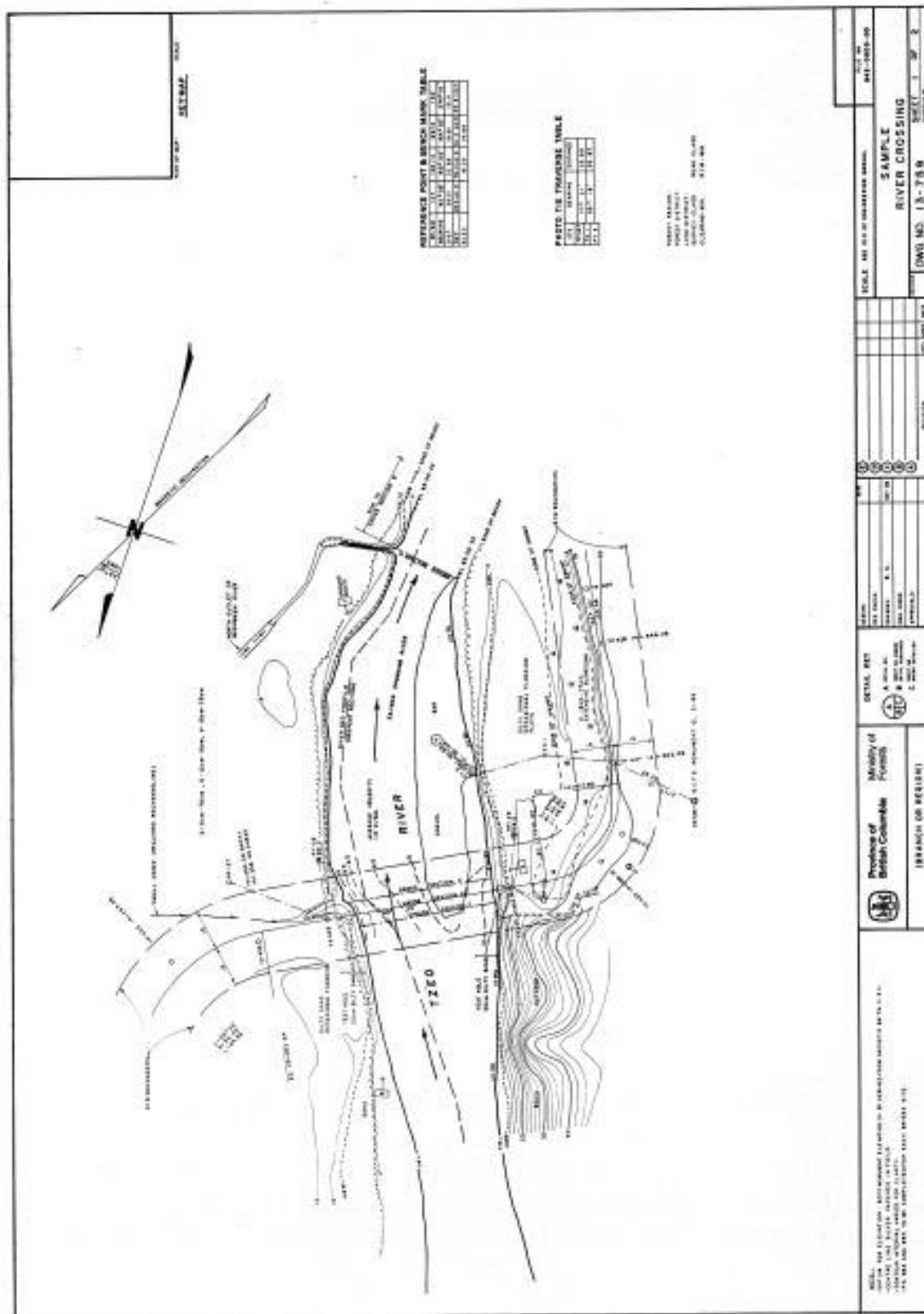
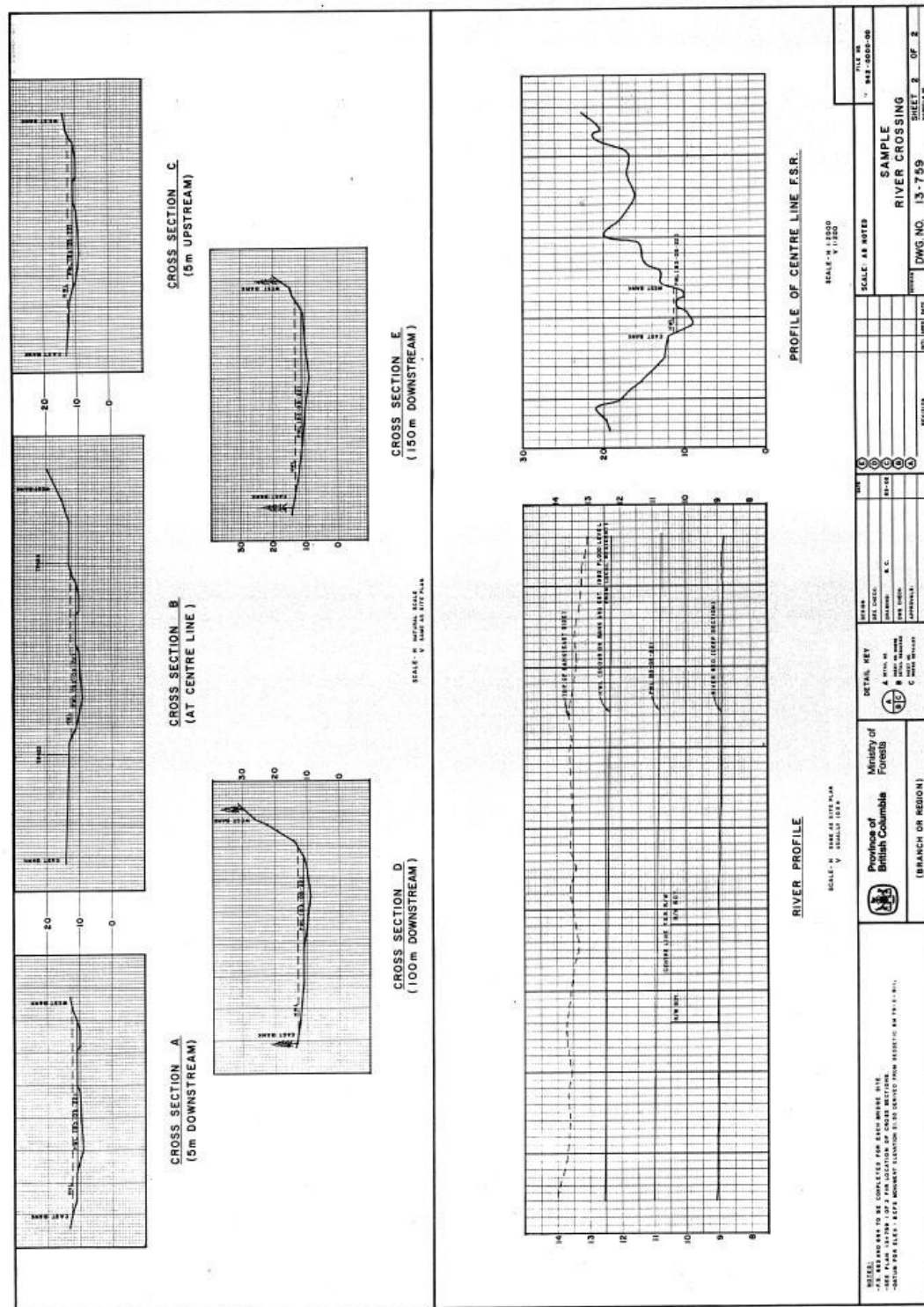
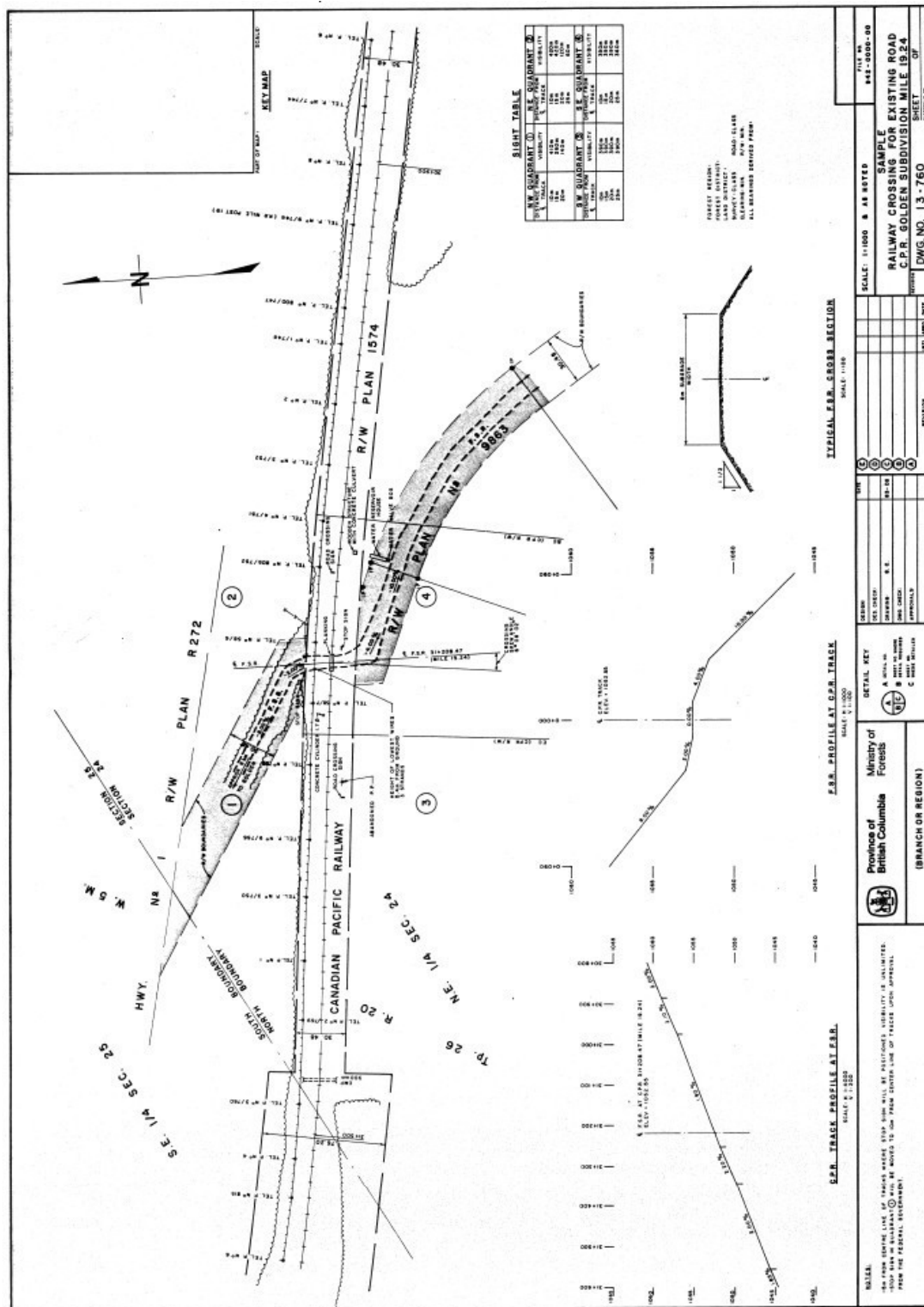


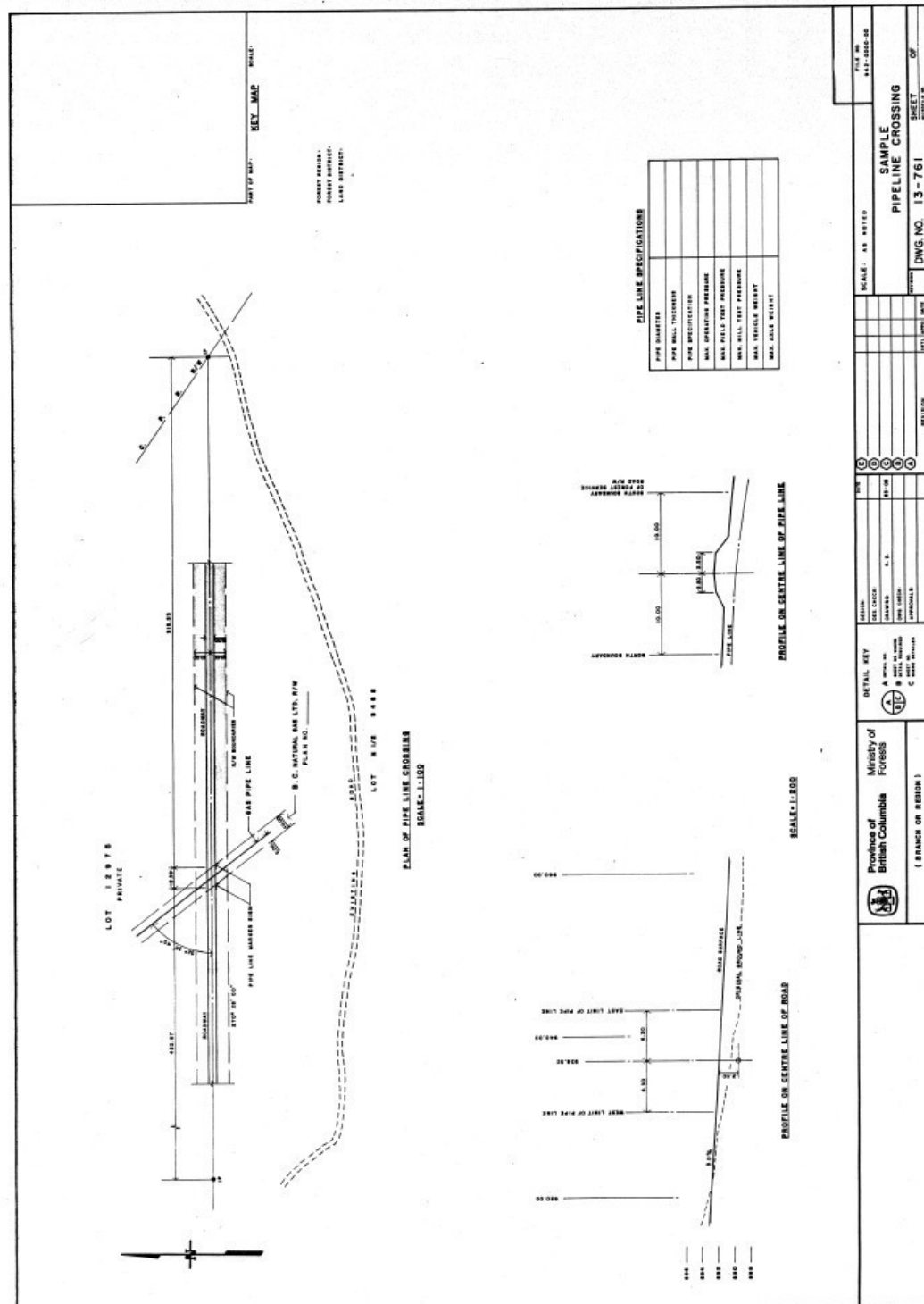
Figure 3-8 Dwg. No. 13-759 2 of 2 Sample River Crossing Profile & Cross-Section



**Figure 3-9 Dwg. No. 13-760 Sample Railway Crossing for Existing Road**

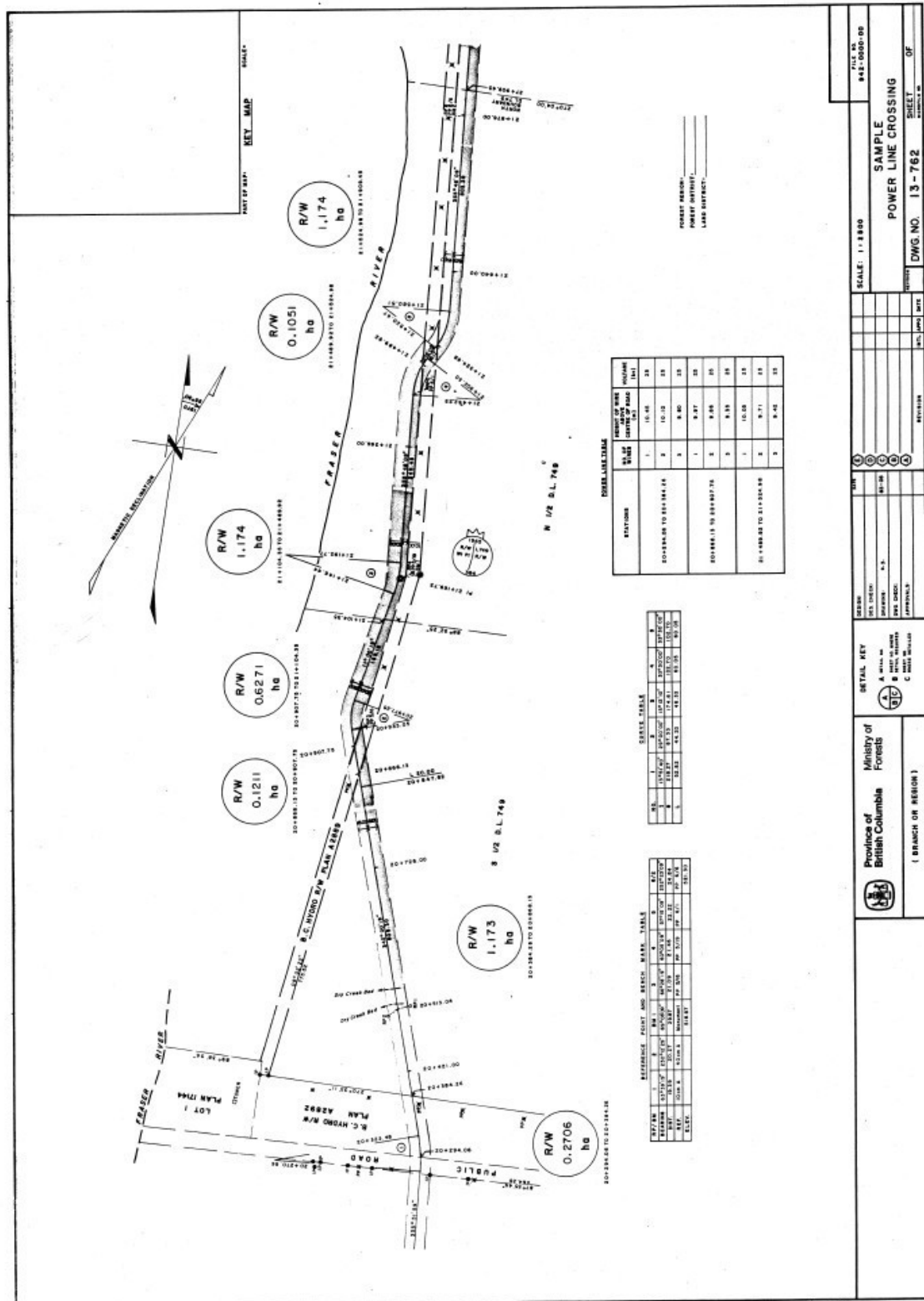


**Figure 3-10 Dwg. No. 13-761 Sample Pipeline Crossing**

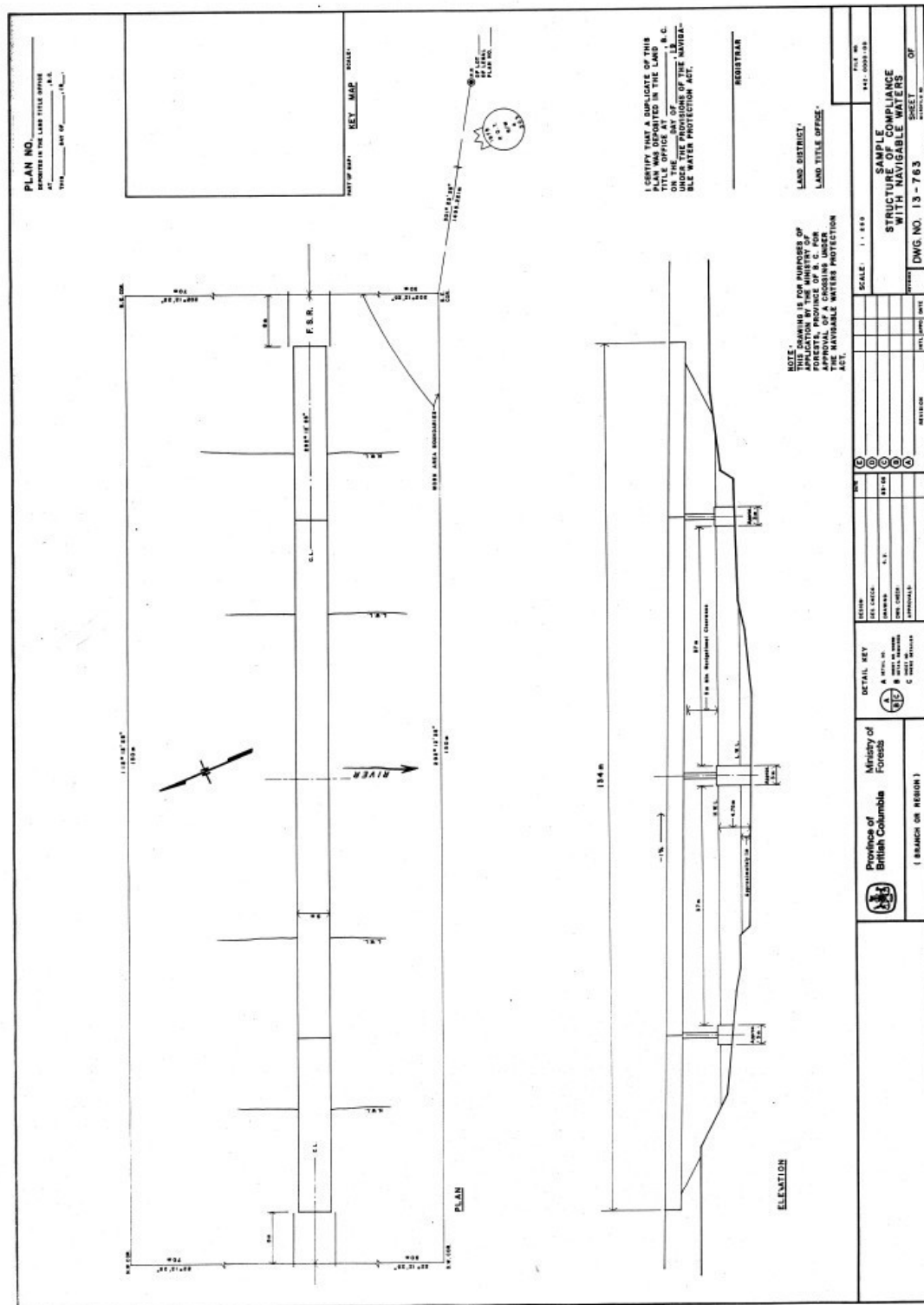




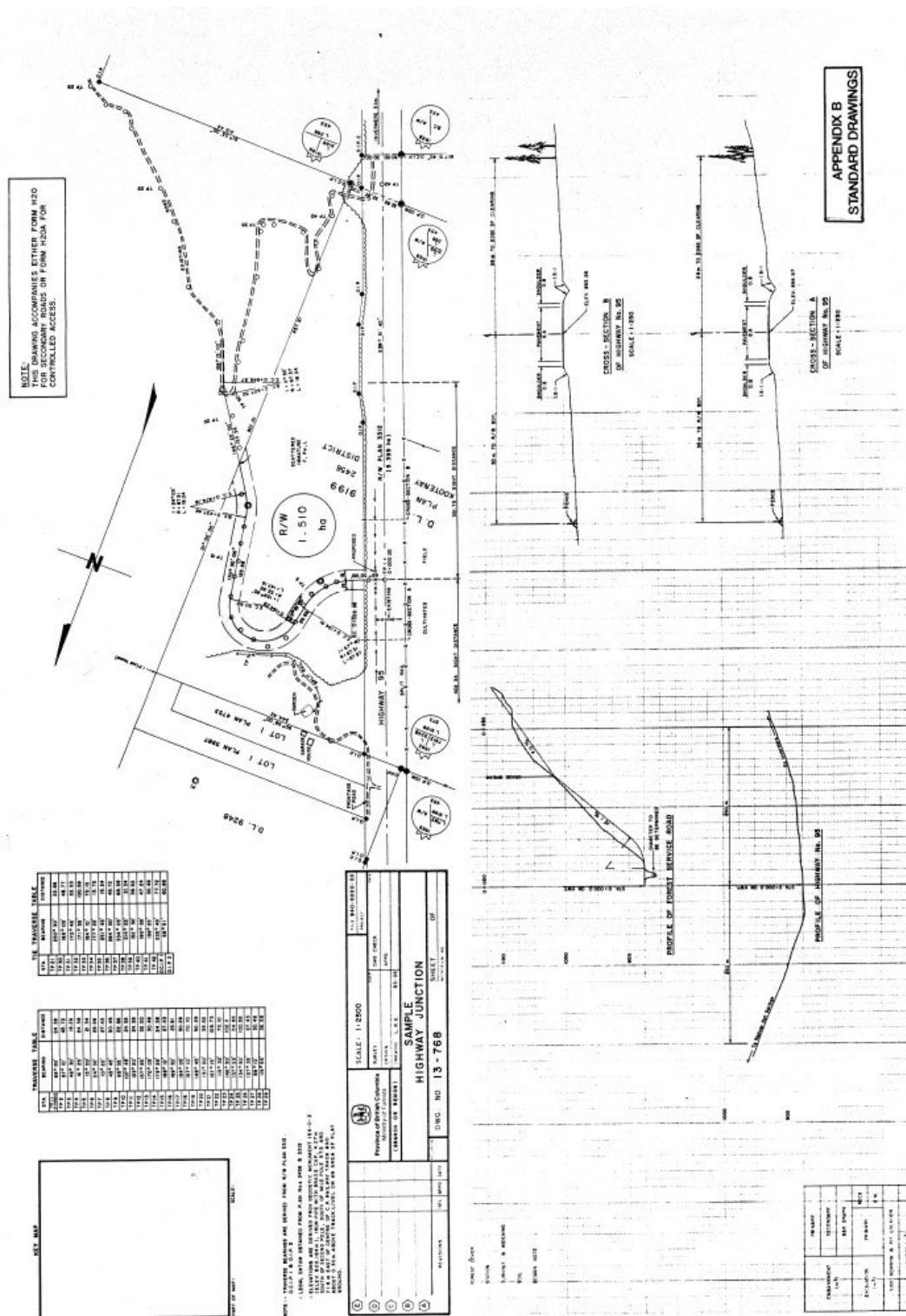
### Figure 3-11 Dwg. No. 13-762 Sample Powerline Crossing



**Figure 3-12 Dwg. No. 13-763 Sample Structure of Compliance with Navigable Waters**



**Figure 3-13 Dwg. No. 13-768 Sample Highway Junction**



## **Appendix 3.3: Basic Drainage Site Report Requirements**

### **Stream Crossing Data Collection**

Carry out the following:

1. Take at least two cross-sections to measure flow. Divide the width of the stream into four equal parts. Measure the flow velocity at each of the four sections.
2. In planning the layout of the structure:
  - Choose an appropriate location, along a stream reach with uniform or uniformly varying flow close to the proposed crossing, to measure a cross-section. Sketch the cross-section of the stream gully, showing evidence of the high-water level, present water level, and depth of the stream across the bottom. Extend the cross-section back from the stream an appropriate distance to show the terrain that affects the proposed crossing and road alignment.
  - Note any visual evidence of high water.
  - Measure and record the average gradient of the stream at the crossing and at the cross-section if the two are taken at different locations.
  - Record the soil type, soil profile, parent material, and substrate material at the crossing and describe the stream bottom.
  - Describe the stream channel (debris loading, bank stability, crossing location on a fan, bedload problem, etc.).
  - If the site is a fish stream, consult the [Fish-stream Crossing Guidebook](#) for site and design requirements.
3. For the flow measurement cross-sections, sketch a graph of surface velocity across the channel and estimate average surface velocity ( $V_s$ ) from the graph. Compute cross-sectional area ( $A$ ), wetted perimeter ( $WP$ ), and hydraulic radius ( $R$ ) for each section. Average these values for two sections and use the slope of the reach between them to obtain discharge ( $Q$ ) at present water level ( $PWL$ ) and estimated high water level ( $HWL$ ).

### **Centreline Profiles**

- Take a centreline profile showing streambed,  $PWL$ ,  $HWL$  (if possible), and top of bank (if well-defined), extending 50–100 m on each side of centreline.
- Tie in all cross-sections and profiles to a traverse.

## Photographs

Take stereo pairs of photos looking upstream and downstream, with the centreline in the foreground. Note the sizes of any other culverts on the same stream or its tributaries, and record their past performances, if known.

## Benchmarks and References

Establish a minimum of one benchmark and two reference points.

## Additional Information

- Note the size, amount, and description of debris, and photograph debris accumulation.
- Make soil tests – at least one at the culvert site and one downstream where scour is expected. Drive a bar into the bottom of each hole and note its behaviour.
- Note all topographic control features that may affect culvert design.
- Note possible sources of compaction-zone backfill, riprap, and road fill.

## Plan Details

At a scale of 1:200, with 0.5 m contours, show the following:

- present waterline (give date) and estimated high waterline;
- boundaries and descriptions of rock, soil, and vegetation types;
- large boulders, beaver dams, or debris accumulations (describe);
- any use of private property that might be affected, with status and right-of-way lines (if known);
- flow pattern, by arrows with appropriate length and direction;
- soil test holes and their logs;
- stream cross-section locations or their direction and distance if they are off the plan;
- control traverse;
- declination;
- topography points;
- reference points and benchmark, including elevation datum; and
- the key map.

### ***Appendix 3.4: Sample Survey and Design Contract***

The following [“sample” Survey and Design Contract](#) title page and table of contents are included in this appendix to illustrate the general content of such a contract. The link will display the complete sample contract..

The sample is for illustrative purposes only. Download the correct and current contract form(s) from the forms index as required.

File: 11250-30/ \_\_\_\_\_

## SURVEY & DESIGN CONTRACT

Attached to Minor Service Contract No. \_\_\_\_\_

Dated \_\_\_\_\_

MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS

\_\_\_\_\_TIMBER SALES OFFICE

SURVEY CONTRACT FOR \_\_\_\_\_FOREST SERVICE ROAD

km \_\_\_\_\_ to km \_\_\_\_\_

Date: \_\_\_\_\_

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## Appendix 3.5: Log Culvert Design

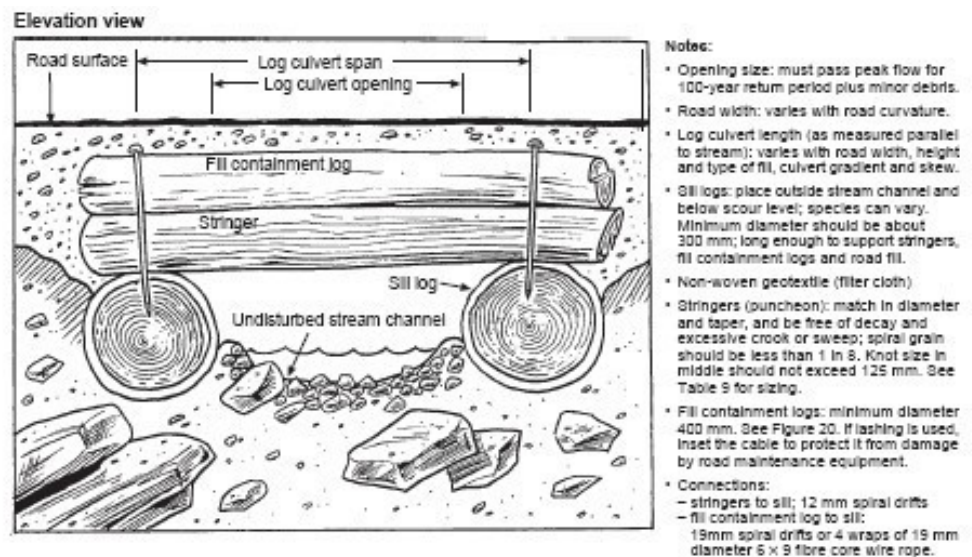
### Terminology

For the purposes of this manual, the term “log culvert” is interchangeable with “woodbox culvert,” “log stringer culvert,” or “wood stringer culvert.”

### Definition: Log Culvert

A log culvert is a log crossing structure having a span of less than 6 m centre-to-centre of bearing, and an abutment height (if constructed as a log crib) of less than 4 m between the underside of the lowest crib log to the underside of the stringers, and is used to carry ephemeral or perennial stream flow in a stream channel from one side of a road to the other. A log culvert structure is covered with soil and lies below the road surface (Figure 3-14).

**Figure 3-14 Simple log culvert**



### Notes Figure 3-14:

- Opening size: passes peak flow for 10-year or 100-year return period, (depending on the anticipated time that the log culvert will remain on the site) plus minor debris.
- Road width: varies with road curvature.
- Log culvert length (as measured parallel to stream): varies with road width, height and type of fill, culvert gradient and skew.
- Sill logs: place outside the stream channel width and below scour level: species can vary. Use minimum diameter of about 300 mm; long enough to support stringers, fill containment logs, and road fill.
- Non-woven geotextile (filter cloth).
- Stringers (puncheon): match in diameter and taper, and be free of decay and excessive crook or sweep; spiral grain should be less than 1 in 8. Knot size in middle is less than 125 mm. See [Table 3-8](#) for sizing.

- Fill containment logs: minimum diameter 400 mm. See [Figure 3-15](#). If lashing is used, inset the cable to protect it from damage by road maintenance equipment.
- Connections:
- Stringers to sill; 12 mm spiral drifts
- Fill containment log to sill: 19 mm spiral drifts or four wraps of 19 mm diameter 6 x 9 fibre core wire rope
- Inlet control: place shot rock to protect against fill erosion below the design flood level.
- Outlet control: place rock as required to prevent outlet scouring and undermining of the sill logs.
- In the case of a skewed log culvert, measure the span of the stringers for design purposes from bearing to bearing along the stringers and not at right angles to the sill logs.

Consider log culverts for:

- streams where other resource agencies require the culvert to be open bottomed; and
- steep gradient streams.

Where the planned service life of the road is less than the life expectancy of the drainage structure components, consider using log culverts:

- as temporary structures on tote roads or pilottrails;
- on roads where ongoing minor debris problems are anticipated; and
- on permanent roads as temporary drainage structures at the clearing or subgrade construction stage, until the permanent drainage structures are installed.

Ensure that a log culvert design addresses the following:

- opening size for design flow and debris management;
- culvert length and fill and surfacing requirements;
- superstructure design (stringer or puncheon sizing);
- substructure design (sills, mud sills, and foundation logs); and
- inlet and outlet protection requirements.

### Log culvert opening size

To meet current legislative requirements, design a log culvert to pass the highest peak flow of the stream that can reasonably be expected within the following return periods specified below for the length of time it is anticipated that the log culvert will remain on site (see FPPR section 74). For methods to estimate the value of  $Q_{10}$  and  $Q_{100}$ , design discharge of a creek see Figure 3-3: High water estimation method for stream culverts in this chapter and [Chapter 4.8: Design Discharge Criteria](#).

**Table 3-8 Peak flows for various log culvert lifespans**

Anticipated period that the log culvert will remain on the site	Peak flow return period
For a log culvert that will remain on site for up to 3 years	10 years (i.e., $Q_{10}$ )
For a log culvert that will remain on site for over 3 years	100 years (i.e., $Q_{100}$ )
For a log culvert within a community watershed that will remain on site for over 3 years	100 years (i.e., $Q_{100}$ )

A log culvert is a type of open bottom structure, designed to span the stream channel width. This is particularly important on fish-bearing streams to avoid impacts on fish habitat and fish passage (refer to the section on “Open bottom culverts” in the [Fish-stream Crossing Guidebook](#) page 6).

In addition to passing the required peak flow discharge, design log culverts to manage anticipated debris. Options may include, but are not limited to:

- increasing the opening size (height and/or width);
- allowing debris to pass over the approaches;
- trapping debris with a specially fitted trash rack or other device; and
- combining these and other options.

Inspect debris catchment devices frequently and clean them as required. The criteria for design of any debris catchment device are site-specific and may incorporate professional input. Identify debris problems from terrain hazard maps, air photo interpretations, field investigations, and reports for the area (see the [Gully Assessment Procedure Guidebook](#)).

The convention for specifying the opening size (inside measurements) of a log culvert is height (vertical distance between the deepest point along the channel floor and the soffit of the stringers) followed by the width (horizontal distance measured at right angles between the inside face of the sill logs).

### Log Culvert Length

Culvert length, as measured in the direction of the stream, is determined by the following:

- road width;
- depth of road fill over the log culvert, and fill slope angles;
- type of fill over the log culvert;

- inlet and outlet treatments;
- culvert gradient; and
- culvert skew.

## Road Width

If the culvert is located within a horizontal curve, provide for extra road width to accommodate side tracking of logging trucks and hence additional culvert length. The required width can be found in [Table 3-3](#): Curve widenings.

## Depth of Road Fill

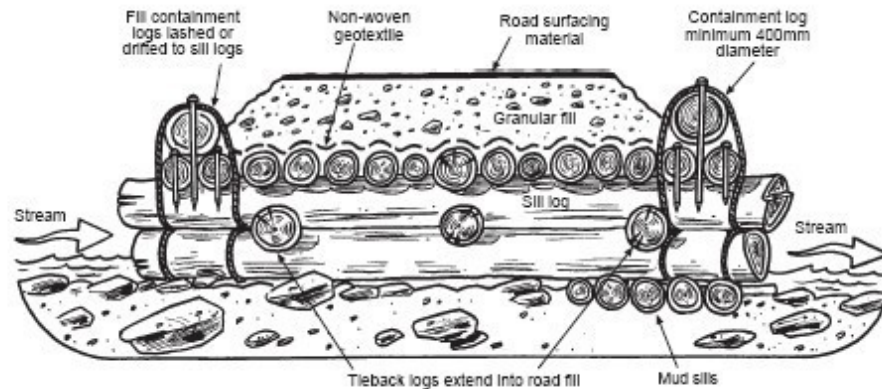
Road fills greater than 2 metres on top of the log stringers should generally be avoided. Should a failure occur, there is a potential for large volumes of sediment-producing materials to enter the stream channel. In addition, deep fills make culvert replacement, repairs or even inlet clean-out difficult. For fills anticipated to exceed depths of 2 metres, ensure that a professional engineer has been consulted or a design table produced by a professional engineer which captures the fill depth is used.

Measures to reduce road fill depth include:

- use of a longer span culvert, or a bridge for V-shaped channels;
- increasing the culvert height, by use of log cribs; and
- relocation of the road to a more suitable crossing.

Ensure that log culverts are sufficiently long to contain the fill and prevent material from entering the stream. As the fill height increases for a given roadway width, increase the culvert length.

Incorporate road fill containment measures into the design. This can be achieved by making the culvert extra long (at least 1 m per side beyond the toe of the road fill) and securing a large containment log (at least 400 mm diameter) at the toe (Figure 3-15.).

**Figure 3-15 Fill containment for log culvert**

In addition, include provisions that prevent road fill materials from encroaching on the design peak flow discharge flood level. For fills up to 1 m thickness, use the sill logs—provided they are long enough—for this purpose. For higher fills, incorporate other site-specific measures into the design.

### **Type of Road Fill**

To maximize fill slope angles and minimize culvert length, use shot rock or granular pit-run material for the fill material placed over a log culvert. Avoid the use of silty and clayey materials because these materials require flatter fill slope angles (and therefore longer slope lengths) to maintain fill slope stability, and increase the potential for sedimentation.

### **Log Culvert Gradient**

For stream gradients less than 10%, place the stringer soffit (culvert soffit) at 0% grade or at or near the same gradient as the stream. Should the proposed culvert soffit gradient (not the stream channel gradient), exceed 10%, then apply other structural considerations.

### **Channel Gradients Less than 10%**

A cross-sectional sketch of the culvert, the fill, and a profile of the stream bed provide the best tools for determining log culvert length. Measure the required length directly from a sketch drawn to scale.

### **Channel Gradients Greater than 10%**

Measure the length directly from the cross-sectional sketch for the stream.

### **Inlet and outlet treatments**

Incorporate headwalls or sill logs into log culvert design, allowing vertical end fills and therefore reduced culvert length.

## Length for skewed culverts

Where a culvert crosses the roadway at other than a right angle to the road centreline, allow for the increased culvert length caused by this skew.

## Log culvert stringer selection

Stringer sizing involves selection of the appropriate log diameter and species to be used for the stringers. [Table 3-9](#) is an example of a log stringer sizing table developed by a professional engineer. [Table 3-9](#) presents stringer sizing for log culverts, as a function of span (see [Figure 3-15](#)), total fill depth, logging truck axle loads (e.g., L75), and log species. In this professionally engineered table, the total fill depth is the combined thickness of road surfacing and underlying road fill materials that extend down to the top of the stringers. The log diameters given in Table 3-9 are minimum mid-diameters, which are measured at mid-span under the bark. The total fill depth ranges from a minimum of 300 mm to a maximum of 2 m for this table.

If the design discharge is  $6 \text{ m}^3/\text{sec}$  or greater, or the road fill depth is greater than 2 m, ensure that a professional engineer has been consulted or a design table produced by a professional engineer which captures the fill depth is used.

Use oversize logs to account for unseen flaws, to give added strength for overloads and general heavy use, and to extend the service life of the structure. For maximum service life, use sound western red cedar. Fill containment logs contain the fill or road surfacing and can be structural or non-structural. Firstly, place a geosynthetic over the stringers to prevent surfacing or fill material from migrating between the stringers and into the watercourse.

## Log culvert substructure design

The substructure required depends on the bearing capacity of the foundation soils and the length and diameter of the logs available. Choice of substructure is based on an estimate of the bearing strength of the soil at the site. From this, determine the diameter and length of the logs needed to support the design loads. Refer to FPInnovations' Log Bridge Construction Handbook (1980) for a detailed explanation of this topic.

## Single sill logs

Use single sill logs as culvert foundations if the ground is firm and the sill log provides sufficient clearance for the design flood and debris passage. Use a minimum diameter for sill logs of about 300 mm. For short service-life culverts (planned for less than three years use), almost any species of wood will suffice for the sill logs, provided it is sound throughout. However, it is very important that the anticipated life-span of the road be well thought-out. If there is a good chance that the life of the road will be extended, design and construct a culvert with a longerservice-life.

The expected service life for sill logs is as follows (subject to site-specific soil and climatic conditions):

- Cedar (sound, with preservatives applied to cut surfaces): 20 years plus;
- Douglas-fir: 8-10 years;
- Spruce, hemlock and balsam: 4-6 years; and
- Hardwood species: Variable but assume it is less than four (4) years.

**Table 3-9 Log culvert stringer sizing table--log diameters are mid-diameters in millimetres**

SPAN (metres)	TOTAL FILL DEPTH (metres)	L75 D. Fir	L75 Other	L100 D. Fir	L100 Other	L165 D. Fir	L165 Other
1.5	0.3	250	275	250	325	350	450
	1.0	250	225	225	250	250	300
	2.0	250	250	250	250	250	275
3.0	0.3	375	475	400	475	650	800
	1.0	275	300	275	325	350	400
	2.0	275	325	300	350	375	450
4.5	0.3	500	625	575	675	700	825
	1.0	350	425	375	475	500	600
	2.0	400	475	425	475	525	625
5.9	0.3	600	725	650	775	800	950
	1.0	450	550	500	575	600	750
	2.0	500	625	525	650	625	825

Notes Table 3-9:

1. Other refers to cedar, spruce, lodgepole pine, Jack pine, and hemlock.



2. Sizes are based on sound logs, with no allowance for decay.
3. Logs should be free of cracks, excessive taper, sweep, damage, or large knots.
4. Reverse the taper of adjacent logs.
5. Spans over 3 m should be lashed at mid-span.
6. Logging truck axle loads in accordance with B.C. Ministry of Forests, Lands and Natural Resource Operations standards.
7. Axle loads allow for unbalanced 60%-40% wheel loading.
8. Ensure that fill depths greater than 2 metres are designed by a Professional Engineer, or designed from tables prepared by a Professional Engineer.

## **Mud Sills**

If the natural ground will not support the culvert loads on a single sill log, increase the load-bearing area with the use of mud sills. These are short logs, 250 mm (or larger) in diameter, and 1 to 6 m in length, placed at right angles under the sill log for the entire length of the sill.

For crossings on soft ground, on non-fish bearing streams, another option is to extend the mudsills completely across the channel to and beneath the other sill log. This increases the stability of the structure. It is important that the mudsills be placed below the scour level.

## **Log Culvert Inlet and Outlet Protection**

Where the sill logs for log culverts are placed outside the stream channel and bedded below scour level, do not provide for additional inlet and outlet protection. If there is a concern about erosion around the inlet or outlet, protect any erodible surfaces with rock to a level equivalent to the design flood. Provide at some sites an individually designed settling or debris catchment basin at the inlet.

### **Inlet Protection for Cross-Drain Log Culverts**

Inlet protection for cross-drain log culverts will normally be achieved with a ditch block to ensure that ditchwater is directed into the log culvert and not past it. In most cases, use a catch basin to trap sediment and debris. For cross-drain culverts on a steep road grade, consider lining the ditch block, catchment basin, and the bottom of the channel with rock to minimize scouring.

### **Outlet Protection for Cross-Drain Log Culverts**

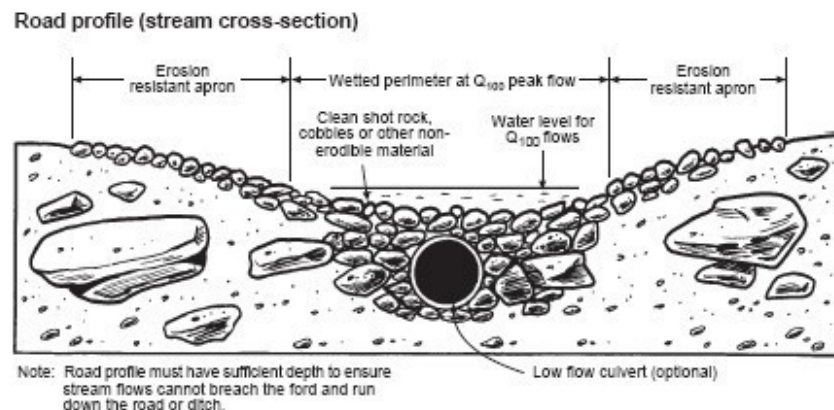
Do not consider placing log culverts on top of erodible fills. Direct ditch flows onto erosion-resistant areas or onto outlet protection such as flumes or riprap aprons. Do not direct ditch water flows onto unprotected sidecast material unless it is composed of rock or other erosion-resistant materials. On steeper slopes, erosion control at the culvert outlet is a design challenge. One option is to provide extensive outlet protection down the slope to an erosion-free area.

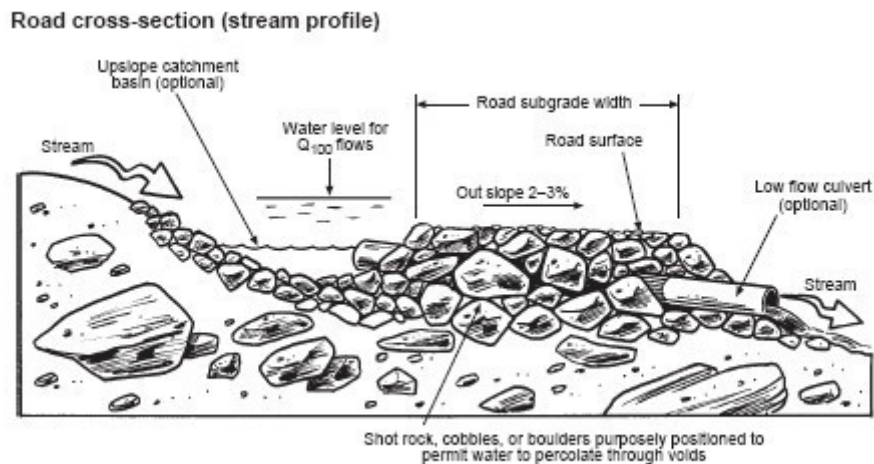
### Appendix 3.6: Ford Design and Construction on Non-Fish Streams

A ford is a dip in a road constructed to facilitate crossing a stream. The objective of a ford is to maintain drainage and provide a safe, erosion-free, and storm-proof crossing that requires little or no maintenance. In the past, inappropriate location and design of fords, and uncontrolled use, has led to a number of negative environmental impacts. These include increased sediment delivery, and degraded water quality downstream.

In isolated locations where maintenance equipment may not be available on a continuing basis, properly designed and constructed fords require little maintenance, and can be effective in reducing adverse impacts in drainage systems that are prone to debris flows or debris floods (Figure 3-16). Consider the use of fords for areas of low traffic and intermittent use. Consider them as alternatives to bridges or culverts only where the crossings would not result in negative environmental impacts and where traffic use is confined to low-flow periods. Do not consider using a ford if the crossing is expected to be subjected to extensive or year-round traffic.

**Figure 3-16 Road profile (stream crossing)**



**Figure 3-17 Road cross-section (stream profile)**

## Ford Planning

Identify fords in the planning stage of road development to ensure that the required design and measures include appropriate road grades leading into and out of the stream crossing.

Prior to planning a ford, evaluate the stream to ensure that it is not a fish stream. Refer to the [Fish-stream Crossing Guidebook](#) for limitations on the use of fords on fish streams.

When planning a ford, and establishing design criteria, determine if any of the following possible user safety restrictions (or combination of restrictions) will apply to the stream crossing:

- the design vehicle will only be able to cross the ford during certain months of the year;
- the design vehicle will not be able to cross the ford during periods of specific maximum stream flows;
- only certain types of vehicles will be able to cross the ford; and
- only certain specific road uses will be considered for ford applications (such as industrial use).

Each proposed ford design is unique, but the objectives of any design are to:

- pass the design peak flow;
- minimize downstream erosion of the stream;
- prevent sediment input into the stream from the approaches and associated ditches;
- provide a suitable road profile to accommodate safe passage of the design vehicle;

- ensure that the stream remains in its channel and cannot be diverted down the road or ditches; and
- ensure that the ford will either pass channel debris—the preferable option—or trap it.

## Ford Design

For a ford, the road profile dips into and out of the stream, creating a concave shape sufficient to ensure that the stream cannot be diverted away from its natural channel and down the road.

Ensure that the anticipated design vehicle can negotiate vertical and horizontal curves at the proposed ford. Where it is practical to do so, design the approaches to be at right angles to the stream.

Check the debris flow history of the stream channel:

- on air photos;
- on terrain stability maps or terrain stability field assessments; and
- in the field and considering local knowledge.

For further information, refer to the [Gully Assessment Procedures Guidebook](#).

If there is a debris flow hazard, decide whether the ford should be designed to:

- trap the debris, or
- allow the debris to pass over the ford (the preferred option).

The size and shape of the largest cobbles or boulders in the stream channel indicates the minimum size of rock required to resist movement when the stream is in flood, and thus provides a guide to the minimum size of rock to be used to construct the ford. The more angular the rock (such as shot rock), the more resistant it will be to moving.

In some situations, the use of a ford may be restricted to low-flow periods when the flow is subsurface. Design a low-flow culvert to pass the anticipated low flow. With this design, peak flows and debris flow over the top of the ford, resulting in some increased annual maintenance. Use a sufficient size of running surface material to resist erosion.

Design methods are available for determining flow rates through voids in rock fills. Such voids may plug up with sediment and debris, so design the dip in the road profile to accommodate the peak flow discharge based on considerations similar to those applied to the design of a bridge or culvert.

## Design Approval Requirements

Prepare sketches of the ford design, showing:

- the road profile, extending at least 50 m at each end beyond the wetted perimeter at the design peak flow discharge;
- the width and depth of the wetted surface during;
- those months when use of the road is anticipated;
- design peak flow level and an estimate of debris volumes to be passed or trapped;
- annual low-flow level, or the flow levels for the periods of anticipated use;
- the range and average size of the material in the stream channel and its shape (angular, semi-angular, or rounded);
- the minimum width of the road running surface required to accommodate anticipated traffic;
- the requirements for any erosion-resistant materials for the road running surface, such as shot rock and concrete cross-ties, including use of any geosynthetics, to help separate different types and gradations of road fill materials;
- the rock source, size, and volume requirements;
- the length, width, and depth of the upstream catchment basin if one is proposed;
- the type and dimensions of the low-flow culvert, if one is proposed; and
- the length of apron to be surfaced with erosion resistant material.

## Appendix 3.7: Project Tracking Checklist

<b>Project Tracking Checklist</b>		
<b>Use this checklist to prepare a paper trail of key outputs prepared by consultants and sign-offs by BCTS/Timber Pricing and Operations Division.</b>		
<b>Element Being Reviewed &amp; Results Achieved</b>		<b>Date of FLNR sign-off</b>
<b>ROAD SURVEY AND DESIGN</b>		
Ensured that the road site plan has been completed and signed off by the appropriate professional		
Ensured that a location survey was carried out in accordance with the field reconnaissance report and flagged road centre-line	YES NO N/A	_____
Carried out field review of the accuracy of the location survey	YES NO N/A	_____
Where not captured in the road site plan, ensured that the results of assessments or measures were carried out and incorporated into the road design	YES NO N/A	_____
Ensured that the road design incorporated suitable specifications for alignment (including maximum grades), turnouts and clearing width	YES NO	_____
Ensured that a geometric design was prepared for road sections in potentially unstable terrain and on sideslopes greater than 50%	YES NO N/A	_____
<b><u>Statement of Road Survey and Design Responsibility</u> signed off (P.Eng, RPF, RFT)</b>	YES NO	_____

### Appendix 3.8: Statement of Road Survey and Design Responsibility

TO BE COMPLETED BY QUALIFIED REGISTERED PROFESSIONAL **AFTER** COMPLETION OF THE ROAD SURVEY AND DESIGN

Road Name	Project #	Forest District/Business Area
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I am a (check one) ☐ Registered Forest Technologist, ☐ Professional Engineer or ☐ Professional Forester, registered with the appropriate professional association in British Columbia, and I have undertaken professional responsibility as the Coordinating Professional for all field and office reviews required with respect to the survey and design of this road. I have taken steps as regulated under the Provincial Statute for my profession and required by good practice in order to sign and seal this Schedule.

#### Road Survey and Design:

In my professional opinion:

- a location survey was carried out in accordance with the field reconnaissance report and flagged road centre-line;
- the results of professional assessments or measures were incorporated into the road design
- suitable design specifications were incorporated; and
- the road design incorporates horizontal and vertical road alignments that provide for equipment use and for usersafety.

Signature (and seal as appropriate) of Professional	
Name of Professional (please print)	DATE SIGNED YYYY M M DD

## 4. Design and Construction of Bridges and Major Culverts

### 4.1 Introduction

This chapter describes key activities and practices related to addressing safety, environmental and structural issues in the design and construction of bridges and major culverts on Forest Service roads (FSRs). The topics covered include:

- design requirements and considerations;
- types of structures;
- site data and survey requirements;
- estimating design discharge for streams;
- construction drawings and specifications;
- construction materials, quality assurance, and fabrication; and
- statement of general conformance and construction documentation.

### 4.2 Definitions

- Bridge means a temporary or permanent crossing structure carrying a road above a stream or other opening and includes a log stringer/gravel deck structure with i) a span length equal to or greater than 6 m or ii) an abutment height of 4m or greater.
- Major culvert means a culvert i) having a pipe diameter of 2,000 mm or greater; ii) a pipe arch with a span greater than 2,130 mm; iii) an open bottom arch having a span greater than 2,130 mm, iv) has a design discharge of  $6 \text{ m}^3/\text{sec}$  or greater. or v) is a log stringer/gravel deck structure (log culvert) with a span less than 6 m and a design discharge of  $6 \text{ m}^3/\text{s}$  or greater.
- Portable bridge superstructure is a bridge superstructure that is designed and fabricated, in accordance with the Forest Service Bridge Design and Construction Manual, for ease of movement and installation.
- Permanent materials: steel, concrete or treated wood.
- Temporary materials: untreated logs or untreated timbers.
- Permanent bridge is a bridge that has its stringers or girders and abutments comprised of permanent materials (even though it may have an untreated timber deck or untreated timber sills bearing on an abutment comprised of permanent materials). Rail car structures are an exception to the foregoing and will be considered a temporary bridge regardless of the abutment type.
- Temporary bridge is a bridge that has its stringers or girders, or abutments, comprised of temporary materials.



The [Forest Service Bridge Design and Construction Manual](#) (B.C. Ministry of Forests, 1999) provides further discussion on planning, design, and construction of forest road bridges.

**Note:** Log / wood box culverts, defined as those with gravel decks, spans less than 6 m and abutment heights less than 4 m, are covered in [Chapter 3: Road Survey and Design](#) and [Chapter 5: Road Construction](#) of this manual.

### 4.3 Policy

All bridges and major culverts on Forest Service roads will be designed and constructed to:

- be safe for users;
- minimize the impacts on forest and other resources;
- be cost-effective; and
- be appropriate for the site.

### 4.4 Mandatory Procedures and Best Practices

**Table 4-1 Design and Construction of Bridges and Major Culverts**

#### Mandatory Procedures and Best Practices<sup>1</sup>

Results to be achieved:

- bridges and culverts safe for industrial user (FPPR s. [72](#))
- meet or exceed bridge design standards (FPPR s. [73](#))
- bridges and culverts designed to pass peak flow (FPPR s. [74](#))
- culvert materials standards (FPPR s. [76](#))
- retaining as-built information (FPPR s. [77](#))
- standards for FSR bridges built by licensees [FPPR s. [79\(8\)](#)]

**Note:** all references to bridges and major culverts includes those bridges and major culverts built under Road Permit (BCTS) and designated in that permit to be an FS bridge to be used for harvesting after completion of the Timber Sale License. Insert the appropriate clauses in the Road Permit to achieve the results described herein.

B1.	In consultation with the ministry bridge engineer, determine the design parameters for a bridge or major culvert structure (see <a href="#">Design Implementation Section 4.5.4</a> )
	Where the maintainer of an industrial use FSR will replace a bridge or major culvert on that road under a Road Use Permit, ensure that the conditions for that crossing structure: <ul style="list-style-type: none"> <li><input type="checkbox"/> provide mandatory site specific design and construction requirements to the maintainer; and</li> <li>• direct the maintainer to submit the completed construction drawings for review and approval prior to commencing construction. [see <a href="#">Design Implementation Section 4.5.4</a> and <a href="#">FS 1229 DM REQUIREMENTS – BUILDING OF FSR BRIDGES BY A ROAD USE PERMIT HOLDER</a>]</li> </ul>
B3.	Ensure that practitioners in bridge and major culvert design for FSRs have established skill sets. Refer to the <a href="#">Engineering Equipment and Services (EES) Directory</a> . [see <a href="#">Design Implementation Section 4.4.4</a> ]
B4.	Ensure that a detailed site survey is carried out for bridge and major culvert projects. [see <a href="#">Site Data Section 4.7</a> ]

**M1.** Bridge and major culvert construction drawings for any FS bridge project **must** be signed and sealed by a qualified professional, to clearly identify the Coordinating Registered Professional and/or Engineer of Record [see [Design Responsibility Section 4.4.1](#)]

**M2.** Where portable bridge superstructures or other structural components are used for any FS bridge project, the components **must** have been designed or structurally analyzed by a professional engineer, to demonstrate adequacy for the intended use. [see [Portable Bridge Section 4.10.6](#)]

B5. Ensure that general arrangement drawings clearly depict the proposed components and configuration of the bridge or major culvert in relation to the forest road, stream, and streambanks. [see [General Bridge Arrangement Section 4.10.1](#)]

B6. Ensure that the construction drawings clearly show all construction details and provide for installation in general conformance with the design intent. [see [Construction Drawings, Section 4.10](#)]

B7. Ensure that for log superstructures on log cribs, the drawings address layout of the structure and its elements, required component sizing, and connection details. [see [Log Bridge Section 4.10.4](#)]

B8. Ensure that final bridge drawings are signed off by the ministry bridge engineer as acceptable. [see [Construction Drawings Section 4.10](#)]

**M3.** Bridge components assembled or manufactured off the construction site (such as treated timber, steel girders, and precast concrete footings, girders, footings or deck panels) **must** be inspected during fabrication to provide quality assurance that all materials and procedures meet the materials specifications as well as the applicable codes and standards. [see [In-Plant Section 4.12.1](#)]

B9. Obtain and keep on file all relevant material documentation, such as mill test certificates, in-plant test results, field test results, and all reports or comments made by field or in-plant inspectors. [see [In-Plant Section 4.12.1](#)]

B10. Ensure that all structural field welding and field grouting is carried out in accordance with the [Forest Service Bridge Design and Construction Manual](#). [see [Field Section 4.12.2](#)]

B11. Retain an environmental monitor when specified by the environmental agencies on a site specific project basis. [see [Environmental Monitors Section 4.14](#)]

B12. Ensure that after construction of a bridge or major culvert, the Coordinating Registered Professional signs and seals a statement indicating that the entire structure is in general conformance with the design drawings and specifications. [see [General Conformance Section 4.15](#)]

**M4.** As-built drawings of bridges and major culverts **must** be signed and sealed by the Coordinating Registered Professional or Engineer of Record as appropriate, in addition to providing a statement of conformance for the design and construction of the bridge. [see [Construction Documentation Section 4.15](#)]

B13. Ensure that a BCTS/District engineering technician inspects the completed bridge for acceptability/assurance of the structure; and a ministry bridge engineer reviews the as-built information and field inspection note. [see [General Conformance Section 4.15](#)]

B14. Ensure that the necessary steps in the bridge and major culvert design and construction processes were undertaken and issues addressed [see [Project Tracking Checklist Appendix 4.1](#)]

<sup>1</sup>In the above table of chronological events:

Mandatory Procedures are marked

**M**

and Best Practices are marked

**B**

## **4.5 Design Requirements for Bridges and Major Culverts**

### **4.5.1 Project and Design Responsibility and Considerations**

A “bridge” includes the superstructure, substructure, connections, approach road fills, and scour protection works. A “major culvert” includes the culvert materials, compacted bedding and backfill, embedment materials for embedded culverts, scour protection, and the roadway.

In the design of any bridge or major culvert, consider:

- user safety;
- accommodation of pedestrian traffic where required;
- site selection, including assessment of stream geomorphology and geotechnical (global and local) considerations;
- environmental integrity;
- fish habitat and fish passage;
- impact of the proposed structure on the stream during and after construction;
- site revegetation requirements;
- structure alignment and location (vertical and horizontal) relative to the road and stream channel;
- complete structure combination (substructure, superstructure, connections, and scour protection);
- suitability of selected foundations for the specific site;
- design flood development;
- navigation (*Navigable Waters Protection Act*), if applicable;
- debris potential and passage;
- scour protection;
- design vehicle configuration for load and alignment;
- design traffic frequency;
- design service life influence on selection of bridge type and composition;
- construction layout, methodology, and timing; and
- economics.

The design of bridges and major culverts encompasses more than just the design of structural components. In a bridge or major culvert design, consider the composition and interaction of all the components, as well as their relationship and impact on not only the users, but also on the road and stream components and other resources. A key concept in a successful stream crossing project is continuity of professional oversight and output reviews. The professional that is charged with retaining a close familiarity with the progress of the project, and with coordinating the various specialist inputs into the bridge or major culvert, is known as the Coordinating Registered Professional (CRP), who carries overall responsibility for the delivery of the professional aspects of the project.

The [Guidelines for Professional Services in the Forest Sector - Crossings](#) describe the roles and responsibilities of the CRP related to bridge planning as follows:

- confirm that the necessary assessments for the project have been completed;
- utilize specialists in the planning;
- gather site information, including the site plan and other information;
- take overall responsibility for the conceptual plan and general arrangement drawings;
- address environmental considerations in the plan;
- coordinate activities relating to the crossing project in the context of the overall development;
- understand all generally accepted uncertainties inherent in the crossing project and assumptions made in relation to the project, including assumptions made by the specialists;
- have an understanding of the roles and responsibilities of all the people involved in the planning of the crossing project; and
- consider information received from specialists and where appropriate incorporate the information into the plan.

To address these planning issues, the CRP ensures that a qualified professional has addressed the need, if any, for specialist assessments for a new bridge or a bridge replacement, including those as part of a BCTS road site plan for new construction as described in FRPA, to provide results and strategies to meet the objectives of the FSP. In practical terms for bridges and major culverts, this means a map showing the proposed road location (and approximate crossing locations) together with the results of any specialist assessments that may have been required along or adjacent to the road, such as:

- riparian;
- fisheries values;
- wildlife corridors;
- archaeological;

- terrain stability;
- soil and sediment transport;
- visuals;
- invasive plants;
- range barriers;

and how they might impact the selected road (and hence) crossing location. The CRP uses the results of the assessment information to determine:

- what if any additional information may be required for the bridge crossing; and
- how to implement the bridge project to address the assessment outcomes.

The CRP undertakes the subsequent engineering project-specific roles and responsibilities such as carrying out or overseeing the preparation of the conceptual and final design and drawings, acquisition of materials and construction of the structure. Finally, the CRP will complete the general conformance sign-off and preparation of as built drawings.

For the CRP to practice due diligence with respect to the project operations and oversight, the CRP determines that any specialists involved in the bridge project:

- are qualified to do the work;
- are used in an appropriate manner; and
- have access to any project information and to any other project personnel.

The Crossing Guidelines provide limitations as to the types of bridges (simple crossings) that may be undertaken by an RPF as the CRP. The bridge elements that may be restricted include footings, substructures and superstructure types. However, the bridge types can generally be characterized as single, simple span log stringer or other short span non-composite superstructures on cribs <4m high or interlocking concrete blocks <2m high. The usual scenarios for bridge projects are described below. Ensure that the CRP meets the qualifications described in the [Skill Set](#) for simple crossings, and those additional qualifications described in the [Engineering Equipment and Services \(EES\) Directory for more complex crossings](#).

### **Scenario 1: where a P.Eng will be the CRP for a bridge:**

The CRP has addressed the need, if any, for specialist assessments for a new bridge or a bridge replacement, or in a BCTS road site plan for new construction as described in FRPA, to provide results and strategies to meet the objectives of the FSP

An Engineer of Record, who is a P.Eng and may or may not also be the CRP, carries out some or all of the subsequent engineering project-specific roles and responsibilities, including:

- the preparation of the conceptual design and general arrangement design drawings;
- quality assurance of materials fabrication;
- construction inspections;
- addressing required design revisions that become evident during construction;
- compiling materials and construction documentation; and
- preparation and sign-off of as-built drawings and statement of construction conformance.

Those items not carried out by the EOR are done by the CRP, and the CRP signs off that the completed crossing structure has adequately addressed any other resource issues that were identified at the outset of the project.

### **Scenario 2: where an RPF will be the CRP for log stringer bridge superstructures:**

The CRP has addressed the need, if any, for specialist assessments for a new bridge or a bridge replacement, or in a BCTS road site plan for new construction as described in FRPA, to provide results and strategies to meet the objectives of the FSP

The CRP uses design aids as required for stringer arrangement and sizing, needle beam sizing where appropriate, lashing of stringers and connections to sills or caps, placement, arrangement and sizing of crib members or concrete block sills

The CRP is responsible for:

- the preparation of the conceptual design and general arrangement design drawings;
- construction inspections;
- addressing required design revisions that become evident during construction;
- compiling construction documentation; and
- preparation and sign-off of as-built drawings and statement of construction conformance.

### **Scenario 3: where an RPF will be the CRP for re-use of portable bridge superstructures:**

The CRP has addressed the need, if any, for specialist assessments for a new bridge or a bridge replacement, or in a BCTS road site plan for new construction

as described in FRPA, to provide results and strategies to meet the objectives of the FSP.

The CRP ensures that a professional engineer has carried out the design analysis to ensure adequacy for the intended use, and the structure has been inspected before re-use by a qualified inspector.

If any additional structural analysis is to be carried out by a professional engineer due to any potential issues raised by the inspection prior to re-use, that engineer will generally be the EOR and as such will likely provide the necessary drawings, specifications, connection details, etc. for any structure that requires remedial work prior to re-use.

The CRP uses design aids as required for placement, arrangement and sizing of crib members or concrete block sills.

CRP is responsible for:

- the preparation of the conceptual design and general arrangement design drawings;
- construction inspections;
- addressing required design revisions that become evident during construction;
- compiling construction documentation; and
- preparation and sign-off of as-built drawings and statement of construction conformance.

#### **Scenario 4: where an RPF will be the CRP for other short span steel girder bridge superstructures:**

The CRP has addressed the need, if any, for specialist assessments for a new bridge or a bridge replacement, or in a BCTS road site plan for new construction as described in FRPA, to provide results and strategies to meet the objectives of the FSP

An EOR who is a P.Eng carries out (under the project oversight of the CRP) the subsequent engineering project-specific roles and responsibilities, including:

- the preparation of the conceptual design and general arrangement design drawings;
- quality assurance of materials fabrication;
- construction inspections;
- addressing required design revisions that become evident during construction;
- compiling materials and construction documentation; and
- preparation and sign-off of as-built drawings and statement of construction

conformance.

Note that if the superstructure is composite, the EOR or another professional engineer will necessarily become the CRP, in accordance with the Crossing Guidelines.

The CRP signs off that the completed crossing structure has adequately addressed any other resource issues that were identified at the outset of the project.

Bridge and major culvert construction drawings for any FS project (including those structures built under Road Permit (BCTS) and designated in that permit to be an FS structure to be used for harvesting after completion of the Timber Sale License) ***must*** be signed and sealed by one or more professionals, to clearly identify the CRP and/or Engineer/Engineers of Record (EOR). The EOR is usually the structural/design engineer, but in some complex projects with two or more contributing engineers (such as geotechnical, river engineering, etc.), each of those participants can be designated as an EOR. An EOR can also be responsible for the overall general arrangement drawings, as described in Scenario 4 above.

If the CRP has prepared the conceptual design and general arrangement drawings, the CRP will sign and seal those drawings. Where a designer working for the supply/erect contractor will prepare structural drawings, that engineer will be the EOR for that work. In consultation with a ministry bridge engineer, consider having the professional that will carry out the field review for general conformance with the design and drawings complete and submit for review the proposed Assurance of Field Reviews FS 137 along with the construction drawings.

#### **4.5.2 Skill Set for CRP for Simple Crossings**

*Knowledge Requirements:*

1. be members in good standing with ABCFP or APEGBC;
2. have appropriate education, training and experience within the discipline of forestry or engineering that are congruent with CRP bridge design services;
3. have considerable recognized specialization in the layout and conceptual design of forest roadbridges;
4. be familiar with forest road and bridge planning, construction considerations and techniques, design vehicle configurations and assessment, scour and scour protection, design flood hydrology determination, and bridge component properties and fabrication;
5. be thoroughly familiar with the “Guidelines for Professional Services in the Forest Sector – Crossings” (Crossing Guidelines) prepared by the Association of Professional Engineers and Geoscientists of British Columbia and the



Association of BC Forest Professionals (see

[http://www.abcfp.ca/regulating\\_the\\_profession/documents/guidelinesforestercrossings\\_2008.pdf](http://www.abcfp.ca/regulating_the_profession/documents/guidelinesforestercrossings_2008.pdf));

6. be thoroughly familiar with stream crossing requirements and procedures of the Department of Fisheries and Oceans Canada and the British Columbia Ministry of Environment;
7. have a working knowledge of related riparian and aquatic environmental issues (such as stream classification and fish passage requirements) and associated construction mitigation techniques;
8. have a working knowledge and understanding of the principles and best management practices related to stream crossings provided in the following publications:
  - Forest Practices Code of BC [Forest Road Engineering Guidebook](#) (June 2002)
  - Forest Practices Code of BC [Fish-stream Crossing Guidebook](#) (March 2002)
  - Forest Practices Code of BC [Riparian Management Area Guidebook](#)
  - Forest Practices Code of BC [Fish-stream Identification Guidebook](#)

*Experience Requirements:*

All CRPs require a minimum of 8 years of direct bridge experience in forestry or related industries in British Columbia within the past 10 years, including at least 3 years of professional experience at a level contemplated by the Crossing Guidelines. Such work experience includes:

1. Preparation of conceptual designs of forest road bridges, including analysis for log, timber, and steel components.
2. Development of general bridge arrangement drawings with consideration for:
  - design flood estimation;
  - design flood and debris passage;
  - bridge configuration alignment in relation to the road and stream;
  - road approach and alignment considerations;
  - crossing alignment to the stream;
  - scour and scour protection;
  - substructure and connection component alternatives including consideration for geotechnical conditions and construction parameters;
  - cost effectiveness of bridge options;

- construction equipment and practices in the forest sector.
- 3. Preparation of reports, drawings, specifications and cost estimates.
- 4. Field reviews during construction of bridges to provide quality assurance and confirmation of conformance to drawings and specifications, including:
  - field monitoring of construction activities during critical phases;
  - assessing actual field conditions for consistency with design assumptions and recognized “changed conditions”;
  - assessing alternatives, and providing revisions to designs for “changed conditions”;
  - preparing as-built drawings, and providing statements of construction conformance.

#### **4.5.3 Development and Use of Professional Engineer Forest Road General Arrangement Bridge Design Aids**

Design aids may be utilized by qualified individuals producing general arrangement forest road bridge designs. The “Guidelines for Professional Services in the Forest Sector – Crossings”, Section 3.1, “Simple Crossings” requires where the Coordinating Registered Professional (CRP) is a Registered Professional Forester that - “plans must be prepared using structural details provided in drawings, tables, charts and other design aids that have been prepared by a Professional Engineer”.

These guidelines are applicable to: a CRP, an individual working in support of a CRP, a limited license holder with the Association of Professional Engineers and Geoscientists of BC, or anyone taking responsibility for a bridge general arrangement design and is utilizing design aids.

#### **Definition and Content of a Design Aid**

A design aid is a tool, produced by a professional engineer, which will provide an unambiguous result tied to clear parameters, and can be applied to a site-specific situation. An example of a design aid is a log stringer design table specifying log stringer diameters, subject to species and other identified limitations, for particular spans for specific design loads. A manual such as the FPINNOVATIONS Log Construction Handbook is not considered a design aid because a manual cannot be applied to a specific situation. However, individual stringer tables within that manual may be design aids.

When preparing design aids, a professional engineer should clearly state:

- the intended purpose, authorized users and application for the design aid;

- requirements and restrictions for those using the design aid (such as specific material or site conditions, specific aspects requiring higher level oversight, materials or connection requirements);
- assumptions made; codes referred to; and where applicable, Factors of Safety used in producing the design aid;
- limitations for application of the design aid;
- the name of the professional engineer having professional responsibility for the design aid; and
- except for those design aids in the public domain, the signature and seal of the professional engineer having professional responsibility for the design aid, the date the design aid was signed, and a date when the design aid is not longer valid (as applicable).

### Use of Design Aids

A person should undertake the following best professional practices when using a design aid produced by others:

- are authorized by the “owner” of the design aid to use the design aid (note that some tables such as FPINNOVATIONS or FLNR log stringer tables are in the public domain; otherwise, the design aid is usually proprietary and often intended to be used only for client-specific applications);
- have discussed the design aid with the professional engineer that created the design aid to ensure that the individual using the design aid understands the limitations of the design aid and to ensure that they have the latest applicable version of the design aid;
- reference the specific design aid(s) in drawings and documentation when used for specific projects;
- provide copies of the design aid(s) used (that are not in the public domain) with the design documentation provided to the client; and
- seek specialist assistance (usually from a professional bridge engineer) when applicability of the design aid is in question or unforeseen circumstances make the design aid not applicable or questionable.

#### 4.5.4 Typical Bridge Design Approach

Bridge and major culvert designs and construction approaches for FSRs have evolved into industry standards. Typical details and arrangements are described in the [Forest Service Bridge Design and Construction Manual](#) and in guidelines and requirements for ministry bridges. The most common components have been structurally pre-engineered and are well known by bridge designers, fabricators, and erectors.

Ensure that practitioners in bridge and major culvert design for FSRs meet established skill sets. Refer to the [Skill Set](#) for simple crossings and the [Engineering Equipment and Services \(EES\) Directory for more complex crossings](#).

### **Forest Service Bridge Design and Construction Manual**

The [Forest Service Bridge Design and Construction Manual](#) drawings include ministry-approved component configurations and details. Detailed designs for various components, such as concrete decks, slab girders, and various footing arrangements, are also provided in the manual.

As well, the manual lists proprietary bridge components (consisting of conceptual drawings with minimal details) that have been approved by the ministry. Proponents whose proprietary systems have been accepted by the ministry have provided proof that their components will meet the stringent requirements laid out in the manual for structural integrity, durability, and other relevant aspects pertaining to the product's usage.

### **Design Implementation Process**

Where the maintainer of an industrial use FSR will replace a bridge or major culvert on that road under a Road Use Permit, ensure that the District Manager, in the conditions for that crossing structure:

- provides mandatory site specific design and construction requirements to the maintainer; and
- directs the maintainer to submit the completed construction drawings for review and approval prior to commencing construction.

For most other situations, utilize the following bridge or major culvert design implementation process:

- in consultation with a ministry bridge engineer, determine the design parameters for a bridge or major culvert structure (see Appendix 4.3 DESIGN CHECKLIST) and determine whether the conceptual designer will be the ministry bridge engineer or a consultant professional engineer retained by BCTS/District; as described earlier, this person will normally be the CRP;
- convey the design parameters and the performance requirements for the crossing to the conceptual designer;
- have the conceptual designer conduct a site visit and make note of the physical site parameters, including observations on design flood hydrology, foundation evaluation, vertical and horizontal alignment and crossing location opportunities, and construction limitations (such as equipment and materials access);
- have the conceptual designer evaluate the options for the crossing given the available information and make a recommendation for the development of a

site plan and oversee its completion (generally a detailed site plan for all but the simplest crossings (see [4.7: Site Data and Survey Requirements for Bridges and Major Culverts](#)).

Note that in the above scenario, the ministry bridge engineer may undertake the conceptual design and become the CRP for the project, should time and resources permit.

### **Conceptual Design/General Arrangement Drawings**

A conceptual design illustrates how the proposed crossing structure addresses the site-specific operational requirements. Typically, the general arrangement drawings consist of one or more drawings showing the components and configuration of the proposed bridge or major culvert crossing, as well as construction details overlain on a site plan and profile (see [4.10: Construction Drawings and Specifications](#)), making reference to specific ministry standard drawings and details laid out in the Forest Service Bridge Design and Construction Manual.

Ensure that the conceptual designer signs and seals the General Arrangement drawings.

### **Detailed Structural Design**

For all but the most complex structures, a detailed structural design is typically not completed as part of the development of general arrangement designs. The final superstructure arrangement is best left to the fabricator or erection contractor, who can provide the most cost-effective and efficient design based on their materials availability and erection schemes. As part of the design/build process for the typical, simply supported forest road bridge structures, the detailed structural design of the superstructure components are completed by the bridge fabricator or the contractor who is the successful bidder to construct the bridge. In such cases, the contractor's or fabricator's engineer will normally be the structural EOR, and the professional that prepared the conceptual design will be the Coordinating Registered Professional (CRP) as described earlier in this chapter.

#### **4.5.5 Design Opening**

Base the design flood requirements for bridges and major culverts on the anticipated life of the structures. Structures to be in place for a relatively short life pose reduced risks (compared with those expected to have longer life), and thus reduced design flood concerns can be considered.

In addition to design flood passage, make allowances for anticipated debris. For bridges, incorporate freeboard above the design highwater to allow for passage of floating debris. In the case of major culverts, also accommodate debris (floating or submerged) in the design process.

## 4.6 Types of Bridge Structures

### 4.6.1 Bridge Superstructures

#### Unapproved Superstructures or Systems

Before an unproven system or product is implemented, bring it to the attention of Engineering Branch for evaluation. If the branch determines that products or systems provide efficiencies and meet stringent performance requirements, those components are incorporated into the Forest Service Bridge Design and Construction Manual as acceptable ministry standards.

Deviation from the requirements of the Forest Service Bridge Design and Construction Manual and the associated standard drawings is not recommended. Where an unapproved structure or system is being considered for a project before the branch has completed its review and acceptance of such structures, contact the ministry bridge engineer for input into the implementation requirements.

#### Approved Superstructures or Systems

Approved ministry superstructure configurations, identified in the Forest Service Bridge Design and Construction Manual, provide for numerous construction options such as:

- timber decks on steel;
- precast concrete slabs;
- non-composite concrete decks on steel girders;
- composite concrete decks on steel girders;
- all steel portable bridges;
- Compo-Girders™; and
- steel-free decks (precast concrete arch panel composite deck).

Generally, use the following “rules of thumb” to help guide estimating or evaluating conceptual designs for typical single-lane, simply supported, permanent single-span bridges. Note that these rules of thumb are for completed in-place structures which consider both the materials and installation costs for the finished product. For example, materials for an application may be cheaper than some others, but the finished structure may cost more due to higher installation costs:

- For spans 12 m or less, concrete slab structures are typically most economical. They are particularly conducive where there are alignment issues such as skews or extra width is required to accommodate vehicle tracking on curves. Precast concrete slabs are extremely heavy, and as such are expensive to ship and difficult to launch. The equipment that will be used to launch and place them **must** be considered when selecting component size in the design phase.

- For spans between 12 and 18 m, non-composite concrete decks on steel girders are typically most economical. They can be set up to allow for bolted deck connections, providing for bridge removal and use elsewhere.
- For spans greater than 18 m, composite concrete decks on steel girders are typically most economical. Concrete composite deck panel installation involves grout work that requires attention to quality control, is labour-intensive and time-consuming, and the deck panels are not easy to dismantle.

In addition to the above, for some configurations, an economical solution might be timber deck on steel girder superstructures, or less likely, all steel portable superstructures. Generally, all steel portable superstructures are much more expensive than other options. All steel portables are recommended only where they are being utilized for temporary situations and moved from site to site.

#### 4.6.2 Bridge Substructures

Several types of substructures are available to support bridge superstructures. When determining the substructure options for a particular site, base the selection on the type of superstructure, operational requirements, and specific-site conditions.

Substructure types range from simple log sills to driven piles. The [Forest Service Bridge Design and Construction Manual](#) presents numerous permanent bridge substructures standards. The standard design drawings in the manual typically consist of precast concrete spread footings and are suitable where adequate soil bearing can be obtained. The standard drawings also provide for “T” footings, suited to concrete slab girder superstructures requiring shallow abutments; and steel pipe columns on precast footing standards, suited to steel girder superstructures and concrete slab superstructure requiring higher abutments.

Consult the [Forest Service Bridge Design and Construction Manual](#) for the standards on cap and bearing details for pile foundations.

The following structures are examples of those not captured in standard design drawings in the [Forest Service Bridge Design and Construction Manual](#):

- log cribs (suited to temporary usage);
- interlocking concrete block abutments (typically limited to three blocks high); and
- steel binwalls (numerous steel binwalls exist, but few new ones are being installed).

### 4.7 Types of Major Culvert Structures

Major culverts are often preferred structures in suitable situations. Their advantages over bridges may include:

- economics – culverts are generally cheaper than bridges for typical sizes used;

- reduced maintenance when installed correctly; and
- greater flexibility in terms of alignment options – culverts are suited to sites with horizontal and vertical curves; they can be fit to suit the road alignment and approaches so as to minimize impacts; and they enable maintenance of road widths and provide for road widenings more readily than bridges.

Steel and aluminum culverts are typically soil-metal structures. The soil and the metal work together to provide the structural integrity to support loads on the structure. The metal without the soil is insufficient to support the design loads and would collapse. Soil is compacted in lifts immediately adjacent to and in contact with the culvert bottom and sides, to combine with the metal to support the design loads. Uncompacted fill is not sufficiently dense to combine with the metal to support the design loads.

For most soil-metal culvert installations, the metal is galvanized steel. Some aluminum culverts exist, but they are less common than galvanized steel. For a given installation, aluminum culverts are generally thicker but lighter than galvanized steel. However, the aluminum culverts tend to be more easily damaged during installation.

Culverts come in a variety of shapes and sizes. The selection of appropriate size and shape should be a function of the design parameters. Where floating debris is minimal and regular maintenance is anticipated, consider the use of debris catchers/traps. Where significant volume or size of floating or other debris is anticipated, a culvert may not be an option, and a bridge will be necessary to allow high water and debris to pass.

#### **4.8 Site Data and Survey Requirements for Bridges and Major Culverts**

Ensure that a detailed site survey (see Forest Service Bridge Design and Construction Manual [Appendix E Bridge and Major Culvert Site Plan Specifications](#)) carried out for a bridge or major culvert project. Use the survey information to produce site plan and profile drawings for planning, evaluating, and developing the crossing design. Determine the type and extent of site survey to be completed, including the quality of site information to be collected.

Typically, collect and note on a site plan the following information:

- contours to 0.5 m interval accuracy (may vary depending on complexity of the site);
- the riparian class for streams or lake classification;
- the apparent high-water elevation of the stream, based on visible evidence of recent flooding;
- a description of the composition and size of stream bed materials;
- a description of streambank materials and stream stability;



- cross-sections and a profile of the stream: one cross-section should be along the proposed road centreline and extend beyond the stream channel width, normally to at least 50 m on each side;
- horizontal and vertical location of reference points established during the site survey, which can be used to establish (and re-establish) the structure location during construction;
- the stream flow velocity and direction, if the flow may influence the size or layout of the structure;
- a description of the soil profiles and foundation soil conditions, based on soil explorations appropriate to the level of risk;
- presence (or absence) of bedrock, and depth to bedrock;
- a description of any evidence of stream debris or slope instability that could affect the crossing, based on upstream observations;
- any existing improvements or resource values in the vicinity that may influence the size or layout of the structure;
- location and dimensions of any existing structure, including edge of roadway, abutment, superstructure, stream, edge of clearing information, profile of existing road to the limits of the survey, and location, general description, and extent of vegetation;
- the locations and dimensions of any upstream structures, and a note about whether there is any evidence of damage or disturbance from any sources (erosion, debris damage, etc.);
- potential sources of rip rap, endfill material;
- any other pertinent information: Is the site currently accessible by road? Are there road or bridge restrictions on load length or weight? If so, how can these be overcome? If test drilling seems likely, how much work is required to get a drilling truck (usually not all-wheel drive) to the site?
- if equipment fording or temporary bridge crossings will be necessary for construction, information about possible ford and temporary bridge crossing locations and other considerations such as depth of stream at that point, bottom material, and access gradients; and
- the date of the survey and name of the surveyor.

If a fish stream is involved, consult the [Fish-stream Crossing Guidebook Chapter 3](#) for additional site information requirements.

## 4.9 Design Discharge Criteria

Determine the design discharge for streams for a particular recurrence interval. Establishing a return period provides a benchmark of the relative risk to be attached to any particular design. The current regulation requires peak flows to be

determined in accordance with the anticipated life span of the structure at a site [see [FPPR section 74\(1\)](#)].

#### 4.9.1 Factors Affecting Runoff

The runoff effect of a stream depends on many factors, most of which are not readily available or easy to calculate, such as:

- rainfall (e.g., occurrence of cloudbursts; hourly and daily maxima);
- snowpack depth and distribution, and snowmelt;
- contributory watershed area, shape, and slope;
- topography and aspect;
- forest and ground cover;
- soil and subsoil composition;
- weather conditions;
- harvesting and road or other upslope development or disturbance;
- drainage pattern (stream order, branchiness; lakes and swamps); and
- stream channel shape, length, cross-section, slope, and “roughness.”

Because topography, soil, and climate combine in infinite variety, design the drainage for specific sites individually from available data for each site. In addition, consult those who have long experience in maintaining drainage structures in the area, as well as observing evidence of local activity/events.

#### 4.9.2 Methodologies to Estimate Design Flood Discharge

There are too many analytical and empirical methods for estimating stream discharge to be discussed at any length in this manual. Professional engineers, who in the course of carrying out their professional functions as designers of a bridge or a major culvert, are ultimately responsible for establishing the design discharge for a structure. Methodologies for determining design flood discharge include:

- working from available evidence of flood flows in the stream in question;
- gathering evidence of flood flows in other streams, relating these to their drainage basin characteristics, and then, from the characteristics of the basin under consideration, estimating a flood flow; and
- relating meteorological data to stream basin characteristics and estimating flood flow through empirical methods.

Obtain the necessary data for these methodologies from various sources:

### ***Site Information***

Use site-specific data at, and adjacent to, the proposed crossing to estimate the maximum flow. Records of culverts and bridges within the vicinity that have successfully withstood known flood events can provide useful information in the estimation of floodflows.

### ***Stream Basin Characteristics***

Use stream basin characteristics such as length, slope, order, roughness, vegetative characteristics, and elevation band, combined with meteorological data, in empirical approaches to determine design flood flows.

### ***Data on Other Streams***

Use studies done on other streams in the vicinity, with similar characteristics, to provide information on relationships and comparative values.

### ***Hydrometric Records***

The Water Survey of Canada publishes Surface Water Data (annual reports of readings on hydrometric stations throughout the province), as well as Historical Stream Flow Summaries in which mean values and annual peaks are tabulated. Use these stream flow records to project design flood flows from theoretical analysis.

## **4.9.3 Comparing Discharges Using Hydrological Information**

Determining design flood discharge usually involves applying several different methods and then using judgment to select an appropriate design value. In all stream flood discharge determinations, compare the proposed opening size with historically problem-free existing stream crossings serving similar drainages in the same area.

Compare the flood discharge estimates derived from the site information with other data and theoretical derivations. Base the final selection of design discharge and resulting bridge opening or major culvert size, taking into account these comparisons together with consideration of debris potential, ice jams, and any other local factors that might influence the structure opening.

## **4.10 Agency Referrals**

Once the site plan and preliminary design are completed, decide if applications for permits to construct a crossing need to be made with relevant agencies such as the B.C. Ministry of Environment ([MoE](#)), Fisheries and Oceans Canada ([DFO](#)), and Transport Canada ([Navigable Waters Protection Act](#)).

### **Ministry of Environment**

MoE is concerned with protecting water, land and air quality, managing flood and erosion control, and protecting the population and habitat of animals and resident

fish species. The ministry administers various Acts that might be relevant to bridge or major culvert construction.

### **Fisheries and Oceans Canada**

DFO is the lead federal government department responsible for protecting anadromous fish species and their habitat by administering the [Fisheries Act](#) and Regulations. Timing and methods of construction might be stipulated by either DFO or MoE agencies.

DFO Pacific Region has provided some commentary for small clear span bridges: [Pacific Region Operational Statement - Small Clear-Span Bridges](#).

### **Transport Canada**

Transport Canada administers the [Navigable Waters Protection Act](#). Its mandate includes protection of the public right of navigation in tidal waters. According to the division, approvals are required for every crossing. However, only refer and apply for crossings where the type and size of the structure or the nature of the stream have a potential for navigation problems.

Formal approvals issued by the Navigable Waters Protection Division require that the work be subjected to an Environmental Assessment in accordance with the [Canadian Environmental Assessment Act](#).

### **Local and Regional Governments**

Where old structures are being removed as part of the new construction process, ensure that proper approvals from local government offices are received for any waste disposal needs, normally dealing with treated wood and occasionally metal culverts.

## **4.11 Construction Drawings and Specifications**

A set of construction drawings consists of the general arrangement drawings supplemented with detailed superstructure and substructure drawings and other fabrication, material, and construction specifications.

It may be appropriate in some cases for the ministry bridge engineer to take on the CRP role, given that engineer's familiarity with the initial decisions for the project. However, the bridge engineer's time constraints may preclude this option. If the ministry bridge engineer is not the CRP, have the ministry bridge engineer review the construction drawings (a combined package of general arrangement and structural drawings, including erection loads) and the FS 137 Assurance of Field Reviews and approve them as meeting the ministry's design and construction requirements.

Shop drawings are prepared by material fabricators to detail, and in many cases, complete the structural design of bridge structure components. Ensure that these drawings are retained as part of the as-built documentation. The complete

construction drawing set provides comprehensive details on the location, composition, arrangement, design parameters, and fabrication, materials, and construction specifications for the specific proposed structure.

On the construction drawings, clearly show all construction details and provide for installation in general conformance with the design intent.

#### 4.11.1 General Bridge Arrangement Drawing Requirements

Ensure that general arrangement drawings clearly depict the proposed components and configuration of the bridge or major culvert in relation to the forest road, stream, and streambanks. Also, use these drawings during the agency referral process (see the [Forest Service Bridge Design and Construction Manual](#)).

Ensure that the contents for bridge and major culvert general arrangement drawings include:

- site location key map;
- designer's name (and seal);
- name of the stream, road, and station (km) and adequate information to detail the location of the structure;
- design vehicle configuration for load and alignment;
- design code references, specifically those from the most recent version of the CAN/CSA S6 – Canadian Highway Bridge Design Code and the Canadian Foundation Engineering Manual;
- expected life of the structure in place (temporary or permanent);
- design high-water elevation for bridges and design discharge;
- clearances between the design high-water level and soffit (low point of underside of superstructure) of bridges;
- details of debris passage or management strategies, if required;
- road approaches and grades, including width requirements (e.g., allowance for vehicle side tracking) and side slopes, to a sufficient distance back from the bridge to show potential problems, or to the end of the first cut or fill;
- dimensioning and labeling of component parts (to be confirmed with the shop drawings);
- connection requirements for component elements;
- drawings scales;
- relevant site plan and profile data (for suggested contents, see [4.8: Site Data and Survey Requirements for Bridges and Major Culverts](#); sample general arrangement drawings are shown following in Figure 4-1 and Figure 4-2);
- location (vertical and horizontal) of proposed structure relative to field

reference points;

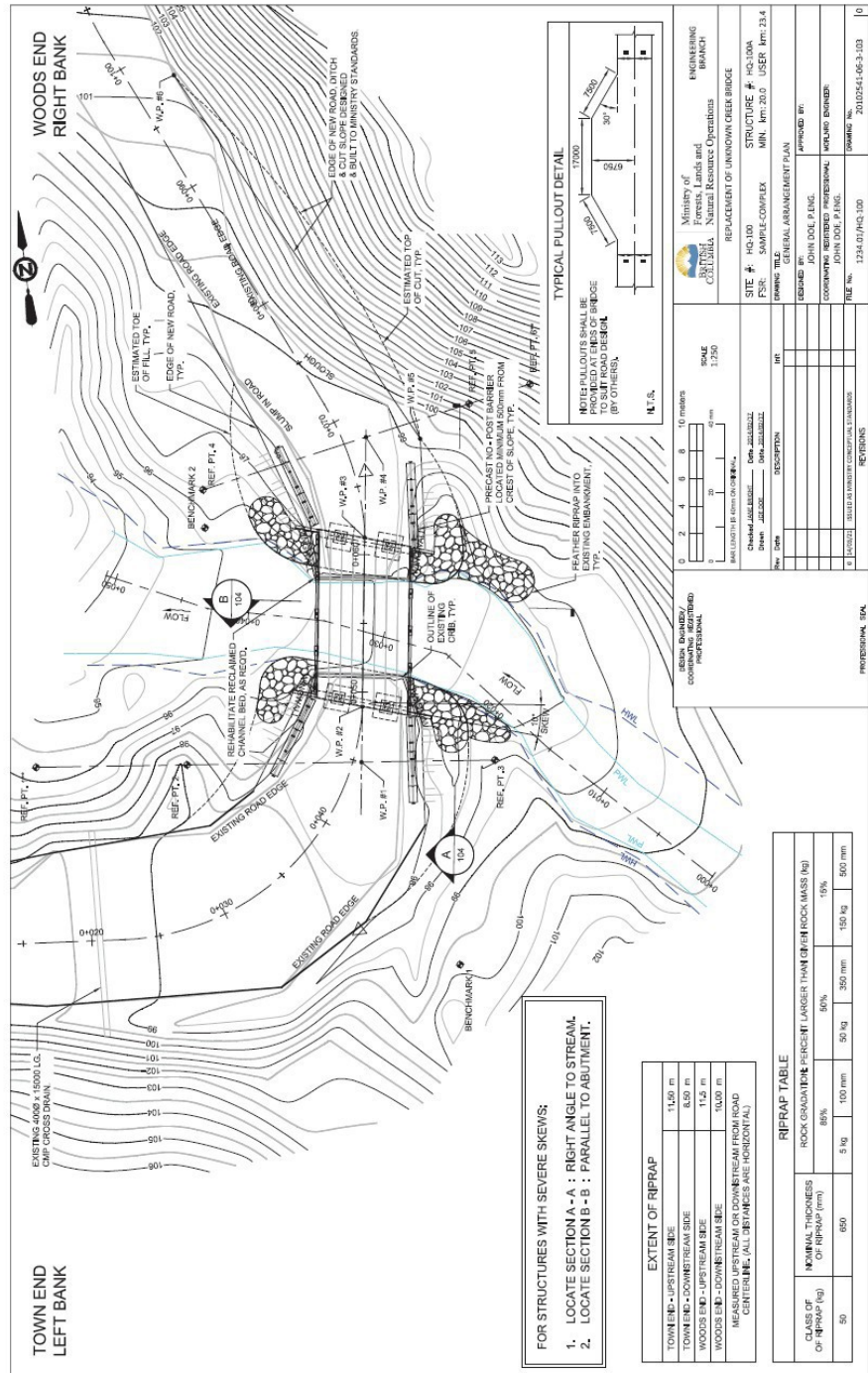
- deck elevations at bridge ends;
- possible ford or temporary bridge crossing locations;
- road and bridge or culvert signs;
- approach barriers, if required;
- rip rap extents;
- limit of construction for contract purposes;
- special provisions related to the unique nature of the site and crossing, including specific instructions to bidders related to process or results, as appropriate;
- special instructions relating to material erection, installation standards, requirements, or methods as deemed necessary.





**Figure 4-2 Sample of General Arrangement and Layout (complex creek crossing) Full set located at:**

**<https://www.for.gov.bc.ca/hth/engineering/documents/Bridges and MC/Sample GA Complex Final.pdf>**





#### 4.11.2 Bridge Superstructure Drawing Requirements

Detail the following elements on bridge superstructure drawings:

- design code references, specifically those from the latest version of the CAN/CSA S6 – Canadian Highway Bridge Design Code and the Canadian Foundation Engineering Manual;
- individual member shapes, dimensions and connection details;
- materials specifications and CSA references, including but not limited to:
  - steel grades, impact category, finish;
  - timber species, grades, preservative treatment;
  - concrete strength, slump, and air entrainment;
  - bearing materials and connections;
  - superstructure elements, configuration, and connections;
  - dimensions and sizes of components;
  - girder or stringer arrangements and connections;
  - span lengths;
  - bridge and road width;
  - curb and rail configuration, connections, and component elements;
  - bridge label with structure number, date of manufacture, and load rating; and
  - field fabrication details.

Note that the superstructure drawings are normally supplemented by shop drawings prepared by the fabricator.

#### 4.11.3 Bridge Substructure Drawing Requirements

Ensure that the following information on foundation requirements is detailed on the bridge substructure drawings:

- abutment elements, configuration, and connections;
- dimensions and sizes of components;
- critical elevations of substructure components;
- scour protection: dimensions, composition, extent of placement, design slope, design high water, and other considerations;
- piers;
- location and sizes of piles or posts;
- pile-driving specifications, minimum expected pile penetrations, set criteria, and required service level capacities;
- field welding requirements;

- bracing and sheathing configurations; and
- foundation requirements, material types and depth, and compaction level.

The above requirements also apply to portable bridge superstructures.

#### **4.11.4 Log Bridge Superstructure on Log Crib Drawing Requirements**

Since log stringer and crib materials are variable in nature and finished dimensions are not uniform, log bridge drawings are somewhat schematic. Ensure that the drawings address layout of the structure and its elements, required component sizing, and connection details.

Ensure that the following are indicated on the log bridge superstructure and log crib drawings:

- schematic layout indicating width and span;
- reference source for stringer and needle beam sizing;
- minimum stringer, curb, and needle beam dimensions;
- stringer, curb, needle beam, and crib logs specifications, including species, quality characteristics of acceptable logs, and seasoning;
- stringer-to-cap bearing details, including shim types and stringer and cap-bearing width and surface preparation;
- cap details at log connections;
- needle beam locations and connection details, if applicable;
- space to add stringer, curb, and needle beam sizes as part of the as-built record;
- deck layout, indicating tie sizes and spacing, plank thickness, and connections;
- other materials specifications, including sawn timber, hardware, and shims;
- excavated depth relative to scour line for mudsill or bottom bearing log;
- general layout and arrangement of front, wing wall, deadman, and tieback logs, and their connections to each other and to the bearing log or cap;
- description of crib fill material;
- layout and description of in-stream protection, if applicable; and
- rip rap protection layout and specifications (as required).

#### **4.11.5 Major Culvert Drawing Requirements**

Ensure that drawings and notes for major culverts portray and describe the following:

- site plan, [see 4.7: Site Data and Survey Requirements for Bridges and Major](#)

### Culverts:

- location of the culvert, such as a keymap;
- design vehicle load;
- fill height, depth of cover, and maximum and minimum cover requirements;
- design slopes of fill and riprap;
- culvert invert elevations at the inlet and outlet;
- culvert specifications and dimensions: opening dimensions, length, corrugation profile, gauge, material type, and inlet bevel specifications;
- site preparation requirements;
- embedment requirements, including a description of the substrate and any rock used to anchor the bed material in the pipe;
- foundation details;
- backfill and installation specifications;
- installation camber;
- culvert gradient;
- seepage barrier details if required;
- special attachments or modifications;
- inlet requirements (rip rap layout, stilling basin, etc.);
- outlet requirements (rip rap layout, stilling basin, backwater weir for fish passage);
- rip rap specifications, including dimensions and configuration;
- design high-water elevation and design discharge, inlet or outlet control;
- connection details for pipe sections; and
- any existing improvements and resource values in the vicinity of the culvert that would influence or be influenced by the structure.

Combine any of the above requirements where appropriate. For example, drawings for a log stringer bridge on timber piles may include the details from [4.10.4: Log Bridge Superstructure on Log Crib Drawing Requirements](#), plus those from [4.10.3: Bridge Substructure Drawing Requirements](#).

Include any additional requirements for a fish stream culvert, as specified in the [Fish-stream Crossing Guidebook](#).

#### **4.11.6 Portable Bridge Superstructures**

Where portable bridge superstructures or other structural components are used for any FS bridge project (including those bridges built under Road Permit (BCTS) and designated in that permit to be an FS bridge to be used for harvesting after

completion of the Timber Sale License), the components *must* have been designed or structurally analyzed by a professional engineer, to demonstrate adequacy for the intended use.

Record the FLNR portable bridge superstructure number or, if there is no current superstructure number, contact the ministry bridge engineer so that one can be assigned.

Once the components have been reviewed and approved by a professional engineer, re-use the components at new sites without specific professional engineer review of the superstructure, provided that:

- a Qualified Inspector has inspected the bridge at the new site before any use and does not detect any damage or deterioration of the structure; see Chapter [6.7.1: Types of Inspections](#);
- the design loads to be carried are equal to or lower than the original design loads for the superstructure;
- the bridge is suitable and has been specifically designed or analyzed for the new site, and signed and sealed design drawings and specifications have been prepared; and
- the superstructure has been fabricated and constructed in compliance with the appropriate legislation.

#### **4.12 Bridge and Major Culvert Materials Acquisition**

Materials for FSR bridges and major culverts are acquired in two ways:

- a requisition for materials through the Purchasing Commission and BC Bid; and
- through a works contract which includes supply and installation of bridges and major culverts.

In either case, all rules of government public tendering apply, and specifications and standards for bridge and culvert materials are the same.

Standard bridge materials templates for acquiring bridge materials have been developed for use and are available on the [Engineering Branch website](#).

The ministry's standard bridge material requisition templates are intended to be used primarily by ministry bridge engineers and/or the professional engineer taking responsibility for a bridge structure design or installation. Bridge material requisitions need to be consistent with the design. Consult the ministry bridge engineer when a bridge material requisition is being developed for a specific project.

Incorporate the language in the requisition templates into ministry contracts where bridge material supply is included in the contracted works. The design and quality

assurance requirements for bridge material supply under direct requisition or through a design, supply, and construct contract are identical.

#### 4.13 ***Bridge and Major Culvert Materials Quality and Fabrication***

Modern permanent structures have design lives that exceed 40 years. To achieve this longevity, ensure that the components are fabricated to detailed standards. Many important details (e.g., rebar placement, concrete design, and welds) can only be inspected during the fabrication process.

Ensure that bridge and major culvert materials and fabrication meet minimum requirements, by requiring materials and fabrication standards be met, including those of Canadian Standards Association (CSA) and the American Society for Testing and Materials (ASTM). This provides a means of ensuring the quality and consistency of materials, and provides equitable parameters for competition for supply, fabrication, and erection. The requirements, as defined in the standards, provide for a suitable blend of cost-effective and durable products. Ensure that the standards for bridge and major culvert materials and fabrication are adhered to. In exceptional circumstances, there may be a reason to vary from the standards, but consult with a Ministry bridge engineer and Engineering Branch beforehand.

Ensure that all materials used for constructing bridges are new and conform to applicable CSA or ASTM material standards in the [Forest Service Bridge Design and Construction Manual](#). In particular:

##### **Concrete**

Ensure that concrete is designed, mixed, transported, cast, and cured according to CSA Standard A23.1 – Concrete Materials and Methods of Concrete Construction and tested to CSA Standard A23.2 – Methods of Test for Concrete.

Precast concrete bridge elements conform to CSA Standard A23.4 – Concrete Materials and Construction, which means fabrication by a CSA-certified precast concrete plant.

Unless otherwise required by the designer, precast concrete blocks are exempt and may be supplied by non-CSA-certified precast plants provided they meet the following specifications:

- minimum 20 MPa concrete strength unless otherwise specified by a professional engineer;
- single pour (***must*** not have any cold joints); and
- a finish free of honeycombing.

For higher risk structures, those that consist of multiple levels of interlocking concrete blocks, or those with significant bearing pressures, ensure that quality requirements of precast concrete blocks are more rigorous and are specified by the engineer taking responsibility for the design.

## Structural Steel

Structural steel for permanent and portable bridges comply with CSA Standard CAN3-G40.21-M – Structural Quality Steels. Primary tension members of welded structures are of type AT, grade 350 or better.

Weathering steel, type 350 AT, are not to be used for permanent bridges in marine or coastal areas or in areas where there is potential for road de-icing salts to come in contact with the bridge. Alternatively, specify galvanized or painted steel.

Steel fabrication is carried out by firms certified by the [Canadian Welding Bureau \(CWB\)](#) to Div 1 or 2. A list of CWD companies can be found on-line at the [Canadian Welding Bureau](#) website.

## Timber

Timber used for bridge construction is graded in accordance with the standard grading rules of the Canadian Lumber Standards Administrative Board. Timber is grade-stamped, with the exception of unfinished or rough timber (in which case grading certificate may be requested), or local log stringers.

Structural timbers are Douglas-fir/larch #2 grade or better, except timber curbs may be any species #2 grade or better. Note that the structure strength and other characteristics, such as durability, make Douglas-fir/larch a superior product to other species.

## Corrugated Steel and Hardware.

Ensure that corrugated steel culverts are manufactured in accordance with CAN/CSA 3-G401 standard, [Corrugated Steel Pipe Products](#). Steel culverts fabricated from steel sheets need to meet all requirements of ASTM A444, “Standard Specifications for Zinc Coated (Galvanized) Iron and Steel Sheets for Culverts and Underdrains.” Ensure that all hardware conforms to applicable standards (that is, rivets are galvanized, and bolts and nuts are Grade C, galvanized, meeting the requirements of ASTM standard A563.

### 4.13.1 In-Plant Inspection of Bridge Materials and Fabrication

For any FS bridge project (including those bridges built under Road Permit (BCTS) and designated in that permit to be an FS bridge to be used for harvesting after completion of the Timber Sale License), bridge components assembled or manufactured off the construction site (such as treated timber, steel girders, and precast concrete footings, girders, footings or deck panels) ***must*** be inspected during fabrication to provide quality assurance that all materials and procedures meet the materials specifications as well as the applicable codes and standards. The costs associated with inspection are more than balanced off in terms of off-setting future problems with the fabricated components. The ministry engages a contractor to provide the in-plant inspection services at the various fabrication plants around the province. The in-plant quality assurance inspection contract is coordinated by the Engineering Branch.

Ensure that the fabricator producing the bridge materials provides copies of detailed shop drawings to the in-plant inspector. The inspector confirms that the strength of materials and details of fabrication are consistent with the shop drawings and applicable specifications, as accepted for the project, standards, and codes. Where discrepancies occur, the inspector notifies the appropriate ministry bridge engineer for input on acceptability or required modifications.

For more detailed information regarding material and fabrication requirements, refer to the [Forest Service Bridge Design and Construction Manual](#).

The inspector completes an in-plant inspection report for each bridge and submits it to the Ministry bridge engineer.

Obtain and keep on file all relevant material documentation, such as mill test certificates, in-plant test results, field test results, and all reports or comments made by field or in-plant inspectors.

#### 4.13.2 Structural Field Welding

Welding is a specialized field and the ministry requires minimum qualifications for companies and personnel involved in bridge construction.

Typically there are two types of structural welding on resource road bridges;

(a) shop fabrication of primary steel load bearing members and structural components, and (b) field fabrication welding required for erection, assembly, and installation of bridge components (e.g. connection of bearings to pipes and girders, steel braces and diaphragms, and welded shear connectors for precast members).

Both types of structural welds are critical to the long term performance and integrity of the structure. Structural welding on ministry bridge structures is required to conform to Canadian Standards Association (CSA) Standard W59, **Welded Steel Construction (Metal Arc Welding)**. Firms carrying out welding on ministry structures are required to conform to CSA Standard W47.1, **Certification of Companies for Fusion Welding of Steel Structures**.

**The Canadian Welding Bureau (CWB)** is accredited by the Standards Council of Canada as a Certification Body for the administration of CSA Standards including W47.1, for :

- Certification of companies involved in welding
- Certification of Welding Inspection Companies
- Certification of Welding Inspectors
- Certification of Welding Electrodes

The CWB qualifies welders, welding procedures. The activity of the CWB contributes to the high level of competence enjoyed by industries employing welding and joining and the consistent progress in welding technology, and the reliability of welded products.

All CWB certified companies are required to have certified welders and written welding procedures for each specific type of weld produced (Weld Data Sheets). A list of CWB certified companies is found on the Canadian Welding Bureau website.

The minimum welding certification requirements, for ministry bridge work, is CWB Certification Division 2 for shop fabrication and Div 3 for field welding. A ministry bridge engineer or designer may elect to specify a higher certification requirement for complex welding. Note that provincial welding qualification is not adequate as it is different and not equivalent to CWB certification. CWB certification of the firms employing the welders, as well as conformance to CWB procedures and standards, is required for all ministry bridge projects involving structural welding.

#### **4.13.3 Structural Field Grouting**

Structural field grout is a critical component to the safe performance and structural integrity of ministry bridges. Where structural field grouting is required, such as for composite concrete decks or shear connections for concrete slabs, mix and place the grout to attain the required bridge design compressive strength, and in accordance with manufacturer's specifications.

Manufacturer's specifications provide for varying amounts of water which will significantly affect the attainment of the design compressive strength within a specified time frame. When mixed properly, is usually not fluid and cannot be poured, it is packed into place. Where excessive water is used in mixing grout, the cure time, strength and durability of the grout are compromised. This is a serious problem where the grout is intended to be a structural connection, which is almost always the case for ministry bridge projects. Monitor grout mixing procedures and ensure adherence to manufacturer's specifications. Utilize minimal amount of water in order to attain the required design strengths.

It is also noted that other factors influence set time such as the ambient temperature over which there is limited ability to control. Additional precautions are required for mixing and placing concrete or grout in cold or hot weather extremes. Placing of concrete products during extreme cold or hot weather has the potential to affect both the long term strength and durability and procedures should be reviewed by a ministry bridge engineer.



Low temperatures during the placement and curing of grout can affect the ultimate strength and durability of grout both temporarily and permanently. Grout cures slower in cold temperatures and develops ultimate strengths over longer periods of time. Exposure of fresh concrete to temperatures below freezing may actually stop the curing (hydration) process.

Hot weather can have a negative impact on both plastic and hardened state of concrete. Hot weather affects all of the major components of grout including water, cement and aggregates. Hot weather also has an impact on batching, mixing and placing of grout.

Precautions ***must*** be taken in advance of grouting operations that are anticipated to be effected by cold or hot weather.

### **Cold Weather Grout Procedures**

In “cold weather” conditions it is important to protect the concrete from freezing and to maintain curing conditions to ensure sufficient strength and durability to satisfy intended service requirements. When temperatures drop or will potentially drop below 5 degrees Celsius, cold weather procedures should be implemented. Cold weather procedures may extend beyond heating the water used to mix the grout and will need to address forecast temperature conditions. Preheating and continued heating for the initial set period for the concrete or grout may be required to ensure that the curing of concrete or grout is not affected by cold temperatures and kept from freezing. If the concrete deck panels or slabs are not pre-heated, they will draw the heat out of the grout and will increase the possibility of the grout freezing in subzero temperatures. If the grout is not preheated, it will dramatically reduce the temperature of the heated water when mixed. The heat of hydration of the grout is not sufficient to keep the grout from freezing in subzero temperatures particularly if the concrete deck panels or slabs are cold. If the grout freezes, it will most likely need to be extracted and redone which is a highly labour intensive and laborious process to be avoided.

Precautions may include some or all of the following:

- 1) Pre-warm the dry mix grout and components being grouted to above 10 degrees Celsius. The temperature during the initial 24 hours of cure time should be maintained above 10 degrees centigrade. The components’ temperature should be kept above freezing for a minimum of 72 hours subsequent to grout placement. Ensure compliance with the manufacturer’s specifications in order to meet the specified compressive strength within the required time frame.

Practices that have been typically implemented consist of wrapping the structure in tarps and heating from beneath the structure using suitable heaters. Various types of tarps and covers have been used including:

plastic sheeting, construction tarps, lumber wrap and even non-woven geotextile. The basic concept is using the wrapping to contain the heat from a heat source such as a tiger torch or propane heater and to warm the components that are being grouted. The wrapping would cover the deck and drape below the bridge to capture the rising heat. The dry mix grout can be placed on the deck, under the wrap and be heated with the deck or slabs. For steel girder bridges, it may be sufficient to have a heat source between the girders to keep the deck sufficiently warm through the grouting placement and initial setting. Exercise caution to ensure that any heat source be directed away from any bridge components to avoid adversely warping steel components or cause cracking of concrete.

- 2) Use warm water (20 degrees centigrade) in mixing the grout.
- 3) Provide sufficient labor to minimize the time required to place and finish the grouting process, to minimize the handling time of the grout and resulting heatloss.

### **Hot Weather Grout Procedures**

Higher temperatures cause water to evaporate from the surface of grout at a much faster rate and cement hydration occurs more quickly, causing the grout to stiffen earlier, lessening workability, increasing the chances of plastic cracking and reducing ultimate strength.

Precautions may include some or all of the following:

- 1) Moisten precast components, steel reinforcement, and form work prior to groutplacement.
- 2) Keep the grout cool prior to mixing, store in a cool location. Use cold water or ice, as a part of the mixing water. Ice should be crushed, shaved or chipped form and ***must*** be considered as part of the mix design. Mixing should continue until all of the ice is completely melted.
- 3) Use a grout consistency that allows rapid placement and consolidation within acceptable tolerances to achieve the required design strength.
- 4) Provide sufficient labor to minimize the time required to place and finish the grouting process, as hot weather conditions substantially shorten the times to initial and final set.
- 5) Maintain moisture for the curing process by covering with damp burlap, and periodically rewetting, to maintain moisture as the grout sets, as soon as possible after the grout finishing processes have been completed.

- 6) In extreme conditions consider adjusting the time of concrete placement to take advantage of cooler temperatures, such as early morning or night time placement.

### **Grout Field Sampling During Field Placement**

Acquiring samples to allow for compressive testing of field placed structural grout is standard practice for Ministry of Forests, Lands and Natural Resource Operations bridges. The FLNR procedure for grout sampling of in-situ placed structural grout, used for composite precast concrete decks on steel girders and precast concrete slab bridges with grouted shear connections, is in [Appendix 4.5](#). The sampling procedure is to be provided to and followed by the individuals tasked with taking the grout samples in the field for each particular bridge project placing structural grout in the field during construction. The grout sampling procedure may also be implemented for other structural grout applications as may be appropriate.

This FLNR procedure provides instructions on how to take representative samples of the grout that has been placed in the field. The cured grout samples will provide the ability to later test for compressive strength attained at appropriate times to assess the adequacy of the grout. This sampling and testing procedure is not fully consistent with various published Canadian or American standards for grout testing, but rather it is a hybrid of standards to accommodate FLNR's particular needs. Various standards (e.g., ASTM, CSA) specify that grout would typically be tested using 50mm cubes. However, the cube molds are costly and would not be readily distributed where required for our needs. The cylindrical molds are applicable to our utilization and their shape allows them to be tested for compressive strength in a laboratory. Local material testing laboratories will have the capability to test the samples and the testing costs range from \$20 – \$30 per sample.

### **Taking grout samples**

The initial set time for the sampled grout is a critical factor. Allowing the samples to cure in-situ, at minimum, overnight, will provide an approximate representation of the field conditions. These samples are not precise replicas of the grout in the field but should provide a very good indication of quality and strength. Increasing the minimum number of required samples or specifying longer field curing times shall be at the discretion of the ministry bridge engineer.

### **Distributing grout sample molds**

Suggested approach for distributing the cylinders – provide an envelope with an adequate number of cylinders, labels and one page instruction sheet included, to the party responsible for obtaining the samples. Would suggest discussing the procedure with the individual, identifying how the

sample should be handled and placed subsequent to casting and who the sample should be provided to subsequent to initial set.

### **Testing grout samples**

Testing of the grout samples is a recommended procedure as there should be some objective basis from which to gauge when the grout has attained sufficient strength to place the related structure in-service. The number of samples to be tested is at the discretion of the ministry bridge engineer. For example, if the first sample attains or exceeds the required design strength, it may not be necessary to test additional samples.

In the event that tested grout samples are found to be deficient in compressive strength, further investigation would be required. Depending on the nature of the test results, coupled with observations in the field, it may be required that test samples would need to be cored for testing from the actual bridge. Where grout sample test results are deficient, the ministry bridge engineer will specify the necessary steps to assess the problem in order to establish the safe use of the structure of concern.

## **4.14 Major Culvert Construction**

Ensure that major culvert installations receive compaction to obtain adequate structural integrity of the installation because culverts are generally soil-steel structures. The culvert itself will not support the design load without the soil-steel interaction. In order for the soil to work with the steel to support the design load, the culvert is adequately “bedded” and the soil appropriately compacted to be “structural.” The flexible steel is designed to distribute loads to the bedding and backfill surrounding it. Soil is most compactable when it is composed of select granular, free-draining material. Ensure that the backfill conforms to a specified size gradation.

Typical backfill compaction is the minimum Standard Proctor Density of 95%. To achieve that level of compaction, use hand tools to work smaller areas (between corrugations); mechanical compactors such as plate and jumping jack tampers; or rollers and vibrating compactor equipment.

Typical construction practices include the following:

- Provide adequate bedding before culverts are installed and backfilled. Where subgrade material is unsuitable, remove it and replace it with select granular, free-draining material compacted to support the culvert.
- Place and compact backfill in uniform layers, about 150–300 mm thick (compaction equipment and layer thickness as specified by the designer) of select granular, free-draining material on each side of the culvert in a balanced and progressive manner, to avoid potential distortion or displacement of the culvert.

- Remove cobbles and boulders from the backfill, particularly where they could contact the culvert. Use hand tools to compact the material immediately adjacent to the culvert within the corrugations. Fully compact each layer before the next layer is placed on top.
- Monitor compaction and complete compaction testing as specified by the designer.
- Avoid over-compaction of the backfill to prevent distorting the culvert. Continue backfill and compaction above the culvert, as specified in the design. Establish minimum culvert cover before any equipment loads are applied.

#### **4.15 Use and Role of Environmental Monitors**

An environmental monitor inspects site activities for:

- conformance with construction work plans that incorporate measures to protect forest resources in accordance with legislative requirements; or
- during active development operations in sensitive habitats and ecosystems.

Retain an environmental monitor on a site specific project basis when specified in an environmental management plan or where required by an environmental agency (such as where bridge or major culvert construction occurs in critical or important fish habitats, or where instream work is approved outside of the fisheries timing window).

For appropriate qualifications for environmental monitors, see the Engineering Equipment and Services (EES) Directory under two categories:

- i) [Professional Environmental Monitoring \(RPBio\)](#); and
- ii) [Technical Environmental Monitoring](#)

Where an environmental monitor may be warranted, the scope of duties may include:

1. liaise with ministry staff or other regulatory agencies;
2. observe, record, and photograph the baseline site conditions before work commences and identify any significant (material adverse) changes in site conditions during and after work;
3. attend the pre-work meeting and other project meetings as necessary, and provide assistance to the Licensee/Permittee/Contractor or ministry to assess conformance with the construction contract work plans, contract conditions, and BCTS EMS requirements (e.g., EFPs; Hazardous Materials Spill Preparedness Responsibilities and Spill Action Steps; Landslide and Major Erosion Event Response and Erosion Action Steps; and EMS documentation requirements);
4. conduct on-site field visits either continuously or periodically to observe active operations; the timing and duration of field visits will depend on the

- type and complexity of the work, and on the sensitivity of the site and forest resource values at risk of damage or loss;
5. during field visits, evaluate the adequacy of erosion and sediment control techniques, including work procedures for instream work, construction and diversions on watercourses, and observe, record, and photograph site conditions and work procedures;
  6. provide practical and appropriate options to protect or minimize harmful effects to fish and fish habitat if changes to the work occur due to unforeseen circumstances;
  7. modify or stop operations if the following occurs:
    - site activities do not conform with approved construction contract work plans and contract conditions;
    - work activities lead to harmful levels of sediment entering a stream;
    - work activities may harmfully alter, disrupt, or destroy fish or fish habitat or other forest resources;
    - unforeseen circumstances related to the work cause or may cause environmental problems;
  8. assist the Licensee/Permittee/Contractor or ministry with documentation requirements;
  9. if applicable, confirm that the completed work activities meet the requirements of the fisheries agency that grants a variance on the timing window and/or approval for the planned works;
  10. provide a brief written report to the ministry (and other agencies if requested) within two to four weeks after completion of the project; the report includes the following information:
    - background project information;
    - summary of Licensee/Permittee/Contractor's work procedures and environmental protection strategies;
    - description of pre-works activities, works activities, and post-works activities;
    - conclusions; and
    - appendices, including copies of stop work orders (if any) and photographs (with time and date) of all important phases of the work showing site conditions before, during and after the work.

#### **4.16 General Conformance and Construction Documentation**

After construction of a bridge or major culvert, the CRP ***must*** sign and seal a statement (**F.S. 1414 form**) indicating that the entire structure is in general conformance with the design drawings and specifications. The **FS1414** form, ***CRP Crossing Assurance Statement***, is required for all bridge and major culvert works and is the only form required when the CRP carries out all of the professional services—coordination, planning/design, record drawings, and

crossing construction conformance. The **FS 138** form, ***POR Constructure Assurance Statement***, is required when another professional engineer or forester is responsible for conducting construction field reviews for a bridge, major culvert, retaining structure, or other engineered structure, who is not the CRP.

**FS 1414 – CRP Crossing Assurance Statement** (link to form on forms index: <http://www.for.gov.bc.ca/isb/forms/lib/fs1414.pdf>)

The FS 1414 form, ***CRP Crossing Assurance Statement*** replaces the former “*CRP Statement of Bridge Construction Conformance*” form that was provided in appendix 4.2 of the Engineering Manual.

The new FS 1414, is for construction of bridges and major culverts. This form is consistent with the generic crossing assurance statement form provided in the APEGBC and ABCFP Joint Practices Board professional practice guidelines titled, [\*Guidelines for Professional Services in the Forest Sector – Crossings\*](#).

The FS 1414

1. is required for all bridge and majorculvert crossings and is to be signed and sealed by a PEng or RPF acting in the role of the Coordinating Registered Professional (CRP);
2. its use by RPFs is limited to “simple” structures;
3. shall be supplemented with an FS 138 where the CRP has delegated the construction field services to another professional engineer or forester;
4. is more encompassing than the FS 138 because it is intended to be used by the CRP who is responsible for all professional services for the crossing project including coordination, planning/design, record drawings, and crossing assurance statement.

**FS 138 - POR Construction Assurance Statement** (link to form on forms index: <http://www.for.gov.bc.ca/isb/forms/lib/fs138.PDF>)

The FS 138 form, ***POR Construction Assurance Statement*** has been updated. This form is used for construction conformance of bridges, major culverts and other ministry structures. The form has been revised to utilize the term “professional of record” and to provide for RPF sign-off (as applicable).

The FS 138:

1. is to be signed by a PEng or RPF who provides construction field services only, where bridge or major culvert project planning and engineering design may have been carried out by others;
2. its use by RPFs is limited to “simple” structures;
3. is not a crossing assurance statement [i.e., it is not intended to address the Coordinating Registered Professional (CRP) role];

4. used for a bridge, major culvert, retaining structure or other engineered structure.

In addition, ensure that the following as-built records are obtained and kept on file:

- actual log stringer, curb, needle beam and crib log sizes (diameter and length for each member);
- pertinent construction data including, but not limited to, any pile driving records, hammer type, penetration, set criteria, and any critical dimensions;
- fabrication plant inspection reports, including mill test certificates and concrete test results;
- shop or as-built fabrication drawings;
- geosynthetic material identification;
- concrete and grout test results;
- field compaction results;
- confirmation of scour protection requirements;
- footing base elevation, deck elevation, and alignment location; and
- other pertinent fabrication, field, and construction data.

As-built drawings are normally the “approved for construction” drawings that are marked up to show all significant variations from the original design. Ensure that the as-built drawings ([see sample](#)) are signed and sealed by the Coordinating Registered Professional. Where the original design has been modified, these drawings should have been amended accordingly by the designer before the as-built notes and details are inserted.

Ensure that a BCTS/District engineering technician inspects the completed bridge for acceptability/assurance of the structure, often as part of the inspection for contract completion. Forward the package of statement of conformance, as built drawings and field note from the engineering specialist to the ministry bridge engineer for review for completeness and acceptability.

Add all completed FS bridges to the appropriate BCTS/Timber Pricing and Operations Division file records and road and bridge data base.

#### **4.17 Resources and Suggestions for Further Reading**

[Handbook of steel drainage and highway construction products](#), 2007. Can. ed. Corrugated Steel Pipe Institute, Cambridge, Ontario.

[BC Ministry of Forests. 1997. Forest service bridge design and construction manual. Victoria, BC.](#)



\_\_\_\_\_. 1981. [Log bridge stringers and needle beam sizing](#) (Metric Edition). Design Section, Engineering Branch. Victoria, BC.

Canadian Geotechnical Society. 1993. Canadian Foundation Engineering Manual. Richmond, BC

Canadian Standards Association. R2005. Canadian highway bridge design code (CAN/CSA S6-00). Mississauga, Ont.

Nagy, M.M., J.T. Trebett, G.V. Wellburn, and L.E. Gower. Second Edition. 1989. [Log bridge construction handbook](#). For. Eng. Research Inst. Can. (FERIC), Vancouver, BC.

## Appendices

### Appendix 4.1: Project Tracking Checklist

#### Bridge Design and Construction


<p><i>Use this checklist to prepare a record of key outputs prepared by consultants and maintainers, and sign-offs by FLNR. Ensure that only one Project Option is selected for each bridge project.</i></p>		
Element Being Reviewed & Results Achieved		Date of FLNR sign-off
<p><b>Project Option 1: FLNR designs and builds bridge</b> <input type="checkbox"/> YES <input type="checkbox"/> NO</p>		
<b>BRIDGE DESIGN</b>		
<p>Ensured that the ministry bridge engineer was consulted to determine bridge design loading and lifespan, and who should be the CRP:</p> <p><b>Ministry Bridge Engineer:</b></p>	<p>YES NO</p>	<p>_____</p>
<p>Ensured that an appropriately qualified inspector was engaged to inspect any portable superstructure to be re-used at this site, and ensured that the structure was inspected:</p> <p><b>Inspector's Name and Company:</b></p> <p>_____</p>	<p>YES NO N/A</p>	<p>_____</p>
<p>Ensured that an appropriately qualified professional engineer carried out the conceptual design as the CRP, and that BCTS/District provided the CRP with the design and drawing requirements, as well as inspection information on any portable superstructure to be re-used at the site:</p> <p><b>EOR's Name and Company:</b></p> <p>_____</p>	<p>YES NO</p>	<p>_____</p>
<p>Ensured that the construction drawings and specifications were reviewed by the ministry bridge engineer to determine that they reflected the design criteria and were appropriate for the site and the intended use, and signed off as acceptable</p>	<p>YES NO</p>	<p>_____</p>
<b>BRIDGE CONSTRUCTION</b>		
<p>Ensured that the CRP:</p> <ul style="list-style-type: none"> <li>signed the statement of construction conformance; and</li> <li>prepared, signed and sealed as-built</li> </ul>	<p>YES NO</p>	<p>_____</p>

drawings.			
Ensured that bridge was inspected in field by BCTS/District engineering specialist to confirm the completion of the finished product	YES NO	_____	_____
Ensured that the ministry bridge engineer reviewed the CRP's information and the field note from the BCTS/District engineering specialist to confirm acceptability of the package	YES NO	_____	_____
<b>Project Option 2: Maintainer (road use permit holder) designs and builds bridge</b> <input type="checkbox"/> YES <input type="checkbox"/> NO			
<b>BRIDGE DESIGN</b>			
Ensured that the ministry bridge engineer was consulted to determine bridge design loading and lifespan:  <b>Ministry Bridge Engineer:</b>	YES NO	_____	_____
Ensured that maintainer engaged an appropriately qualified inspector to inspect any portable superstructure to be re-used at this site, and ensured that the structure was inspected:  <b>Inspector's Name and Company:</b> _____	YES NO N/A	_____	_____
Ensured that maintainer carried out the bridge design, in accordance with the design and drawings requirements from the District Manager:  <b>Designer's Name and Company:</b> _____	YES NO	_____	_____
Ensured that the construction drawings and specifications were reviewed by the ministry bridge engineer to determine that they reflected the design criteria and were appropriate for the site and the intended use, and signed off as acceptable; ensured that the conclusions were forwarded to the maintainer and recorded on the project file	YES NO	_____	_____
<b>BRIDGE CONSTRUCTION</b>			
Ensured that the maintainer's CRP: <ul style="list-style-type: none"> <li>confirmed that the bridge was constructed in general conformance with the drawings and specifications;</li> <li>prepared, signed and sealed as-built drawings; and</li> <li>provided these outputs to the District Manager:</li> </ul>	YES NO	_____	_____

Ensured that bridge was inspected in field by BCTS/District engineering specialist to confirm the completion of the finished product	YES NO	_____	_____
Ensured that the ministry bridge engineer reviewed the CRP's information and the field note from the BCTS/District engineering specialist to confirm acceptability of the package	YES NO	_____	_____
Ensured that project information, including materials and construction records, has been properly entered on the project file and appropriate electronic data base.	YES NO	_____	_____


## Appendix 4.2a: CRP Crossing Assurance Statement (FS1414)

The FS 1414 Form (image below) is available as a fillable pdf file on the ministry [Forms Index](#).

 Ministry of Forests, Lands and Natural Resource Operations		<b>Coordinating Registered Professional – CROSSING ASSURANCE STATEMENT</b> For Bridges, Major Culverts and Other Structures; submitted with record drawings and documents after construction	
Site No.	Structure No.	Road Name & Location:	Forest/Resource District:
Project/Contract No.		Watercourse Name:	Simple Crossing? <input type="checkbox"/> Yes/ <input type="checkbox"/> No
Type: <input type="checkbox"/> Bridge <input type="checkbox"/> Major Culvert <input type="checkbox"/> Other Structure (describe)			Was Field Welding or Grouting Required? <input type="checkbox"/> Yes/ <input type="checkbox"/> No
Description of Project Covered by This Statement:			
Design Vehicle Configuration (eg BCFS L100, BCL625):			
Design Life (years):			
List of Approved Design Drawings, Design Aides & other supporting documentation - Drawing Number, Name, Revision #, Date:			
I am the Coordinating Registered Professional (CRP) and I am a: <input type="checkbox"/> Professional Engineer (P.Eng., registered with the Association of Professional Engineers and Geoscientists of BC (APEGBC); or <input type="checkbox"/> Professional Forester (RPF) or Registered Forest Technologist (RFT), registered with the Association of British Columbia Forest Professionals (ABCFP)			
1. I am responsible for all the professional services for this crossing project, including coordination, planning/design, and field reviews* and have completed the work as required under the Legislation for my profession, the <a href="#">Guidelines for Professional Services in the Forest Sector - Crossings</a> as applicable to this project and by good practice.			
2. General Arrangement Design (For complex, non-simple crossings, design must be the responsibility of a P.Eng.): <input type="checkbox"/> I prepared the General Arrangement Design; or <input type="checkbox"/> I give my assurance** that the General Arrangement Design has been prepared by a qualified professional who incorporated the necessary specialist assessments. Name of Professional of Record (POR) who prepared General Arrangement Design _____ <div style="text-align: right;">P.Eng. OR RPF OR RFT (circle one)</div>			
3. Field Reviews: <input type="checkbox"/> I completed the field reviews during construction* (FS138 not required); or <input type="checkbox"/> Name of POR responsible for field reviews: _____; see attached FS138 Construction Assurance Statement <div style="text-align: right;">P.Eng. OR RPF OR RFT (circle one)</div>			
Based on the field reviews, I give my assurance** that:			
<ul style="list-style-type: none"> <li>the work substantially complies in all material respects with the engineering concepts or intent reflected in the engineering design documents (approved design drawings, specifications, and all applicable supporting engineering documents), including all revisions;</li> <li>any significant modifications from the crossing design documents:           <ul style="list-style-type: none"> <li><input type="checkbox"/> have been approved by the POR that prepared the general arrangement designs, OR</li> <li><input type="checkbox"/> the undersigned takes full responsibility for the modifications and significant modifications have been documented and marked on the <u>attached</u> Record (as-built) drawings and documents</li> </ul> </li> <li>where field welding was required, the welding was completed by a Division 3 or better CWB certified welding firm;</li> <li>where field welding or grouting was required the POR was a P.Eng.</li> </ul>			
Name of CRP (please print):		(please affix professional seal here)	
SIGNATURE OF CRP (P.ENG. OR RPF OR RFT - circle one)			
DATE SIGNED YYYY MM DD			
Company Name and Address (please print):			
Phone No.	E-Mail Address:		

## Appendix 4.2b: POR Construction Assurance Statement (FS138)

The FS 138 form (image below) is available as a fillable pdf file on the ministry [Forms Index](#).

 Ministry of Forests, Lands and Natural Resource Operations		<b>Professional of Record – CONSTRUCTION ASSURANCE STATEMENT</b> - for Bridges, Major Culverts and Other Structures; submitted with record drawings and documents after construction	
Site No.	Structure No.	Road Name & Location:	Forest/Resource District:
Project/Contract No.		Watercourse Name:	Simple Crossing? <input type="checkbox"/> Yes/ <input type="checkbox"/> No
Type: <input type="checkbox"/> Bridge <input type="checkbox"/> Major Culvert <input type="checkbox"/> Other Structure (describe)			Was Field Welding or Grouting Required? <input type="checkbox"/> Yes/ <input type="checkbox"/> No
Description of Project covered by this statement:			
Name of the CRP for this Crossing Project:			
Design Vehicle Configuration (eg BCFS L100, BCL625):			Design Life (years):
List of Approved Design/Record Dwg's, Design Aides & other supporting documentation - Dwg No.s, Name, Revision #, Date:			

This is to advise that I am the Professional of Record (POR) and I am a:

- ☐ Professional engineer (P.Eng.), registered with the Association of Professional Engineers and Geoscientists of BC (APEGBC);
- ☐ Professional Forester (RPF) or Registered Forest Technologist (RFT), registered with the Association of British Columbia Forest Professionals (ABCFP)

- I completed the field reviews\* during construction for this crossing, consistent with the legislation for my profession, the [Guidelines For Professional Services In The Forest Sector – Crossings](#) as applicable to this project and by good practice.
- General Arrangement Design (For complex, non-simple crossings, design must be the responsibility of a P.Eng.):
  - ☐ I prepared the General Arrangement Design; or
  - ☐ Name of Professional of Record (POR) who prepared General Arrangement Design \_\_\_\_\_ P.Eng. OR RPF OR RFT (circle one)
- Based on the field reviews, I give my assurance\*\* that:
  - the work substantially complies in all material respects with the engineering concepts or intent reflected in the engineering design documents (approved design drawings, specifications, and all applicable supporting engineering documents), including all revisions;
  - any significant modifications from the crossing design documents:
    - ☐ have been approved by the POR that prepared the general arrangement designs, OR
    - ☐ the undersigned takes full responsibility for the modifications and significant modifications have been documented and marked on the attached Record (as-built) drawings and documents
  - where field welding was required, the welding was completed by a Division 3 or better CWB certified welding firm.

**Note:** POR signing Construction Assurance Statement required to be P.Eng. for crossings that include field welding or grouting.

Name of POR (please print):		(please affix professional seal here)	
SIGNATURE OF POR (P.ENG. OR RPF OR RFT - circle one)	DATE SIGNED YYYY MM DD		
Company Name and Address (please print):			
Phone No.	E-Mail Address:		

FS138

March 30, 2016

**Appendix 4.3: Forest Service Bridge Design Checklist**

## FOREST SERVICE BRIDGE DESIGN CHECKLIST



Forest District/Business Area	Road #	Site ID
FSR Name		Km
Stream Crossing Name		

DESIGN SPECIFICATION:	FIELD ENGINEER COMMENTS:
<b>EXPECTED LIFESPAN OF CROSSING:</b> _____ Years	
<b>STRUCTURE TYPE:</b>  temporary log stringer portable bridge permanent bridge major culvert:      fish passage? <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know  Considerations: <ul style="list-style-type: none"> <li>re-use of a portable superstructure will be determined by the designer as appropriate for the site</li> </ul>	
<b>DESIGN VEHICLE:</b>  BCL 625 <input type="checkbox"/> L100 <input type="checkbox"/> L165 Other(specify) _____  Considerations: <ul style="list-style-type: none"> <li>structure will be checked for any known overloads</li> </ul>	
<b>ANTICIPATED CONSTRUCTION PROCESS:</b>  design/supply/build design, then supply/build design, then supply, then build  Considerations: <ul style="list-style-type: none"> <li>separate purchase of materials in accordance with standardized requisitions and purchase orders</li> <li>all materials as per CSA standards, with structural elements to be inspected in plant by FLNR inspector;</li> <li>drawings in accordance with FLNR standards</li> <li>final drawings to be signed off by ministry bridge engineer as adequately addressing FLNR standards</li> <li>for design/supply/build, the engineer who prepares the conceptual design should normally be the CRP; for the other options, the EOR should also be the CRP; in either case, the ministry bridge engineer could be the CRP if that engineer's time is available.</li> </ul>	

<b>NAME OF DESIGNER (IF KNOWN):</b>	
-------------------------------------	--

Signature of Ministry/Ministry bridge engineer:	DATE SIGNED YYYY MM DD
---	---------------------------



## Appendix 4.4: Acceptance of Bridge and Major Culvert Drawings and Specifications

TO BE COMPLETED BY THE MINISTRY/MINISTRY BRIDGE ENGINEER **PRIOR TO CONSTRUCTION**

Forest District/Business Area	Project #	Site ID
FSR Name		Km
Stream Crossing Name		

I have reviewed the drawings and specifications identified as \_\_\_\_\_ and, in my opinion, they:

- address the ministry's requirements for the project, and
- provide for a structure that I would expect to be appropriate for the site.

Signature of Ministry/Ministry bridge engineer	DATE SIGNED YYYY M M DD
--	----------------------------------

### ***Appendix 4.5: FLNR Bridge Field Grouting Sampling Procedure***

This document provides procedures for making and curing cylinder specimens from representative samples of fresh grout being placed on Ministry of Forests, Lands and Natural Resource Operations bridges in the field.

Samples shall be taken during the field grouting processes for all Ministry of Forests, Lands and Natural Resource Operations (including BCTS) bridges incorporating field grouted structural connections. These include:

- precast concrete deck panels on steel or concrete girders, and
  - precast concrete slab girders with grouted shear key details.
1. Sampling of the grout shall occur at various times through the field grouting process, at roughly even intervals as the field grouting process progresses.
  2. The samples shall be taken using the FLNR supplied 50mm diameter X 100mm long plastic cylindrical molds.
  3. A minimum of 3 samples of each type of grout being used shall be taken using these procedures or as directed by the responsible ministry bridge engineer.
  4. Where Target Traffic Patch is used, a minimum of 3 samples of each of the coarse and fine grout shall be taken. Typically, coarse grout is used in the shear connections on slab bridges and for stud grout pockets and fine grout is used in deck panel joints for precast deck panel and girder composite action structures.
  5. Sampling procedure:
    - a. A sample of representative fully mixed grout that is ready for placing shall be taken.
    - b. Fill a cylindrical mold approximately halfway with grout.
    - c. Using a blunt non absorbent rod, approximately 15mm in diameter and 250mm in length (such as a spike head), uniformly over the cross section, rod the grout to the bottom of the mold 15 times.
    - d. Slightly overfill the mold with the second layer of grout and rod 15 times, evenly distributing over the cross section, and approximately 13mm into the bottom layer.
    - e. Strike off the top surface of the mold with a flat edge trowel, or other suitable straightedge, to remove excess grout and create a flat top surface.
    - f. Cover the mold with a damp cloth or paper towel and set the sample aside on site in a safe, flat location where the mold will not be disturbed for a minimum of 12 hours or overnight. The location should be representative of the conditions of the placed grout such as on the deck of the grouted surface or on the inside flange of a steel girder. Longer field curing times shall be at the discretion of the ministry bridge engineer.
    - g. Ensure that a supplied, self adhesive, label is completed and placed on each grout sample.
  6. Grout samples shall be provided to the ministry bridge engineer or provided to the individual identified in contract documents or specifications.

## 5. Road Construction

### 5.1 Introduction

Successful construction involves building Forest Service roads that are appropriate for their expected service life while at the same time minimizing impacts on forest resources and other values.

The purposes of this chapter are to provide:

- the mandatory requirements for road construction on FSRs; and
- best practices for forest road construction activities that will assist ministry staff in achieving the statutory and regulatory requirements in the [Forest and Range Practices Act](#) and the [Forest Planning and Practices Regulation](#).

### 5.2 Policy

All Forest Service roads will be constructed in a manner that considers road user safety, values at risk of damage or loss and cost efficiency.

### 5.3 Mandatory Procedures and Best Practices

Following is a table that summarizes in approximate chronological order the mandatory procedures and best practices with respect to the construction of Forest Service roads. Links are provided to direct the reader to the location in the manual text where the tabular item is discussed.

**Table 5-1 Road Construction**

Results to be achieved:

- minimize the clearing width (FPPR s. [78](#))
- do not cause sediment transport through mass wasting processes that would have a material adverse effect on forest resources (FPPR s. [37](#), [38](#), [57](#), [59](#), [69](#), [70](#), [72](#), [106.2](#))
- maintain natural surface drainage patterns (FPPR s. [39](#))
- no construction of a road in a riparian management area (FPPR s. [50](#))
- no fan destabilization that would have a material adverse effect on forest resources (FPPR s. [54](#))
- protect stream channel and banks (FPPR s. [55](#))
- protection of fish passage and fish habitat (FPPR s. [56](#), [57](#))
- protection of water quality (FRPA s. [46](#), FPPR s. [59](#))
- no construction near licensed waterworks in community watersheds or springs in a community watershed (FPPR s. [60](#), [62](#))
- address general wildlife measures, and resource or wildlife habitat features (FPPR s. [69](#), [70](#))
- road is safe for industrial use (FPPR s. [72](#))

Legislation supported: FPPR sections [37](#), [38](#), [39](#), [40](#), [50](#), [54](#), [55](#), [56](#), [57](#), [59](#), [60](#), [62](#), [69](#), [70](#), [72](#), [76](#), [78](#), [84](#), [106.2](#): all road –related items

B1. Ensure that the road construction is carried out in accordance with a design approved by a Qualified Registered Professional, subject to changes necessitated by site conditions and approved by the designer

[see [General Road Construction Practices, Section 5.4](#)].

Legislation supported: FPPR section 78: minimize clearing width

- B2. Minimize the clearing width, while accommodating the topography, user safety and operational requirements [see [Establishing Clearing Widths, Section 5.5.2](#)].

Legislation supported: FPPR sections 37, 38, 57, 59, 69, 70, 72, 106.2: do not cause sediment transport through mass wasting processes that will impact user safety or have a material adverse effect on forest resources

- B3. Do not deposit debris resulting from grubbing and stripping within the clearing width in areas where the debris could have a material adverse effect on forest resources and other values [see [Disposal of Debris, Section 5.7](#)].
- B4. In areas of moderate to high landslide potential, remove all organic debris from within the road prism width [see [Disposal of Debris, Section 5.7](#)].
- B5. Locate disposal sites and place debris at a disposal site to ensure that activities do not cause a landslide, gully processes on the Coast, or uncontrolled erosion and sediment transport that have a material adverse effect on forest resources and other values [see [Disposal of Debris, Section 5.7](#)].
- B6. To maintain slope stability in areas having steep slopes or unstable (or potentially unstable) terrain, consider applying full bench and partial bench construction techniques [see [Full Bench, Section 5.8.8](#)].
- B7. Ensure that rock drilling and blasting techniques minimize the potential for landslides or slope instability [see [Rock Excavation, Section 5.8.11](#)].
- B8. Shut down road construction work before slope stability is in question, or landslides occur [see [Shutdown Indicators, Section 5.14](#)].

Legislation supported: FPPR section 39: maintain surface drainage patterns

- B9. To maintain surface drainage patterns, keep water in its own drainage area, unless moving it to another area is necessary to avoid unstable or sensitive soils [see [Maintaining Surface Drainage Patterns, Section 5.10.1](#)].

Legislation supported: FPPR section 50: no construction in riparian management areas, except as provided

- B10. Do not locate borrow pits or disposal sites in a riparian management area [see [Location of Disposal Sites, Section 5.7](#)].
- B11. Ensure that there are no subgrade construction works within a riparian management area, unless otherwise exempted from this requirement by regulation [see [Riparian, Section 5.8.2](#)].

Legislation supported: FPPR section 54: no fan destabilization on the Coast

- B12. Ensure that road construction works do not cause fan destabilization on the Coast that will result in material and adverse effects on other resources [see [Fan Destabilization, Section 5.8.3](#)].

Legislation supported: FPPR section 55: protect stream channel and banks

- B13. Ensure that the disturbance to the stream channel and the stream bank at the crossing are mitigated to the extent that the original conditions are reasonably restored. Also, ensure that despite the works at the crossing, the stream banks above and below the crossing are protected [see [Culverts, Section 5.10.8](#)].
- B14. Use culvert outlet protection where discharge velocities and energies at the outlets of culverts, conduits or

channels are sufficient to erode the immediate downstream reach [see [Culverts](#), [Section 5.10.8](#)].

Legislation supported: FPPR sections [56](#) and [57](#): protection of fish passage and fish habitat

B15. Ensure that any culverts constructed on a fish stream do not impede fish passage or harmfully alter fish habitat [see [Culverts on Fish Streams](#), [Section 5.10.9](#)].

B16. Ensure that roads on fans are constructed to account for identified hazards on a fan [see [Fan Destabilization](#), [Section 5.8.3](#)].

Legislation supported: FRPA section [46](#): protection of the environment and FPPR section [59](#): protection of water quality

B17. To minimize sediment delivery to streams, do not discharge the water conveyed in ditches and cross-drain culverts directly into streams [see [Maintaining Surface Drainage Patterns](#), [Section 5.10.1](#)].

B18. For snow and winter roads, do not mix soil with snow in the riparian management area of stream crossings [see [One-Season](#), [Section 5.12.2](#)].

B19. Ensure that debris is placed at disposal sites so as to protect against sediment transport that will have a material adverse effect on forest resources and other values [see [Disposal of Debris](#), [Section 5.7](#)].

B20. When constructing permanent roads, minimize the placement of snow, ice, and frozen material in the road fill [see [Winter Construction](#), [Section 5.9.2](#)].

B21. When constructing fords, consider:

- armouring ditches with non-erosive material;
- directing runoff into sediment basins or other sediment trapping devices; and
- capping the road surface with erosion-resistant material on either side of the ford for an appropriate distance

[see [Ford Construction](#), [Section 5.10.10](#)].

B22. To minimize sediment transport away from the road prism and disposal sites, consider using sediment control techniques [see [Sediment Control](#), [Section 5.13.2](#)].

B23. Ensure that roads on fans are constructed to account for identified hazards on a fan [see [Fan Destabilization](#), [Section 5.8.3](#)].

B24. Surface the subgrade with pit-run gravel or crushed rock aggregate where subgrade material is highly erodible and needs to be protected from water or wind action [see [Surfacing](#), [Section 5.11.2](#)].

B25. Determine when forest road operations are to be shut down because the works are causing, or may imminently cause, environmental damage [see [Shutdown Indicators](#), [Section 5.14](#)].

Legislation supported: FPPR sections [60](#), [62](#): no construction near licensed waterworks in community watersheds or springs in a community watershed

B26. Unless there is an exception in accordance with FPPR, ensure that the road is constructed so as not to damage a licensed waterworks and to achieve at least 100m distance from any such waterworks or springs in community watersheds [see [Licensed Waterworks](#), [Section 5.8.1](#)].

Legislation supported: FPPR sections [69](#), [70](#): general wildlife measures, and resource or wildlife habitat features

B27. Ensure that a road is constructed in accordance with any general wildlife measures that may be in place (as identified in the road layout process), and the construction activities do not damage and resource or wildlife habitat features [see [Wildlife](#), [Section 5.14](#)].

Legislation supported: FPPR section 72: roads and structures are safe for industrial users
B28. Construct turnouts and widenings at locations and to specifications in accordance with the road design to allow safe passage of expected vehicles types on single lane roads [see <a href="#">Turnouts</a> , <a href="#">Section 5.9.3</a> ].
B29. Should a ford become unsafe for traffic during high water, take measures to warn and exclude users for that period [see <a href="#">Ford Operating Constraints</a> , <a href="#">Section 5.10.10</a> ].
Legislation supported: FPPR section 76: culvert materials
B30. Ensure that any permanent culvert materials are fabricated in accordance with the current Canadian Standards Association specifications [see <a href="#">Road Drainage</a> , <a href="#">Section 5.10</a> ].
Legislation supported: FPPR section 40: revegetation
B31. To minimize surface soil erosion after road construction on all soils exposed that are subject to weathering, cover them with grass and legume vegetation [see <a href="#">Soil Erosion</a> , <a href="#">Section 5.13.1</a> ].
Legislation supported: FPPR sections 37, 38, 39, 40, 50, 54, 55, 56, 57, 59, 60, 62, 69, 70, 72, 76, 78, 84, 106.2: all road –related items
B32. Ensure that a Qualified Registered Professional completes a Statement of Road Construction Conformance [see <a href="#">Statement Appendix 5.3</a> ].
B33. Ensure that there is a field inspection to monitor the completeness of the professional certification and to incorporate as-built information into the applicable data base [see <a href="#">General Road Construction Practices</a> , <a href="#">Section 5.4</a> ].
B34. For those roads built by a TSL holder under road permit, and identified as becoming FSRs after construction, ensure that a BCTS/District engineering technician carries out a final field inspection to confirm the suitability of the road construction [see <a href="#">General Road Construction Practices</a> , <a href="#">Section 5.4</a> ].
B35. Ensure that the necessary steps in the road construction processes were undertaken and issues addressed [see <a href="#">Project Tracking Checklist Appendix 5.2</a> ].

<sup>1</sup> In the above table of chronological events:

Mandatory Procedures are marked



and Best Practices are marked



## 5.4 General Road Construction Practices

An essential outcome of any road construction is that it is in general conformance with the approved design and specifications. The design and specifications are based on the road layout outputs, and the outcomes covered off in the road site plan that is prepared after the FSP. Ensure that the road construction is carried out in accordance with a design approved by a Qualified Registered Professional, subject to changes necessitated by site conditions and approved by the designer.

Upon completion of construction, ensure that there is a field inspection to monitor the completeness of the professional certification and to incorporate as-built information into the applicable data base.

For those roads that are built by TSL holders under road permit, and have been identified as becoming FSRs after construction, it may be appropriate for a

BCTS/District engineering technician to carry out a final inspection to confirm the suitability of the works.

## **5.5 Road Corridor Preparation**

### **5.5.1 Preparing the Site**

Site preparation along the road corridor includes all works associated with logging the timber within the right-of-way, including development of pilot trails and skid trails, skidding or yarding, and loading and sorting. Such work may also include the relocation of timber decks or other logistical operations to facilitate construction activities. Grubbing, stripping, and disposal of all unsuitable materials not used in subgrade construction are also considered part of site preparation.

Assess the right-of-way corridor for the presence of any dangerous trees and remove any such trees.

### **5.5.2 Establishing Clearing Widths**

Establish clearing widths to facilitate the construction, use, and maintenance of forest roads. For natural slopes up to 60% slope angle, determine clearing widths from the tables in [Appendix 5.1: Tables to Establish Clearing Width](#). For slopes greater than 60% slope angle, or in areas of moderate or high likelihood of landslides, determine clearing widths from the geometric road design.

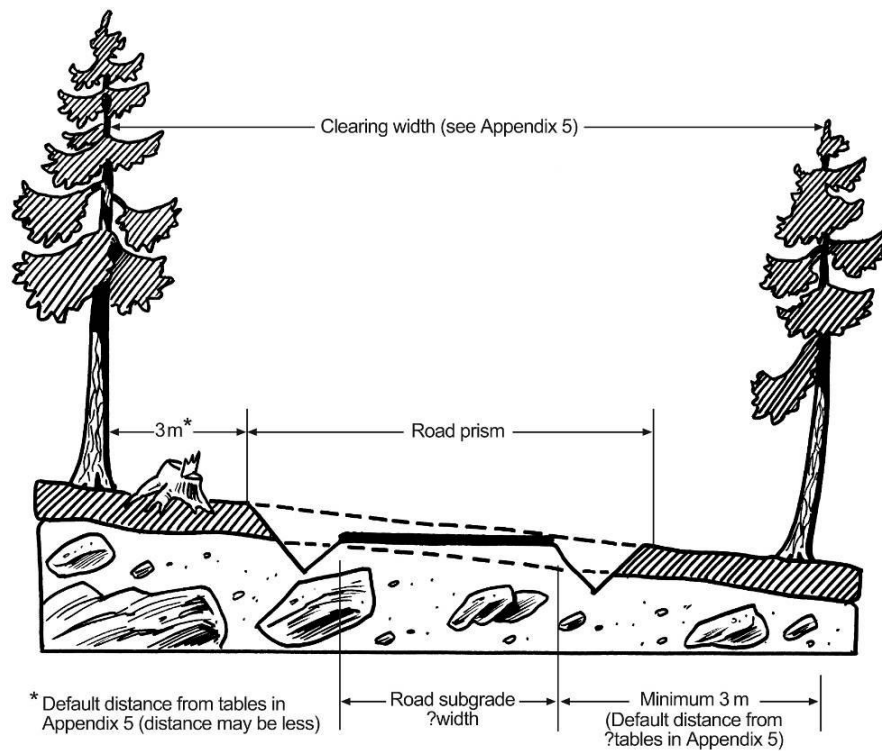
Consideration ***must*** be given to not create hazards for any subsequent potential operations not only within the right of way but in operational forest areas outside this area and especially on the downhill side. (i.e. hazards might include timber decks supports by standing timber, rock supported on slopes by timber to be felled or otherwise in unstable positions. Should hazards be created inadvertently than mitigation strategies and communication to subsequent employers ***must*** be arranged.

The objective when establishing clearing widths is to minimize the width of the clearing, yet accommodate:

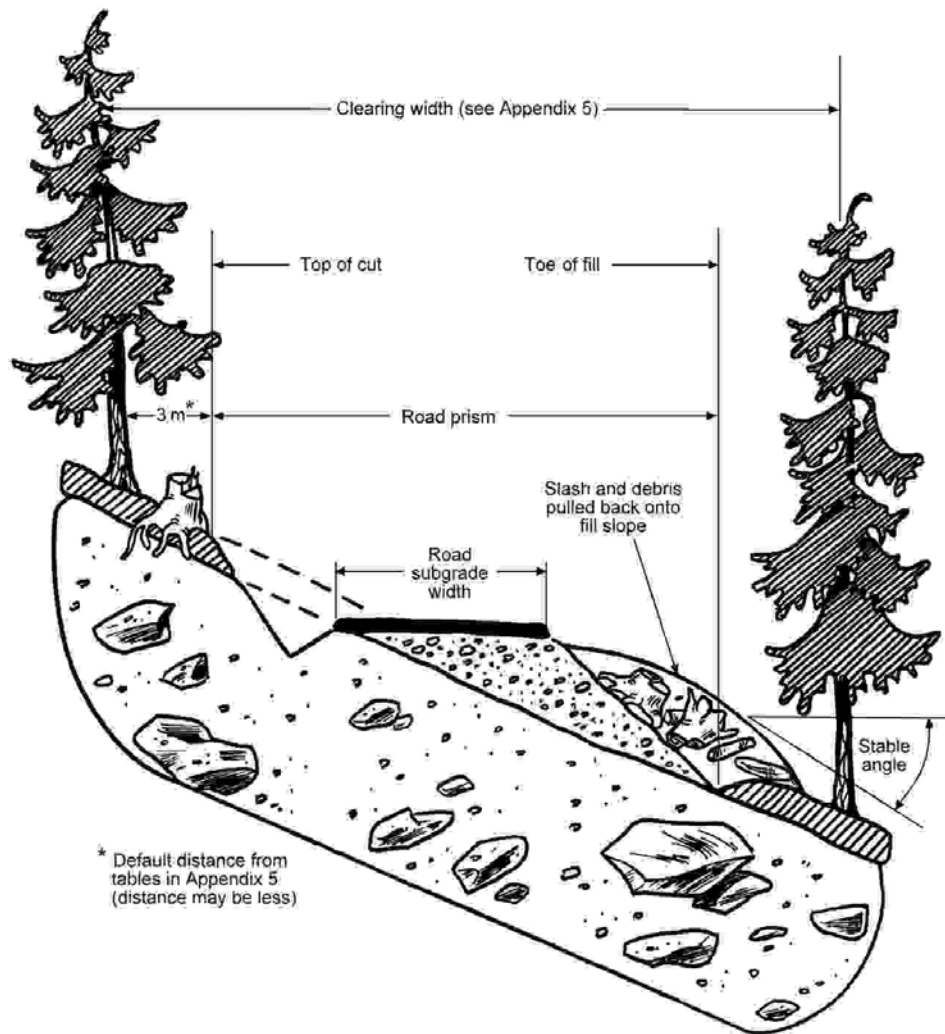
- the road prism;
- user safety;
- decking of right of way timber;
- turnouts;
- subgrade drainage;
- subgrade stability;
- waste areas and endhaul areas;
- pits and quarries;
- landings;

- slash disposal;
- equipment operation;
- snow removal;
- fencing and other structures; and
- standing timber root protection, especially on cut banks.

**Figure 5-1 Typical roadway on gentle slopes with no additional clearing**





**Figure 5-2 Typical permanent roadway on moderate slopes (best practice)**

### 5.5.3 Marking Clearing Widths

Mark clearing widths in the field, usually with flagging tape, so that the clearing boundaries are clearly visible for machine operators or hand fallers to follow.

Ensure that trees that are marked to establish the clearing width remain after the clearing operation is completed. Leave standing those trees that are on the boundary unless the roots will be undermined by operations within the clearing width. Where slope staking is not required, use the flagging as an offset line to establish the top of cut for grade construction.

### 5.5.4 Establishing Pilot Trails

Frequently, pilot trails or tote roads are built within the clearing width before falling begins. These trails provide access for the faller (hand or mechanical), a route for skidding felled timber to a landing or collection point, and temporary access along the road corridor.

Terrain and soil conditions govern the location of the pilot trail within the clearing width. Generally, construct the trail below the flagged centreline on side hills, near the lower clearing width limits. This allows for easy access to skid-fallen timber, and allows for the toe of the road fill to be keyed into the slope. Where drilling and blasting are required, build the trail above the road centreline, just below the upper clearing limit, to permit vertical drilling of the rock cut.

Ensure that care is taken to remove debris from the downslope during the right-of-way logging phase unless the debris can reasonably be reached by equipment operating on the surface of the pilot trail or final road subgrade.

Install drainage structures concurrently with pilot trail construction, including temporary stream crossings that may be required during the road construction phase until the permanent crossing is constructed. For further details, see [5.10: Road Drainage](#).

### **5.5.5 Felling and Yarding Within the Clearing Width**

#### **Felling Methods**

Several methods for falling trees within the clearing width are available depending on terrain, soil conditions, timber size, and total volume.

Fell all standing merchantable and non-merchantable timber along any section of road subgrade remove the timber before construction. Ensure that timber does not become buried under soil, rock, and debris, and the wood is accessible for future retrieval from the road subgrade.

Further information about falling is contained in the [British Columbia Occupational Health and Safety Regulation](#) (Sec. 26.11 and 26.21 to 29.30) and the [WorkSafeBC Guidelines \(Part 26\)](#).

#### **Landings**

Locate landings within the clearing width so as not to interfere with other operations. Ideally, show landing locations on the construction drawings and mark them in the field.

#### **Protecting Streambanks During Felling Operations**

Before felling begins, ensure that streams and their associated riparian management areas and the “machine-free zones” identified on operational plans have their buffer zones flagged in the field. Use appropriate directional falling techniques to protect these areas. For further information, refer to the [Riparian Management Area Guidebook](#).

#### **Protecting Streambanks During Yarding Operations**

Yarding operations can result in streambank destabilization. Prevent this damage by yarding away from streams, not across them.

## Removing Debris from Streams

Where debris is accidentally introduced into the stream, carry out clean-up concurrently with clearing operations. Mitigate without delay any stream bank damage, outside of designated crossings.

## Dangerous Trees

Identify all dangerous trees outside the clearing width deemed hazardous to road workers or users and fell them as part of the falling phase of site preparation. See [5.5.1: Preparing the Site](#)

## 5.6 Grubbing and Stripping

Grub and strip the road prism area of all topsoil and unsuitable mineral soils after all standing timber has been felled and removed, unless the following are applicable:

- between the tops of cuts and adjacent standing timber (other than trees and stumps with exposed roots or roots that overhang the top of cut);
- between the toes of fills and adjacent standing timber; and
- where short-term roads – that is, one-season winter use roads or snow roads—are constructed or where overlanding techniques are applied.

“Grubbing” means the removal of stumps, roots, buried logs, and logging slash (downed logs, tree branches and tops, and uprooted stumps, trees, and shrubs) and other debris left on the ground from clearing operations. “Stripping” means the removal of topsoil or other organic material, and mineral soils unsuitable for forming the road subgrade.

Where grubbing operations have removed all organic soil, stripping is not required unless other unsuitable soils are encountered.

## 5.7 Disposal of Debris

Disposal of debris consists of the disposal of material resulting from grubbing and stripping operations within the clearing width. (For ease of reference, this material is simply called “debris” in this chapter.)

Accomplish disposal of debris by:

- piling and burning;
- scattering;
- burying; or
- endhauling it to a suitable disposal site for debris.

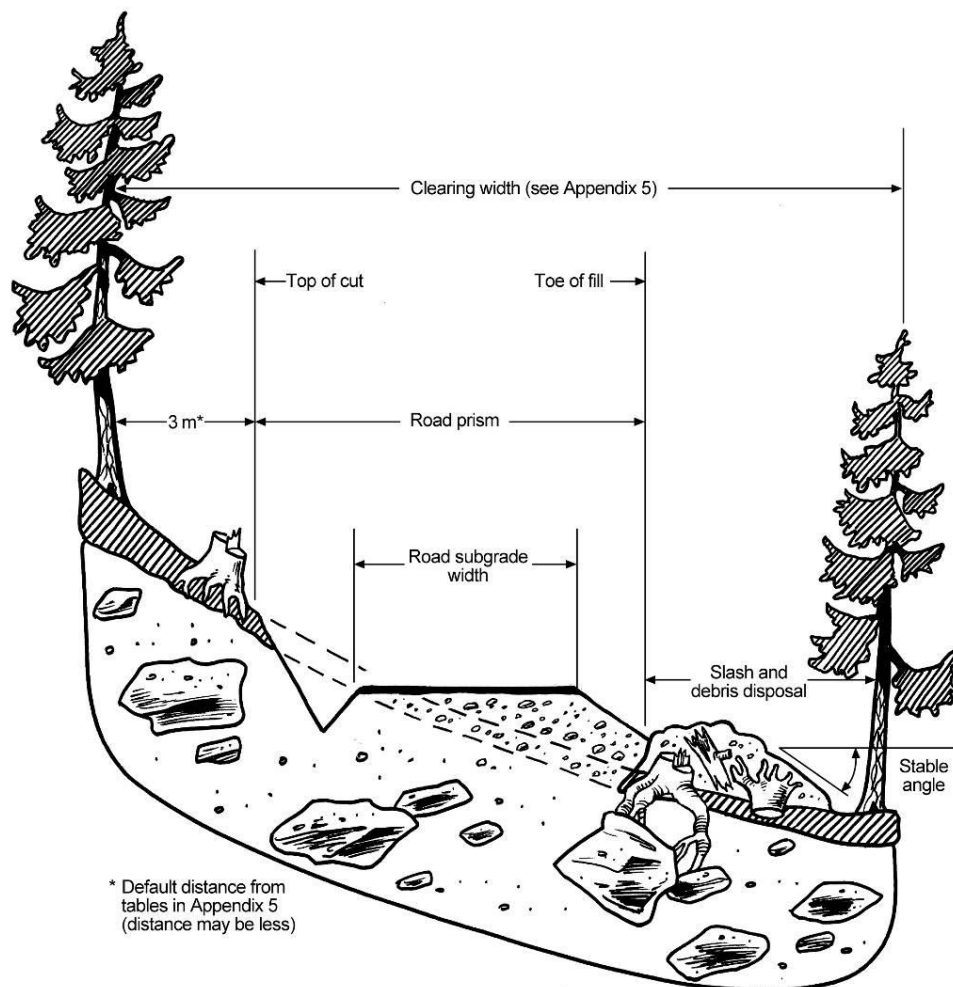
Do not deposit debris resulting from grubbing and stripping within the clearing width in areas where the debris could have a material adverse effect on forest resources or create hazards for any subsequent operations and/or adversely affect

other values. In addition to any other required mitigation actions to prevent damage, immediately remove any debris that is deposited in such areas.

Ensure that the selected method of debris disposal:

- meet objectives of higher level plans (such as those for smoke management, aesthetics, or pest management);
- are compatible with terrain conditions;
- consider the slash volume, loading, species, and piece sizes;
- do not alter natural drainage patterns; and
- are compatible with other resource values.

**Figure 5-3 Debris placement for permanent road on terrain having a low likelihood of landslides (acceptable practice)**

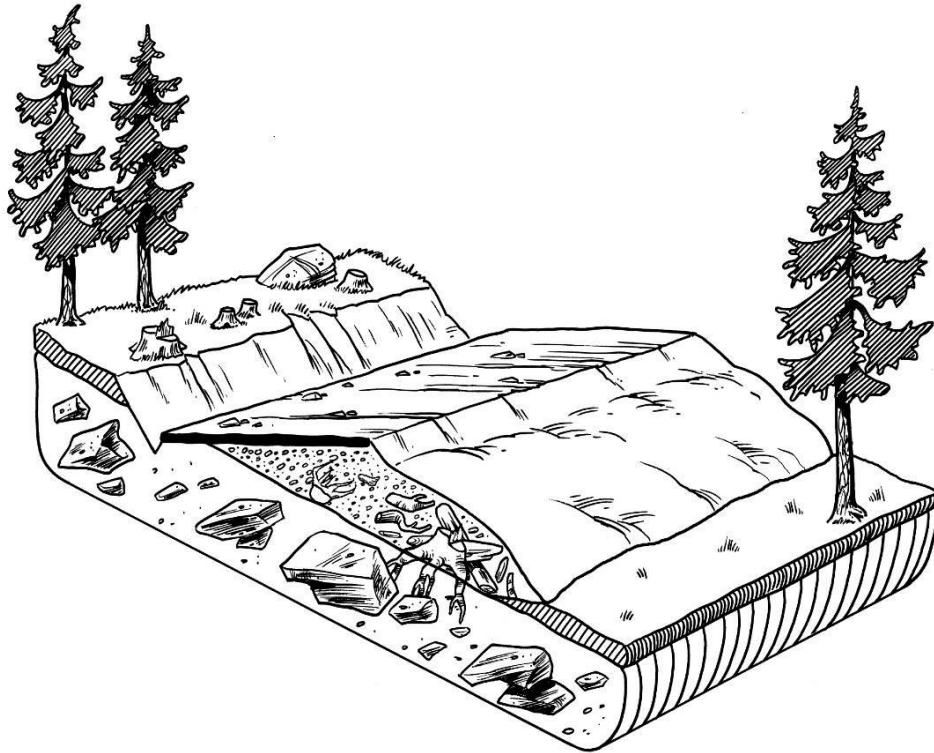


Carefully plan and locate disposal sites for debris, and suitably place material to:

- provide for adequate support of the debris;

- maintain natural surface drainage patterns; and
- ensure that activities do not cause a landslide, gully, or uncontrolled erosion and sediment transport that have a material adverse effect on forest resources and other values.

**Figure 5-4 Debris placement on typical short-term road**



Do not place debris within the high-water mark of a water body (stream, wetland, lake) or in a manner that is likely to cause the debris to fall into a water body.

Generally, remove all organic debris from within the road prism width (Figure 5-2). However, where the road crosses areas not having a moderate or high likelihood of landslides, then incorporate stumps, roots, and embedded logs in the road prism as follows:

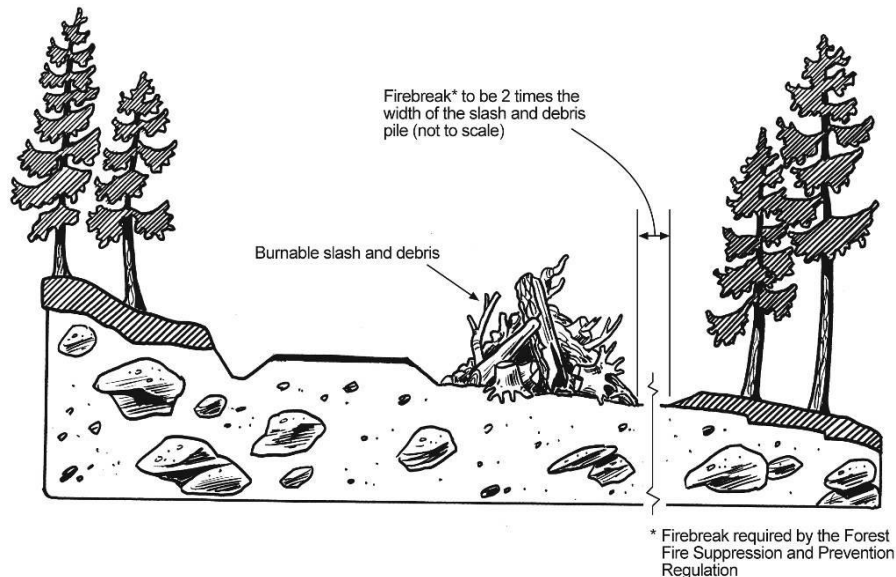
- leave or place stumps, roots, and embedded logs outside the road subgrade width on the downhill side (Figure 5-3).
- for a short-term road (Figure 5-4), leave or place stumps, roots, and embedded logs within the road subgrade width. For more information about short-term roads, see [5.9.1: Construction of Short-Term Roads](#).

For either of the two situations above, report the presence of stumps, roots and embedded logs in the road prism as a part of as-built information. See [Workers' Compensation Act: Occupational Health and Safety Regulation \(Sec 26.79\)](#).

### 5.7.1 Piling and Burning

Consider piling and burning (Figure 5-5) in areas with heavy slash loading and moderate to high pest or fire hazard, and where smoke management objectives can be met.

**Figure 5-5 Debris disposal by piling and burning**



### 5.7.2 Scattering

This process is similar to mounding and windrowing, but does not require the debris to be buried ([Figure 5-6](#)). In low-density stands, spread debris among the standing timber in natural openings along the cleared area, thus reducing the clearing width required for disposal. Take care to avoid damaging the standing timber or eliminating plantable spots if the road is being constructed through an area proposed for eventual planting.

Place logs and stumps away from adjacent timber stands, positioned so they will not roll and so that they do not lie on top of one another.

Consider scattering where:

- sidecasting debris will not increase the likelihood of landslides;
- fire and pest hazards are low; and
- aesthetic concerns are not an issue.

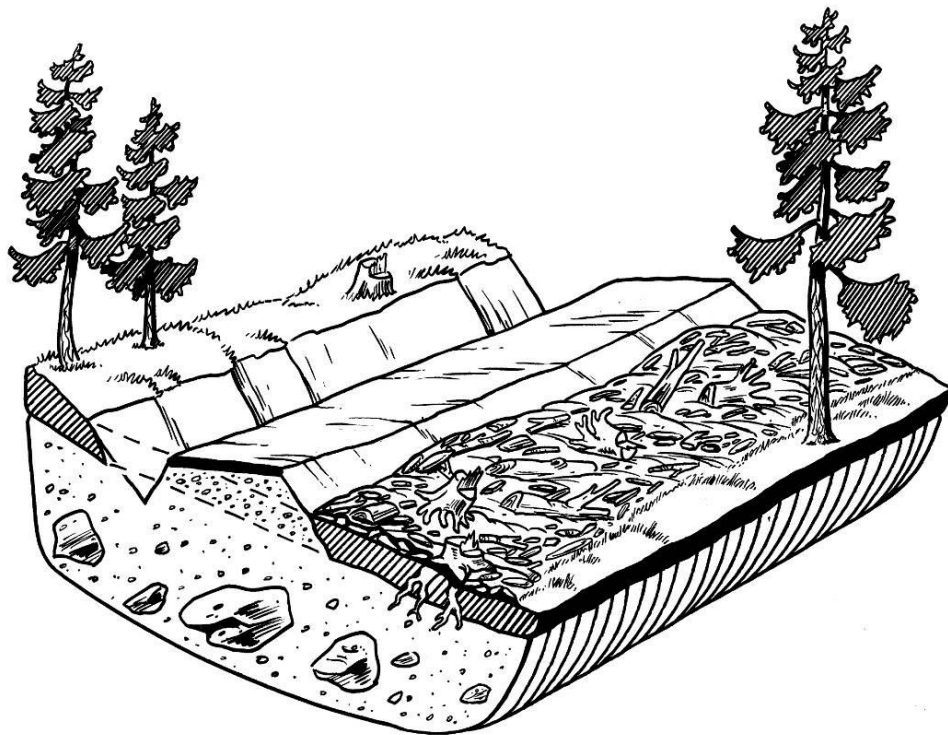
Incidental burying may occur, but is not an objective. If the debris is bunched or spread, breach any continuous accumulations to accommodate drainage, snow removal, and wildlife passage.



Consider chipping or grinding up debris and then blow it along the cleared area or into the standing timber, away from watercourses, to help limit erosion of exposed soils and facilitate revegetation.

Breach accumulations of debris at all culvert locations to facilitate drainage. Remove debris accumulations at some locations where needed to permit the natural passage of livestock and wildlife.

**Figure 5-6 Debris disposal by scattering**



### 5.7.3 Burying

There are three methods for burying debris with soil materials:

- trenching;
- mounding or windrowing; and
- creation of pushouts.

Place all debris between the edge of the structural fill and standing timber ([Figure 5-7](#)), unless otherwise indicated in the construction drawings. Arrange the surface profile of the debris so as to imitate existing ground profiles. Next, compact the debris and then cover it with a layer of soil at least 300 mm thick. Compaction minimizes the hazards to livestock and wildlife stumbling in holes in the buried debris.

As well, place buried debris so as not to interfere with:

- roadway drainage, utilities, planned road improvements, snow removal,

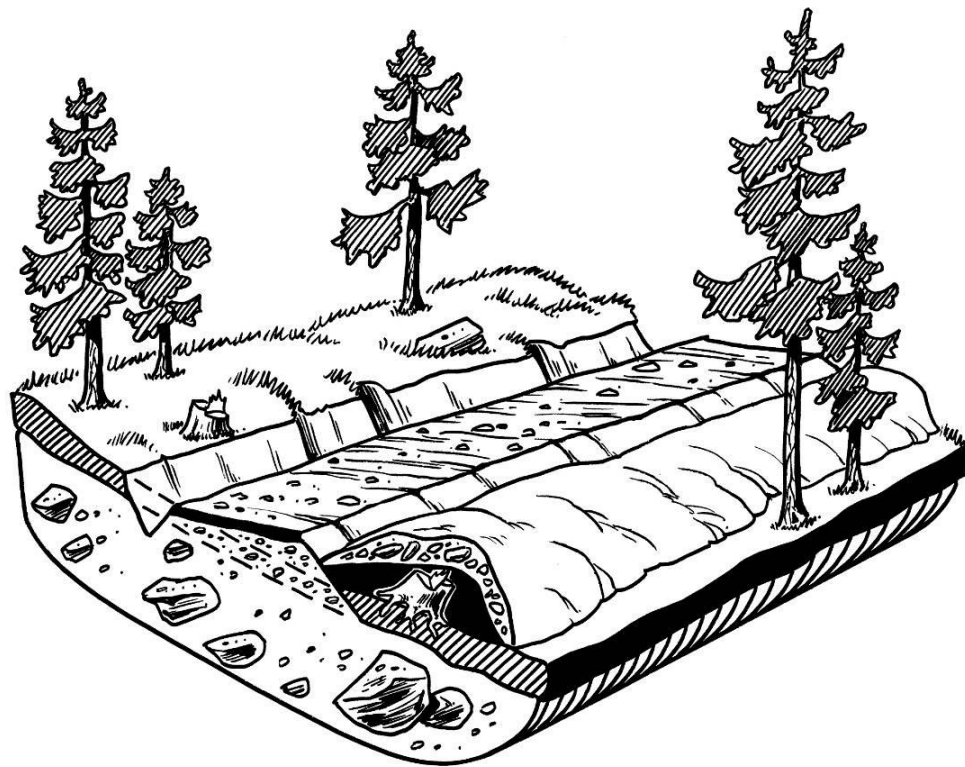
design sight distance, future developments, or standing timber; and

- any watercourse.

Furthermore, breach any resulting berms at each culvert location to facilitate drainage, and at other specified locations to permit the usual passage of livestock and wildlife.

Calculate the volume of debris and of soil cover per lineal metre of road. Generally, for every cubic metre of debris, utilize a metre of clearing for its disposal. When excessive debris volumes are encountered, consider other disposal methods.

**Figure 5-7 Debris disposal by burying**



### **Trenching**

This method takes advantage of trenches that usually result from a particular subgrade construction technique, and not normally where a trench is dug solely for the purpose of burying debris. It works well where usable subgrade material occurs fairly continuously below a veneer of unsuitable soil. Use the excavated trench material to raise the subgrade above the normal ground line. Do not use trenching on natural slopes with greater than 20% slope angle, because it could undermine the road surface and cause long-term subgrade instability.

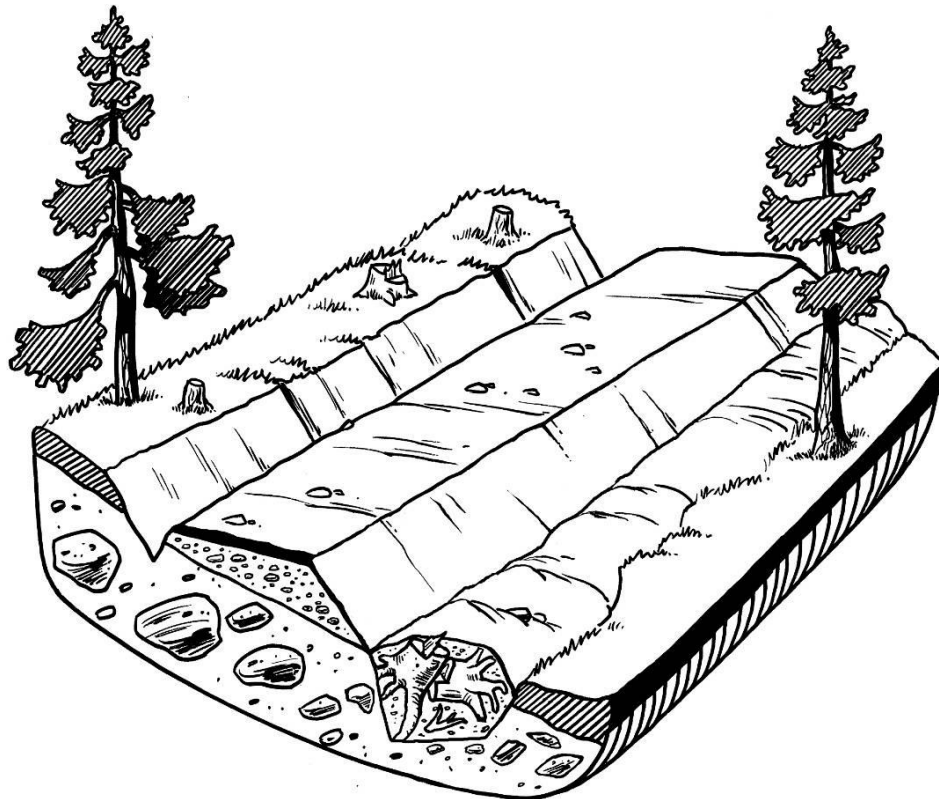
Place the debris in the resultant trench rather than spreading it over the ground surface. Determine the required size of the trench from the volume of debris to be



buried. However, to minimize the size of the cleared area overall, use a deep, narrow trench instead of a shallow, wide trench ([Figure 5-8](#)).

To prevent undermining tree roots, leave 3m of cleared width between any standing timber and the trench. Ensure that the trench lies parallel to the roadway and is either continuous or intermittent, depending on the volume of debris. Place the woody debris on the bottom of the trench and compact it before covering it with soil and other strippings from the road prism.

**Figure 5-8 Debris disposal by trenching**



### **Mounding or Windrowing**

With this method, accumulate all debris along one side of the cleared width between the road prism and the standing timber. Put into place the woody debris and then compact it with the grubbing equipment. Use stripped material from the road prism to cover the debris with additional mineral soil, as required, to ensure coverage by at least 300mm thickness of soil. Because of the difficulty of maintaining an adequate thickness of soil cover on the downslope side, the results of this method are not easy to control on natural slopes with greater than 50% slope angle.

## **Creation of Pushouts**

Locate pushouts in natural openings along the cleared area and ensure that they are appropriate for the volume of material to be disposed. Do not push debris into standing timber and properly groom the piles to be stable and visually acceptable.

### **5.7.4 Endhauling Debris for Disposal**

Where debris or other unsuitable material cannot be disposed of outside of the road prism or within the clearing width, endhaul it (i.e., load and haul) to a suitable disposal site for debris. Endhaul debris from the road corridor in:

- steep or unstable terrain where this material is removed to maintain slope stability; and
- areas with high recreational value where aesthetics may be an issue.

### **5.7.5 Location of Disposal Sites for Debris**

Identify all disposal sites for debris before construction. Ensure that an approved disposal site for debris is stable, well drained, and isolated from streams or wet sites; and does not have a material adverse effect on forest resources and other values. Sometimes, prepare and bench disposal sites in advance to enable stable placement of the endhauling debris. Avoid overloading of slopes. Where possible and practical, stockpile organic and fine-textured debris for placement over depleted borrow and gravel pits, quarries, and disposal sites for excavation spoil, as a means of facilitating revegetation.

Dispose of the debris endhauling to an approved disposal site by piling and burning, scattering, or burying. Whichever disposal method is used, ensure that the top of any remaining debris material is below the road surface (to allow for snowplowing and sight distance) and placed in a manner to allow surface water to drain away from the road.

Carefully place and pile debris to maintain slope stability at all times, and take measures control erosion and sediment transport.

## **5.8 Subgrade Construction**

### **5.8.1 Construction Near Licensed Waterworks**

Licensed waterworks have been identified as part of the road layout and road survey and design processes. Based on the information gathered through those processes, and for any other licensed waterworks discovered during construction of the road, unless there is an exception in accordance with FPPR, ensure that the road is constructed so as not to damage a licensed waterworks and to achieve at least 100m distance from any such waterworks or springs in community watersheds.

Additionally, ensure that at least 48 hours notice of impending construction work is provided to water licensees or water purveyors in community watersheds.

### 5.8.2 Construction in Riparian Management Areas

Ensure that a road is constructed in accordance with the layout and the design, such that there are no subgrade construction works within a riparian management area, unless otherwise exempted from this requirement under FPPR, section 50.

### 5.8.3 Fan Destabilization

Fans can be the runout zones for debris flows and can be influenced by over-bank flows during debris floods and floods. These events are not rare and can impact roads on fans. Conversely, roads can exacerbate the effects of these events. FRPA recognizes fan destabilization on the Coast; province-wide, FRPA recognizes impacts to fish habitat and forest soils—impacts that can result from fan destabilization. There may be a range of causes of fan destabilization as a result of road construction, and a variety of potential mitigative practices (see [Land Management Handbook 57 Forest Management on Fans Hydrogeomorphic Hazards and General Prescriptions](#)). Ensure that the following practices are carried out when constructing roads on fan landforms that are identified along the proposed route:

- explore each fan for evidence of debris flows, debris floods, and floods,
- build to account for the identified hazards with attention to the specific location of the crossing on the fan, the need, if any, for climbing roads, drainage structure size and configuration, and excavations into the stream channel or banks.

### 5.8.4 Wildlife Measures and Features

Ensure that a road is constructed in accordance with any general wildlife measures that may be in place (as identified in the road layout process), and the construction activities do not damage resource or wildlife habitat features.

### 5.8.5 Construction Surveys

Where the location and volumes of road building materials are critical, carry out construction surveys to re-establish the road centerline, to determine the limits of the cut and fill slopes, and to provide grade control during construction. Preferably, carry out construction surveys after clearing and grubbing operations, but before primary excavation begins.

### 5.8.6 Modifying the Road Layout and Design

If the road design does not reflect the field conditions actually encountered after the clearing operations, then modify the design to address those unforeseen conditions. Should a professional prescription not reflect actual field conditions, or if the layout and design revisions affect a prescription to maintain slope stability, then ensure that any design changes are reviewed and approved by a qualified registered professional before construction begins.

### 5.8.7 Sidecast Construction

Where terrain stability is not an issue, cut and fill (sidecast) is a common forest road building technique. During sidecast construction, excavated material from the uphill slope is placed on the downhill slope (using crawler tractors or excavators) to form a fill to support the outside portion of the running surface of the road ([Figure 5-2](#)). If this fill material is not properly compacted, settlement will likely occur, leading to slumping at the shoulders and the creation of settlement or tension cracks in the road surface. Refer to the suggested cut and fill slope angles in [Chapter 3, Table 3-4](#).

Do not use topsoil and debris, and saturated and other unsuitable soils, as road fill. Rather, remove them, because they have a very low strength and can readily fail under vehicle loading. In areas having a low likelihood of landslides, however, consider placing stumps, roots, and embedded logs outside of the subgrade width ([Figure 5-3](#)).

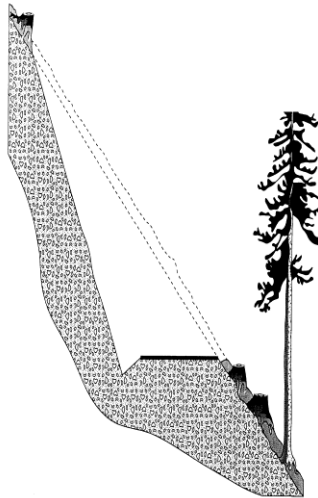
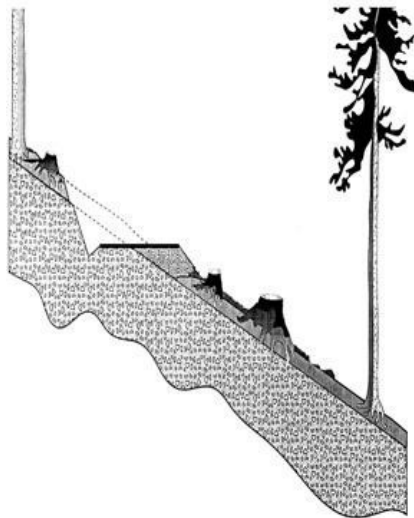
Key in or notch the fill material into the slope, after all organic material and unsuitable soils have first been removed from the road prism. Ensure that the notch is sufficiently wide to allow equipment to work. Build up the fill in shallow lifts and compact it using the road-building machinery—or, ideally, roller compactors. Properly compacted fills have a higher load-carrying capacity, and tend to shed water rather than absorb it. This results in a more stable, erosion-resistant subgrade that requires less maintenance while minimizing the potential for adverse environmental impacts.

### 5.8.8 Full Bench and Partial Bench Construction

To maintain slope stability in areas having steep slopes or unstable (or potentially unstable) terrain, consider applying full bench and partial bench construction techniques. Base the decision to use these techniques for this purpose on the results of a Terrain Stability Assessment prepared by a qualified registered professional. Refer to [Guidelines for Terrain Stability Assessments in the Forest Sector](#) (published by the Association of Professional Engineers and Geoscientists of British Columbia).

Full bench construction involves cutting a bench into the side hill equal to the width of the road (including the ditch). Transport all the excavated material (endhaul) to an approved disposal site for excavation spoil, unless otherwise prescribed by a qualified registered professional.

Partial bench construction is similar to the full bench construction technique except that the bench is less than the full width of the road, with the remaining road width built on sidecast fill. To maintain slope stability, transport (endhaul) the surplus excavated soil and rock material to an approved disposal site for excavation spoil, but do not place it along steep slopes below the road unless prescribed by a qualified registered professional.

**Figure 5-9 Full Bench****Figure 5-10 Partial Bench**

### 5.8.9 Endhauling Surplus Excavation Materials

“Endhauling” during road building is the loading, hauling, and placing of surplus excavated soil and rock material (excavation spoil) from a construction site either to a different location along the road for use in road fills (if required and if the materials are suitable) or to an approved disposal site for excavation spoil.

### 5.8.10 Location of Disposal Sites for Excavation Spoil

Identify potential disposal sites for excavation spoil during the field reconnaissance or survey and design, and incorporate them into the final road design. Ensure that such sites take advantage of swales, depressions, benches, and shallow slopes—and, ideally, are situated in depleted borrow pits or quarries. Do not locate disposal sites:

- in a riparian management area;
- in an area having a moderate or high likelihood of landslides; or
- at the crest of a slope or top of an escarpment.

Ensure that all disposal sites for excavation spoil maintain natural drainage patterns.

Carefully place and pile debris material transported to a disposal site to maintain slope stability at all times, and take measures to control erosion and sediment transport. Consider the following measures:

- placing the coarse material on the bottom and the finer-grained material on the top, and then compacting the pile to eliminate large voids;
- using topsoil to cover the pile to aid revegetation and limit surface erosion;
- not exceeding the natural angle of repose of the soil or rock materials;
- “benching” the sides of the spoil pile when heights exceed 5m;
- crowning, sloping, and grooming the spoil pile to ensure that the surface does not pond water; and
- installing sediment control devices below the disposal site for excavation spoil to capture and prevent sediment transport beyond the site until the spoil pile is revegetated.

### 5.8.11 Rock Excavation

Where the rock hardness, weathering, and jointing are suitable, consider the use of a backhoe-mounted hydraulic hammer or ripper for rock breaking. Where these techniques are not appropriate, fracture rock by drilling and blasting. Ensure that qualified blasters assess rock and site conditions, formulate appropriate blast designs, learn from previous results, and immediately revise field practices to reflect changing conditions. Use controlled blasting techniques where the cut bank height exceeds 5m. Where site conditions are complex or beyond the experience of the blaster, seek guidance from a specialist professional engineer.

Ensure that the rock cut has a ditch of width sufficient to capture material that may fall from the rock cut, and that drilling and blasting techniques minimize:

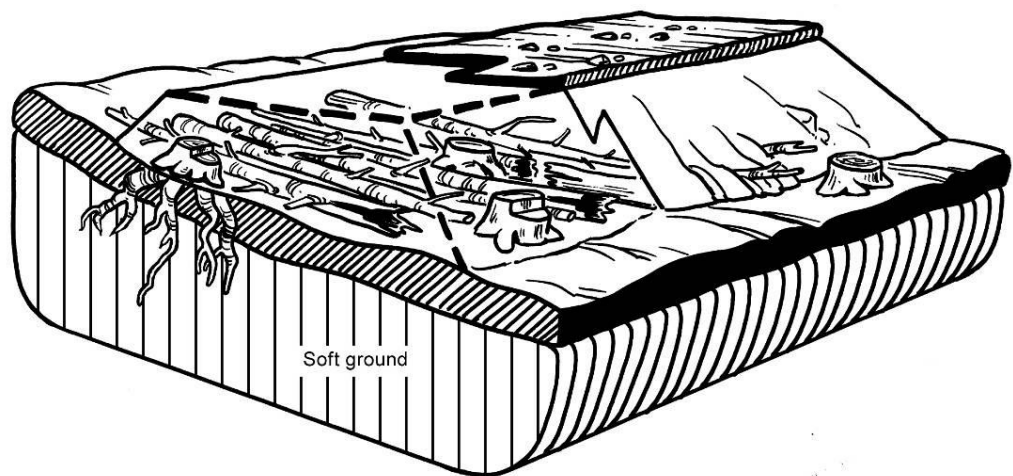
- flyrock (airborne rock displaced beyond the road prism by blasting) to avoid damage or disturbance to forest resources and existing improvements;

- the potential for landslides or slope instability; and
- the amount of overbreak (any material that is excavated, displaced, or loosened outside and beyond the designed road prism, regardless of whether it was because of the inherent character of any formation encountered or because of something else).

## 5.9 Overlanding

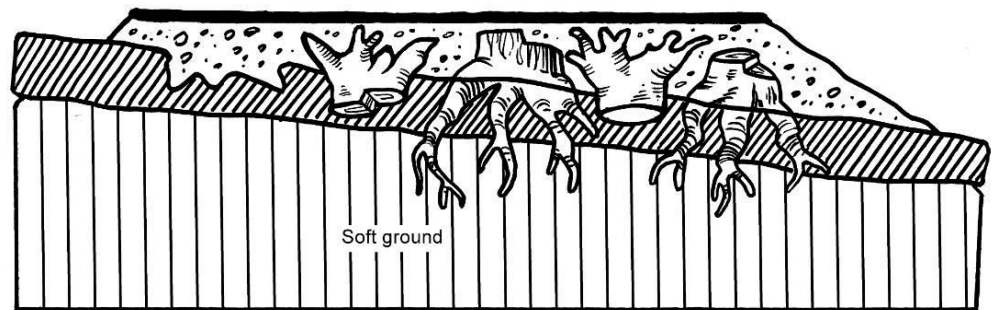
Overlanding is a construction technique used where the underlying soils are too weak to support the road prism ([Figure 5-11](#) and [Figure 5-12](#)). The road fill is placed on undisturbed organic soil, stumps, and vegetative material, using geosynthetic fabric, corduroy, or puncheon (small logs and limbs) as the separating material mat. It is important that the vegetative mat remain undisturbed to prevent the unsuitable saturated soils below the mat from mixing with the imported subgradematerial.

**Figure 5-11 Overlanding cross-section with corduroy**



Ensure that the amount of fill that is placed and compacted during overlanding is sufficient for the anticipated loads. The depth of material is a function of soil properties (particularly bearing capacity), vehicle loading, season of use, and life expectancy of the road. Use geosynthetics or puncheon to reduce the amount of road fill required and to also reduce future road maintenance.



**Figure 5-12 Overlanding cross-section with inverted stumps**

### 5.9.1 Construction of Short-Term Roads

The introduction of stumps, roots, and embedded logs into the road fill under the traveled portion of the road can reduce the long-term stability of the fill. The buried organic material will deteriorate over time and begin to settle. This removes support for the applied wheel loading and results in rutting of the road surface. Water ponding in the ruts may saturate the road fill and lead to failures. Thus, restrict the use of roots, stumps, and embedded logs in the road fill to the construction of short-term roads (e.g., up to five years), subject to deactivation at the end of their operational lives. Consider extending the life of a short-term road (e.g., up to 10 years) only if regular inspections indicate that the road fill is stable and can still support the design vehicle axle loads.

If the road fill begins to show signs of failure, or after the extended time period has passed, deactivate or reconstruct the road.

### 5.9.2 Winter Construction of Permanent Roads

Where another option does not exist, permanent roads may have to be constructed in the winter. Prevent the placement of snow, ice, and frozen material in the road fill. These materials cannot be easily compacted and will settle when they thaw. In turn, this thawing will saturate the fill and create voids that readily collapse. The resulting fill is not only unstable and low in strength, but also highly erodible and often a source of sediment, potentially causing severe damage to streams during the spring break-up period. For more information, see [5.12: Construction and Use of Snow and One-Season Winter Roads](#).

### 5.9.3 Turnouts and Widenings

Construct turnouts and widenings at locations and to specifications in accordance with the road design to allow safe passage of expected vehicle types on single lane roads. Consideration for direction of industrial traffic and adverse versus favorable grades is important for user safety. For design details on turnouts and widenings, see [Chapter 3.6.2: Road Survey and Design](#).



### 5.9.4 Location of Borrow Pits

Borrow pits are developed where additional material for subgrade construction or surfacing is required. Locate them outside of riparian management areas.

## 5.10 Road Drainage Construction

In this chapter, drainage consists of:

- surface drainage works, including ditches and cross drain culverts as well as any ancillary works; and
- stream crossings, including metal culverts, log culverts and fords.

Ensure that any permanent culvert materials are fabricated in accordance with the current Canadian Standards Association specifications.

### 5.10.1 Maintaining Surface Drainage Patterns

To maintain surface drainage patterns, keep water in its own drainage area, unless moving it to another area is necessary to avoid unstable or sensitive soils.

Consider the potential for adverse upslope, downslope and downstream impacts before culvert locations and outlet controls are determined. Measures to limit these impacts include:

- installing flumes or riprap; or
- carrying drainage flow farther along the ditchline to discharge it onto stable slopes.

Drainage systems are used to intercept and manage surface or subsurface drainage. If the soils are easily erodible, consider changing the ditch gradient, alignment, or cross-section, or adding extra culverts, to reduce the distance over which water will have to be carried.

To minimize sediment delivery to streams, do not discharge the water conveyed in ditches and cross-drain culverts directly into streams. Allow these flows to settle out through the natural vegetation on the forest floor before reaching any stream. Alternatively, filter these flows in other ways, such as through the use of settling basins or geosynthetics, until vegetation can be re-established. For more information about sediment control techniques, see [5.13: Soil Erosion and Sediment Control](#).

### 5.10.2 Drainage Practices and Water Quality

Install drainage systems, whether permanent or temporary, concurrently with subgrade construction. Consider constructing temporary structures, such as cross-ditches, swales, or open-topped culverts (e.g., cattleguards and similar structures), as appropriate, where water is encountered, to accommodate the peak flows likely to be encountered during construction. Ensure that, if the site is left unattended and a storm takes place, the in-place drainage structures can handle the runoff

without damage resulting to the road or other resources. For a pilot trail or tote road, ensure that these can accommodate surface and subsurface drainage runoff throughout the construction period. During road construction, remove any temporary drainage structures that were previously installed to facilitate machine access and install permanent structures in their place.

To ensure proper drainage during road construction:

- stockpile an adequate supply of culverts, riprap, geotextiles, silt fencing, and grass seed on-site for immediate and future use, and to avoid construction delays;
- as water is encountered, establish adequate drainage to ensure flows are controlled and water quality is maintained (where required) should a peak flow event occur;
- construct the final drainage structures as early in the construction process as is practicable;
- construct silt traps, armoured ditch blocks, and aprons as construction progresses or as soon as soil conditions allow.

To protect water quality, utilize the following techniques, where applicable:

- avoid working in areas of ponded water or saturated soils where this could result in negative impacts on resource values;
- construct stable cut and fill slopes;
- avoid in-stream work as much as possible. Where in-stream work is necessary, obtain appropriate agency approval before starting the work;
- ensure that machinery used in in-stream work is free of deleterious materials that might be deposited into the water; clean the machine undercarriage and tracks before doing in-stream work;
- install sufficient cross-drains and ditch blocks to keep ditchwater from eroding the ditchline;
- install erosion-resistant aprons at the inlet and outlet of culverts;
- in ditches, use armouring, geotextile or silt fencing, blocks, or traps to minimize erosion;
- revegetate exposed erodible soils as soon as possible; and
- remove maintenance-intensive temporary construction measures such as silt fencing, straw or hay bales, and silt traps, when not required any longer.

### **5.10.3 Ditch Construction Considerations**

Ensure that surface and subsurface flows do not cause excessive ditch or roadway erosion. Consider such factors as:

- ditch soil conditions;

- gradient;
- alignment;
- cross-section;
- ancillary works;
- ditch stabilization; and
- drainage alternatives where ditching is inappropriate.

### **Ditch Soil Conditions**

Ditch soil conditions influence erodibility. Finer textured, non-cohesive soils are more readily eroded than coarser materials or cohesive soils.

### **Ditch Gradient, Alignment, and Cross-Section**

#### ***Ditch Gradient***

The ditch gradient is largely dictated by the vertical alignment of the road. Ideally, construct the gradient at a minimum of 2% to ensure that water will flow and not pond. Lower ditch gradients can still be effective, but may require a higher-than-routine level of inspection and maintenance. Under certain conditions, ponded water can lead to a saturated subgrade. This can contribute to severe roadway rutting, siltation, and possible failure of the roadway prism, as well as sediment deposition and plugging of cross-drain culverts. Such negative impacts can occur in both gentle and steep terrain.

However, keep ditch gradients in granular soils just steep enough to keep intercepted water moving to cross-drain culverts without carrying excessive sediment. Steeper ditch gradients in erodible soils generally increase the likelihood of erosion and sediment transport. More frequent culvert placement and armouring should be considered.

#### ***Ditch Alignment***

Avoid abrupt water flow changes. Sharp angles in the ditch alignment or flow obstructions in the ditch (such as boulders or rock outcrops) can potentially deflect water into the subgrade or cutbanks and can result in erosion of the subgrade or undermining of the cutbank. Where there are impassable flow obstructions, consider installing additional cross-drain culverts.

#### ***Ditch Cross-Section***

Ensure that ditches are of sufficient depth and flow capacity to transport anticipated drainage flows. The ditch should be adequate to provide drainage of the uphill slope, the roadway surface, and minor debris (leaves, twigs, and small woody debris). Slope ditches to a stable angle, design them to have adequate hydraulic and minor debris-carrying capacity, and limit water velocities to prevent accelerated ditch erosion. Obtain additional capacity for water flow, sloughing, and minor debris by widening ditches. Avoid u-shaped ditches because the almost

vertical sides tend to ravel or slough, undermining the cut slope and the shoulder of the roadway. Wide ditch bottoms facilitate grading operations where side borrow methods are used.

### ***Ancillary Works***

The following features are associated with ditches:

**Culvert inlet armouring** is used to protect the road fill from erosion as the water flows into the cross-drain culvert inlet.

**Culvert inlet basins** are depressions dug at the inlet of cross-drain culverts. They are intended to trap material that could, over time, restrict the intake flow or infill and plug the culvert. Properly installed, inlet basins can reduce maintenance frequency. Use them where fine-grained sediments are anticipated from ditch erosion or minor sloughing, and where woody debris movement is expected along ditches in harvested openings. Periodically, clean out inlet basins.

**Sediment settling ponds** differ from culvert inlet basins in that they are designed to allow sediment to settle for later removal. Generally, locate them downslope of the roadway, but in some instances incorporate them into sections of ditchline. They are only effective under low water velocity conditions. Ensure that the configuration and depth of settling ponds are adequate to allow sediment to settle and to facilitate clean-out. Consider armouring the back slope of unstable settling ponds with placed shot rock or stabilizing them with placed large boulders. Settling ponds are a temporary measure to protect water quality during construction. If designed for long-term use, ensure that access is provided to facilitate their cleaning out. Consider vegetating settling ponds to assist filtering sediments.

Install **ditch blocks** to direct flows into the culvert inlet. They are constructed of erosion-resistant material, with the crest being approximately 0.3m lower than the adjacent road grade. This elevation difference is critical because if the culvert becomes plugged and the water rises above the ditch block, then the flow will continue down the next section of ditchline rather than being directed onto the roadway surface. Do not provide ditch blocks where ditches converge; however, take into consideration the effects of the increased water volume on the drainage structures.

Use a **take-off or lateral ditch** where a minimum grade is needed for the water to carry fines away rather than depositing them at the culvert outlet and restricting normal flow. They ensure there is a positive flow away from the roadway. However, dissipate or control the flow.

### ***Ditch Stabilization***

Where it is necessary to carry a ditch farther than what would be ideal to limit ditch erosion, such as in areas of through-cuts, or across gullies or areas of

sensitive downslope soils where concentrating water could lead to small or mass failures, limit ditch erosion by:

- armouring the ditch with angular shotrock;
- lining the ditch with an appropriate geosynthetic;
- constructing an erosion-proof check dam, or series of check dams within the ditchline, where velocity is also a concern (note: if not properly designed, however, check dams can create severe erosion holes below the dams and may require a high level of maintenance); or
- vegetating ditches.

### ***Drainage Alternatives***

Ditches may be inappropriate:

- on sites where there is a need to minimize bench cuts for stability or economic concerns (e.g., to reduce the volume of blasted rock);
- on sites where there is a need to minimize the amount of site degradation;
- on ridge or hilltop roads where natural drainage occurs; and
- along one-season winter roads.

Nevertheless, accommodate cut slope and roadway drainage in the above situations using:

- subdrains (e.g., French drains) in place of ditches;
- French drains in place of cross-drain culverts;
- road surface drains such as dips and swales;
- road insloping or outsloping;
- open top cross-drain culverts (e.g., cattle guard-like structures); and
- erosion-resistant road surfacing with a material such as shot rock.

#### **5.10.4 Cross-Drain Culvert Location**

How far water should be carried in a ditch before being left to dissipate away from the road prism depends on: water volume and velocity, soil types, hill slope aspect, elevation, vegetation, rainfall intensity, the incidence of rain-on-snow events, and downslope conditions.

Typical locations for cross-drain culvert placement are:

- near the top of a steep road gradient – the intent is to prevent accelerated ditch, subgrade, or cutbank erosion by dispersing ditch water before its volume and velocity increase downgrade;
- at seepage zones;

- at zones that have localized overland flow with undefined channels (ensure that ditchwater is dissipating at the downgrade side of these zones; otherwise water flow will carry on to the next segment of the ditch, increasing the flow at the start of the next section of ditchline and increasing the potential for erosion and natural drainage pattern disruption);
- at any location where accelerated ditch erosion could potentially begin (again, ensure the dissipation of ditchwater volume and velocity to prevent build-up and the risk of adverse impacts on improvements and other resources);
- at low points in the road profile;
- where ditchline bedrock approaches the elevation of the finished grade;
- immediately before sections of cut slope instability or raveling;
- before large through-cuts that may be drainage divides; and
- at any other location found necessary during construction, or evident during maintenance inspections.

Cross-drain culverts and ditches at switchbacks often need site-specific consideration.

### **5.10.5 Cross-Drain Culvert Installation**

Proper installation of cross-drain culverts—regardless of the material used—is critical to ensuring that road stability will not be compromised by ineffective drainage. In wet areas, particularly along steep road segments, consider decreasing the spacing between cross-drain culverts to decrease ditchwater flow volumes and minimize ditch erosion.

Make culverts long enough to ensure that the inlet and the outlet cannot become blocked by the encroachment of road embankment fill. Protect unstable or erodible fill at culvert outlets with flumes or other erosion-resistant material, and protect inlets to prevent scour and erosion.

Install cross-drain culverts at a minimum gradient of 1%. Shallower gradients may allow silt to build up inside the pipe. Consider the need to provide outlet protection, particularly if the culvert gradient exceeds 3%.

To encourage smooth entry of ditch flows, skew cross-drain culverts to be perpendicular to the road centreline by 3 degrees for each 1% that the road grade exceeds 3%, to a maximum of 45 degrees. This skew will increase the overall length of the culvert, a fact that needs to be taken into consideration when culverts are being ordered for installation.

Excavate unsuitable materials beneath the pipe and replace them with suitably compacted fill to provide a firm and uniform foundation. Assess whether seepage along the outside wall of the pipe could cause internal piping erosion (loss of fines and gravel, resulting in voids forming channels or “pipes”) that could impair the stability of the culvert installation and road prism. If this is a concern, consider

using suitable geotextiles or other seepage control measures (such as sand-bagging or installing pre-fabricated anti-seep barriers or collars at right angles to the pipe) along the pipe wall near the inlet to retard longitudinal seepage along the pipe. Remove large rocks or ledges and replace them with suitably compacted fill before the pipe bedding is prepared. Backfill and compact around the culvert in the same manner as for stream culverts (see [5.10.8](#)).

### 5.10.6 Log Culvert Construction

Proper log culvert construction requires experience, skill, and good workmanship. Before construction begins, the crew should be made familiar with any particular installation requirements, including any design drawings. Ensure that the design is in accordance with the requirements set out in [Chapter 3 Appendix 3.5: Log Culvert Design](#). Use the following procedures to lay out and construct a log culvert:

- mark the location of the substructure on the ground before and after the site-clearing operation;
- particularly for those log culverts with high fills or requiring skewing, ensure that the sill logs be cut to the correct length and placed in the proper position;
- lay two evenly sized sill logs parallel to and clear of the wetted perimeter of the stream, and on solid bearing;
- excavate a trench for the sill logs below the scour depth of the stream or construct a non-erodible foundation pad of large angular shot rock;
- pin the outside stringers to the sills with drift pins or lashing, or place them in neat notches; avoid sharp notches or slabbing of the stringer ends that will result in unacceptable stress concentrations or degradation of the shear strength;
- place a layer of non-woven geotextile filter cloth over the stringers.

### 5.10.7 Temporary Stream Crossings

Temporary stream crossings are used to provide access until the prescribed access structures are in place. Depending on the season that the stream crossing structure is constructed and used, there are options as to the type of temporary crossings that should be installed. The range of options depending on site conditions and type of road construction may include snow fills, fords, log bundles, log culverts, and log skid or portable bridges. Ensure that a temporary structure can handle peak flows without causing negative impacts on the streambed. Install the permanent structure as soon as conditions permit.

### 5.10.8 Construction of Open and Closed Bottom Metal Culverts on Non-Fish Streams

Intrusive excavation and local modification of channel conditions may be by-products of the construction of metal culverts on non-fish streams. However, ensure that the disturbance to the stream channel and the stream bank at the

crossing are mitigated to the extent that the original conditions are reasonably restored. Also, ensure that despite the works at the crossing, the stream banks above and below the crossing are protected.

For non-fish streams, the choice of open or closed bottom metal culverts is generally one of economics, whether it be the cost of materials or the complexity of installation considering the required opening of the culvert and the streambed gradient and composition.

Use culvert outlet protection where discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the immediate downstream reach. This practice protects the outlet from developing eroded pools. Protection against scour at culvert outlets varies from limited riprap placement, to protect the channel and redistribute or spread the flow, to complex and expensive energy dissipation devices. Preformed scour holes, approximating the configuration of naturally formed holes, dissipate energy while providing a protective lining to the streambed. When outlet velocities are high enough to create excessive downstream problems, consider using more complex energy dissipation devices. These include hydraulic jump-basins, impact basins, drop structures, and stilling wells. However, for small installations, where riprap will not suffice, it may be financially prudent to consider an open bottom culvert option or small bridge structure. In any event, where the culvert slope exceeds 10%, and scour will be an issue, retain a specialist professional to review the hydraulics at the site and determine the best site-specific solution to the scour issue.

### **Constructing “in the dry”**

Construct culverts “in the dry” whenever possible to prevent or minimize impacts on water quality and other biological resources. This typically enables faster construction of the culvert and reduces the potential for sediment transport into the stream.

### **Open bottom culvert foundation**

Lay an open bottom culvert on a foundation that will prevent differential settlement over time that could compromise culvert functions and cause damage to overlying road. The foundation generally consists of parallel supports through the length of the culvert, and may be:

- continuous spread footings (generally precast or cast in place concrete); or
- footing pads (intermittent supports).

The size and complexity of culvert footings depend on the underlying soil qualities as well as the volume and size of traffic that will pass over the culvert. Bury the footings for open bottom culverts at a depth that will prevent the footing from being exposed by scour.



Limit the disturbance of the stream bed and banks to that necessary to place the structure, embankment protection and any required channel modifications associated with the installation. Revegetate disturbed areas to assist in reducing future surface soil erosion.

### **Backfilling and Compaction**

The ability of a pipe to maintain its shape and structural integrity depends on correct selection, placement, and compaction of backfill materials, and adequate depth of cover for the pipe material selected.

The likelihood of a culvert failure increases with a lack of adequate compaction during backfilling. In general, utilize the procedures below:

- select good backfill material;
  - use a granular, non-saturated backfill material; pit-run gravel or coarse sands are usually satisfactory;
  - use cohesive materials as backfill material only if careful attention is given to compaction at optimum moisture content;
  - avoid placing large angular rock, boulders, snow, or ice within the backfill material;
- ensure adequate compaction underhaunches;
- maintain an adequate width of backfill;
- for culverts 1200mm diameter and larger, place backfill material in layers to about 150--300mm loose thickness, depending on compaction equipment, materials being placed and the designer's requirements;
- balance the fill height on either side as backfilling progresses;
- compact each layer before adding the next layer;
- do not permit construction vehicles or equipment to cross the structure until the minimum allowable depth of cover established by the manufacturer or by a designer has been placed.

#### **5.10.9 Construction of Open and Closed Bottom Metal Culverts on Fish Streams**

Ensure that any culverts constructed on a fish stream do not impede fish passage or harmfully alter fish habitat. Because of the special precautions and limitations on instream work in fish streams, refer to the *Fish-Stream Crossing Guidebook* for information on the construction of such culverts.

#### **5.10.10 Fords on Non-Fish Streams**

##### **Ford Construction**

For low-flow or ephemeral streams, a properly designed and constructed ford allows the stream flow to pass around and between subsurface rocks. To

accomplish this, place the larger size rock across the base and lower portion of the ford cross-section. For perennial streams where appropriate rock sizes are unavailable, consider the following alternatives:

- construct a broad catchment basin, or upstream weirs, to slow the stream flow velocity and thus reduce the size of rock required to enable the ford to resist the erosion forces; and
- for steeper gradient streams, build up the downslope portion of the ford by positioning log cribs, gabions, lock blocks, etc., to contain the rock fill for the ford. In most situations, this will flatten the stream gradient at the crossing, thus reducing the stream velocities and permitting the use of smaller size rock.

Both to prevent sediment delivery where approach drainage cannot be directed away from the stream, and to prevent sediment tracking by equipment and vehicles, consider the following procedures:

- armouring ditches with non-erosive material;
- directing runoff into sediment basins or other sediment trapping devices; and
- capping the road surface with erosion-resistant material on either side of the ford for an appropriate distance, to protect the road and minimize sediment delivery to the stream.

### **Ford Operating Constraints**

Once a ford is constructed, control its use to ensure that the integrity of the structure is maintained and that any potential adverse impacts on the environment are minimized. Do not drag or skid anything across the ford that could destroy the running surface of the ford. Where possible, ensure that vehicles using the ford are in good working order and not leaking fuel, hydraulic fluids, lubricating oil, or cargo. Remove excess soil heavy equipment before it crosses a watercourse. Do not use the ford if the water depth is greater than the axle height of the vehicle. Consider installing a water-depth gauge and a warning sign that are clearly visible from the road. Should a ford become unsafe for traffic during high water, take measures to warn and exclude users for that period.

### **Ford Maintenance**

Properly designed and constructed fords are usually low maintenance structures. Nevertheless, inspect fords at a frequency commensurate with the risk to road users and the environment, and properly maintain:

- running surfaces;
- approach grades and aprons;
- ditches; and
- catchment basins.

## **5.11 Stabilizing the Subgrade and Surfacing the Road**

### **5.11.1 Ballasting**

Ballasting is the use of rock to construct the road subgrade when other available material is incapable of supporting the design traffic load during the period of use.

Generally, ensure that suitable ballast material:

- drains well;
- forms a structurally competent fill;
- compacts well; and
- resists erosion.

### **5.11.2 Surfacing**

Surface the subgrade with pit-run gravel or crushed rock aggregate for one or more of the following reasons:

- where subgrade material is highly erodible and needs to be protected from water or wind action;
- where subgrade material will not support traffic loading during periods of use; and
- to form a driveable and gradeable surface.

#### **Surfacing Material Selection**

Surfacing materials include crushed rock and pit-run gravel aggregates. Surfacing materials consist of inert, tough, durable particles that will not deteriorate when worked (handled, spread, or compacted) and combined with suitable fines, or when exposed to water and freeze-thaw cycles. Ensure that aggregate particles are uniform in quality and free from an excess of flat or elongated pieces.

Ensure that the aggregate is well graded (contains a mix of all particle sizes) for compaction and for a durable wearing surface. When the only source material is poorly graded, consider:

- screening the material to remove the excessive particle sizes; or
- blending in the deficient material size.

Because crushed aggregate is expensive to produce, protect it with a base coarse stabilizer (e.g., calcium chloride or magnesium chloride, installed to the manufacturers' specifications) to prevent the loss of fines. Obtain and rigidly apply specifications for high fines crushed gravel when use of a calcium chloride or related stabilizer is being considered. Note that some stabilizers are not acceptable in community watersheds or near licensed water intakes.

### 5.11.3 Surfacing Compaction

Compaction of the subgrade and surface through the use of equipment designed for this purpose will increase the load-carrying capacity of the road bed and reduce the volume of surfacing material that will be required to maintain the road bed during its service life.

For optimum strength, place the surfacing material in uniform lifts compatible with the compaction equipment that is to be used. Uniformly compact each lift before being covered with the next lift. To achieve maximum compaction, ensure that the moisture content of the material is close to optimum. Material that is too dry or too wet will not achieve the best compaction. Therefore, during the spreading phase, add water to dry material, or allow saturated material to dry to achieve the optimum moisture content.

### 5.11.4 Protecting Erodible Fills Located Within Floodplains

All embankments, dikes, streambanks and channels, culvert inlets and outlets, abutment wings, and structure foundations may require protection by the addition of riprap, or other armouring material.

When constructing embankments within active floodplains, take action to prevent erosion of those embankments by forming the entire embankment of non-erodible material. Where this is not possible or practical, armour the fill.

Table 5-2: Indicates the stream velocities that can erode different size materials.

**Table 5-2 Example erosion velocities**

Material	Diameter (mm)	Mean velocity (m/sec)
Silt	0.00	0.15
Sand	1.	0.55
Fine Gravel	10.0	1.00
Medium Gravel	25.0	1.40
Coarse Gravel	75.0	2.40
Cobble	150.0	3.30

If the embankment is to be formed by one of the materials in Table 5-2 and will likely be subject to velocities at least equal to those corresponding to that material, then use armouring. Several forms of armouring material exist:

- angular and durable riprap (see below);

- sand bags (a very short-term solution only, as bags break down over time);
- concrete, including concrete blocks (quick, easy installation), sprayed concrete (shotcrete or gunnite), or poured-in-place concrete (uncured concrete products should be kept isolated from the stream until the concrete has cured);
- binwalls (for velocities less than 1 m/sec or used in conjunction with riprap and where suitable fill material – cobble, coarse gravel – is readily available); and
- other commercial erosion control systems.

For riprap, ensure that the rock selected is sized to resist peak flow velocities, and graded to act as a filter to resist movement of underling soil through the riprap (all in accordance with the approved design). Place the riprap on firm, stable ground, taking care to provide mass stability and a regular surface with a minimum of voids. Place it horizontally to form an apron, and trench it below the scour depth. Consider keying it into the bed of a watercourse below the scour depth where acceptable to the environmental agencies.

### 5.11.5 Litter, Petroleum Products, and Other Waste Materials

Ensure that all workers on the site are familiar with the requirements for the use, storage, and disposal of litter, equipment fuel, and servicing products. Those most commonly associated with road construction are:

- waste oil and grease and spoiled fuel;
- refuse: camp garbage, waste paper, old machine parts, and damaged culvert pipe;
- batteries and battery acid;
- sewage and litter: where camps are to be established, sewage disposal via permitted septic systems is required; and
- fuel storage (a permit from the appropriate agencies is required for the establishment of fuel tank farms).

Ensure that all ministry contractors have petroleum product spill response kits on hand, and that personnel are familiar with spill containment procedures. Refer to the BC Timber Sales [Environmental Management System Manual](#), which contains information on environmental policy, training, awareness and competence, emergency preparedness and response and records, among other items. Spill kit contents vary by type of work, potential size of spill, and impact potential, covering a range of incidents, from minor hydraulic leaks to major watercourse spills. At a minimum, ensure that each machine has a spill kit with extra absorbents in the support vehicle.

Dispose of waste and contaminated materials as appropriate and in accordance with the relevant federal and provincial statutes, including:

- burning;

- burying; or
- containing and removing from the site to an approved disposal location.

### 5.12 ***Construction and Use of Snow and One-Season Winter Roads***

Throughout much of British Columbia, forest operations are best conducted during the winter months. By using deep snow or frozen ground as the running surface, equipment working on snow roads or one-season winter roads has a lower environmental impact than when working on all-weather roads. Fine-textured soils and muskeg ground conditions are especially vulnerable. Construct these seasonal roads during the early part of the winter, so that harvesting can be completed before snowmelt and the break-up of frozen ground in the spring. If there is insufficient snowpack, these road types cannot be constructed.

Snow roads and one-season winter roads use the strength of ice and snow to produce a stable road bed that will support the design vehicle axle loads. In areas with heavy snowfall, the main reliance is on the snow pack. In either case, weather is the essential and unpredictable factor in the construction process, and logistics are key to constructing and using winter roads effectively. Where mid-winter thaws are common, construct short spur roads, and use and deactivate them in a matter of weeks.

Generally, watercourses are frozen for the life of the road, and in many cases drainage structures may not be required. Compact snow fills across small streams and gullies with the use of log bundles to allow the passage of any seepage that may occur or to reduce the volume of snow required. Where mid-winter thaws are common, install culverts in the snow fill to accommodate possible flowing water.

Coordinate deactivation of these road types with operations and complete such work before the spring freshet. Restore all natural drainage channels while road access is available. Do not leave logs in stream channels, and breach snow fills to prevent the damming of watercourses. Though mid-winter thaws can disable even a well-built road, the high-risk period begins during spring break-up. During that period, snowmelt can occur very quickly, resulting in rapid overland flows of meltwater, high flows in watercourses, and an extreme softness of soil materials that renders them highly susceptible to erosion. Any soils that have been mixed with snow become fluid and highly susceptible to mass erosion. Debris or excavated spoil material piled on top of a snow layer can become unstable on even gentle side slopes. For more information on road deactivation techniques, see [Chapter 7: Road Deactivation](#).

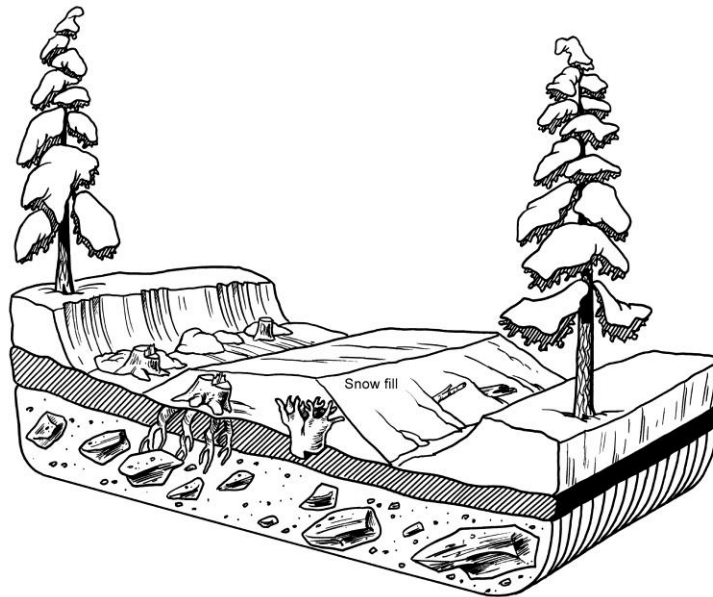
#### 5.12.1 **Snow Road Construction**

Snow roads are a form of overlanding construction in which clean snow and ice are used as fill ([Figure 5-13](#)) and can support the design vehicle axle loads. Snow roads are appropriate for providing access across gentle terrain to winter-harvest-only areas. Snow roads are limited to terrain with slopes less than 20%, unless

there is a very deep snowpack. The surface is often built-up with ice by using water in areas of flat terrain with a minimal snowpack.

Excavation is not permitted (cut slopes or ditches) other than the removal of the occasional stump that cannot be readily covered with snow and ice. The road may be reconstructed and re-used each winter in the same location.

**Figure 5-13 Typical snow road**

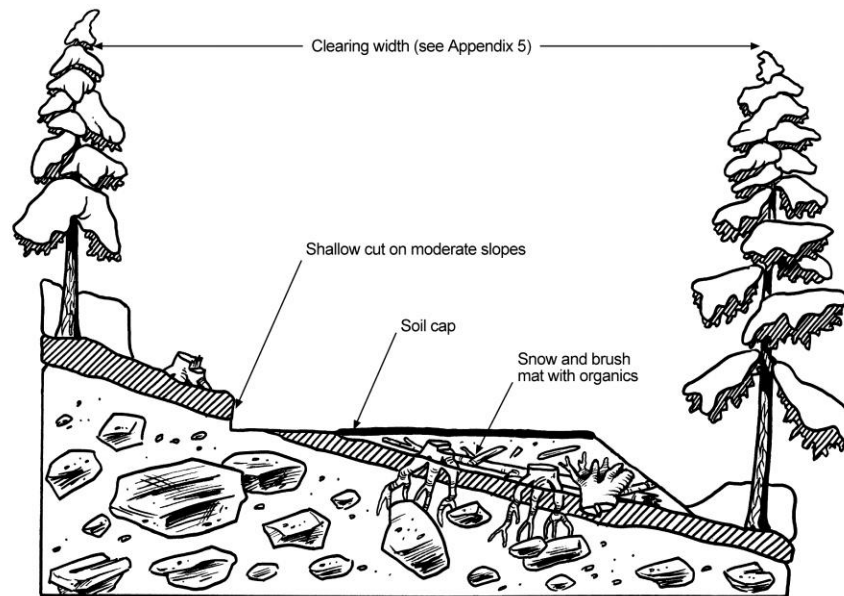


### 5.12.2 One-Season Winter Road Construction

Similar to snow roads, one-season winter roads are constructed mainly from snow and ice, with a minimal amount of soil (10%-20%) to assist the freezing-in of the road, or to provide a more durable surface where infrequent mid-winter thaws may occur. They are suitable for temporary access to winter harvest areas for one season only and are not intended to be reconstructed.

Because of the high risk of sediment deposition during the spring freshet, do not mix soil with snow in the riparian management area of stream crossings. Only use log bundles and clean snow in gullies and riparian areas.

Limit stripping to the removal of large stumps that cannot be easily covered with snow or ice. For cuts into mineral or organic soil, do not exceed 300mm in depth for sustained distances on slopes greater than 15%, or 500mm in depth for short distances on steeper slopes up to 35%. [Figure 5-14](#) shows a finished one-season winter road.

**Figure 5-14 One-season winter road**

For one-season winter roads, a mixture of dirt and snow on the road surface can provide a stable roadway when frozen, but it becomes highly liquid during spring thaws. Any appreciable side slopes or gradients may result in mass erosion from the roadway. Debris disposal sites constructed on top of snow can become unstable during melt periods, or can create a situation where meltwater on the roadway cannot run off the road but only run down it.

Plan for and install deactivation measures during the design and construction of one-season winter roads. For example, construct swales, inslope or outslope the subgrade, install log-filled cross-ditches, and stockpile coarse rock for use at armoured swales and cross-ditch locations so deactivation requirements after the life of the road will be reduced.

Where possible, overland the road with a brush mat and snow excavated from the clearing width. Use a small amount of unfrozen dirt as a freezing agent to construct the road surface. Breach berms and snowbanks at intervals of not more than 50m. Smooth the road surface at the time of construction to avoid building in ruts and other irregularities, and construct waterbars on long grades. Remove fills in natural drainage channels, pull back soil-contaminated snow fills in the vicinity of stream crossings, and take measures to prevent sediment from entering streams around crossings.

### 5.12.3 Road Use

Mid-winter thaws are commonplace in the Interior and can disable even a well-built winter road. Because of heavy use and adverse weather, rutting and deformation of the road surface can occur as the subgrade begins to thaw. Use these roads only in frozen conditions. For this reason, monitor weather forecasts as far in advance as possible. As well:



- schedule night hauling when temperatures are expected to be above freezing during the day; and
- strictly control all light traffic during unfrozen conditions.

### **5.13 Soil Erosion and Sediment Control**

Soil disturbance is inevitable from most road construction activities. Control of soil erosion and the subsequent transport of sediment during road construction are therefore important concerns where there is direct or indirect connectivity to water. Erosion control addresses the source of soil erosion, whereas sediment control addresses the control and retention of sediment. As erosion control has a generally higher level of effectiveness than sediment control, ensure that the primary goals are, first, to minimize potentially damaging erosion of the disturbed sites; and, second, to limit the transport of sediment from these sites.

#### **5.13.1 Soil Erosion Control Techniques**

To minimize surface soil erosion after road construction, cover all exposed soils that are subject to weathering (e.g., silty and sandy non-cohesive soils and clayey and other cohesive fine-grained soils) with grass and legume vegetation. A variety of erosion seed mixes are available that provide for rapid germination and long-term growth to create a solid sod layer. Take care to ensure that the seed species selected are compatible with domestic livestock. Establish this vegetative cover to protect and hold soil by:

- decreasing the erosive effects of rain drop impact on soil particles;
- decreasing runoff velocity and volumes; and
- promoting water infiltration into the soil.

Apply the cover as soon as slopes are completed, rather than after the entire road project is complete. Prompt revegetation by dry broadcast (by hand or spreader) or by hydroseeding not only assists with erosion control; it also helps to prevent the spread of noxious weeds.

Other soil erosion control techniques include, but are not limited to, the following:

- confinement of sensitive operations to periods of dry weather and selection of equipment that will create the least disturbance;
- compliance with local rainfall shutdown guidelines;
- temporary diversion or impoundment of stream flow using diversion ditches and berms to reduce the exposure of disturbed soil to flowing water during stream-crossing structure construction, or construction of rock-lined ditches or channels to provide a durable erosion-resistant surface; and
- installation of rock, straw bale, or sand bag check dams across a defined ditch or channel, or placement of riprap on a slope, to reduce water velocity and scour potential.

For more detailed information on control of soil erosion and sediment transport, refer to the Ministry of Forests' [Best Management Practices Handbook: Hillslope Restoration in British Columbia](#).

### 5.13.2 Sediment Control Techniques

To minimize sediment transport away from the road prism and disposal sites, consider using the following sediment control techniques:

- install silt fencing to collect and detain runoff and retain sediment;
- install sediment retention berms (e.g., berm constructed of brush, rock, wood chips, or other material that may be wrapped in geotextile fabric);
- install sediment basins and traps to detain runoff and retain sediment;
- confine sensitive operations to periods of dry weather, minimize traffic through these areas, and select equipment that will create the least disturbance (e.g., rubber-tired or rubber-tracked machinery);
- for stream culvert installations, use temporary diversion or impoundment of stream flow to reduce the exposure of disturbed soil to flowing water – being sure to obtain prior agency approval, if required.

For more detailed information on control of soil erosion and sediment transport, refer to the Ministry of Forests' [Best Management Practices Handbook: Hillslope Restoration in British Columbia](#).

## 5.14 Road Works Shutdown Indicators

Several visible weather- and soil-related conditions can be used on site to help determine when forest road operations are to be shut down because the works are causing, or may imminently cause, environmental damage. Refer to the BC Timber Sales [Environmental Management System Manual](#), which contains information on environmental policy, training, awareness and competence, emergency preparedness and response and records, among other items.

Be prepared to shut down or alter construction activities during periods of adverse weather to avoid uncontrolled soil erosion and sediment transport. In general, work on earth materials in environmentally sensitive areas only during favourable soil moisture conditions. Consider maintaining a rain gauge at the work site and keeping a written record of rainfall levels.

The objective is to reduce potential adverse impacts on forest resources such as:

- erosion of exposed soils;
- sediment transport to fish streams; and
- slope failure originating within the limits of the construction site or in the adjacent terrain.

When a qualified registered professional develops a prescription for a road-related activity in areas having a moderate or high likelihood of landslides, ensure that

the prescription contains site-specific, weather-related shutdown indicators and start-up requirements.

In general, and where predictable, shut down work before the following happens:

- sediment transport cannot be controlled;
- slope stability is in question, or landslides occur;
- windfall is happening around or near the site;
- the road surface deteriorates and vehicle traffic damages the road;
- activities damage adjacent stands and plantations;
- activities damage soils and inhibit future reforestation; and
- spills of fuel or explosives occur.

#### 5.14.1 Procedures for Shutting Down Operations

1. **Stop the activity.** Cease works before soils are visibly soft or muddy and associated silty waters or sediment are flowing toward streams, lakes, or marine-sensitive zones or where such conditions are reasonably anticipated to develop. Equipment operators are usually in a position to first recognize signs of pending soil erosion on site. Emphasize the need for them to communicate their observations to the site supervisor during the project pre-work phase.
2. **Take steps necessary to avoid impacts.** Before shutdown, control drainage to ensure that subsequent damage does not occur. Carry out protective measures in the work area, primarily on sites where works are not at a completed and controlled stage. Consider the following general practices:
  - minimize sediment delivery from stockpiled erodible soils;
  - ensure that drainage systems are functional;
  - add water control measures (such as cross-ditches and waterbars) and other soil erosion and sediment control measures where appropriate.
3. **Document and report the shutdown to the supervisor.**
4. **Account for all people working in the area before leaving the site.**
5. **Restarting the works.** Establish and convey to the road crew the criteria for restarting works, including any further required mitigation measures.

#### 5.14.2 Limiting Road Use to Minimize Adverse Impacts

Restrict traffic where works are shut down because of saturated soil conditions. Post temporary signs warning of the danger, and advise the appropriate managers, agencies, and local residents of the necessity to close/restrict the road to traffic.

### 5.14.3 Emergency Road Maintenance

Only in emergencies is it appropriate to carry out maintenance during high water flow or saturated soil conditions because of the potential for creating an adverse impact. For example, if a culvert is plugged or will imminently plug and wash out a road fill or drainage structure, then rectify the problem immediately. Failure to carry out such works may result in the loss of infrastructure and unacceptable impacts to other resources. If adverse impacts indeed occur during such maintenance work, notify the appropriate agencies at the earliest possible time.

## 5.15 Resources and Suggestions for Further Reading

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## Appendices

### Appendix 5.1: Tables to Establish Clearing Width

#### Clearing Width

The clearing width is shown in Table 5-3 and Table 5-4. Since clearing width calculations are straightforward, but very tedious, Tables 5-3 to 5-9 and accompanying Table 5-10 and Table 5-11 have been developed for convenience.

**Note that the right-of-way width will not normally exceed 75m and the clearing width will not exceed the right-of-way width; any geometry in the tables in this Appendix that indicates clearing widths that approach or exceed the 75m width should be reconsidered and perhaps other road construction alternatives used.**

These tables provide slope distances (not the horizontal distances) for establishing suitable offset distances from road centreline to facilitate easy field marking of the upper and lower clearing width boundaries. Note that the offset slope distances in the tables depend on several factors:

- unstabilized subgrade width;
- side slope angle of the natural ground surface; and
- angles of the fill and cut slopes.

On the tables in this appendix, the **clearing width** is the sum of the width determined from the tables *and* any additional width to account for special circumstances (see below, “Additions to Clearing Width”). The clearing width established from these tables may be expressed as:

**Clearing width** = offset distance on cut side of centreline (from tables) +  
offset distance on fill side of centreline (from tables) +  
additional width (if necessary)

For a specific subgrade width, these tables assume:

- no horizontal or vertical adjustments at the road centreline;
- 0.3m overburden thickness;
- 3.0m clearing allowance above the top of the cut slope to standing timber;
- selection of the appropriate cut and fill slope angles (Refer to the suggested cut and fill slope angles in [Chapter 3, Table 3-4](#));
- a ditch depth of 0.5m;
- sidecast road construction with little or no longitudinal movement of material; and
- a minimum 3.0m distance from the road shoulder to the lower side clearing width boundary.

As well, it is assumed that where there is road fill, the toe of the fill slope demarcates the lower clearing width boundary. Therefore, to establish the clearing width when using these tables, include additional width allowances as required (e.g., additional width will be required for debris disposal on the lower side of the road below the toe of the fill slope).

Where the offset slope distance from the road centreline to the upper or lower clearing width boundaries exceeds 50m, consider using alternative construction methods, such as retaining walls, to reduce the clearing width requirements.

### **Determining Clearing Width from Tables in this Appendix**

The following procedure is suggested:

Select the appropriate unstabilized subgrade width table (the tables have been developed for unstabilized subgrade widths of 4, 5, 6, 7, 8, 9, and 10 m). Do this after:

- adjusting the road subgrade width to compensate for cuts or fills (see following: Adjustments to Road Subgrade Width in Tables to Compensate for Cuts and Fills at Road Centreline); and
- adjusting the road subgrade width to compensate for road surfacing materials (see following: Additions to Clearing Width).

Choose the appropriate natural side slope angle in the selected subgrade width table. Based on the expected soil type to be encountered during road construction, choose the appropriate cut and fill slope angles for application in the tables.

Details about selecting cut and fill slope angles for road design are given in [\*Forest Road Engineering Guidebook\*](#) (Appendix 1: Field Identification of Soils).

To establish the upper clearing width boundary, read the offset slope distance from the appropriate cut slope angle column (the offset distance given in the cut slope angle column is a slope distance between the road centreline and the upper clearing width boundary).

Use a two-step procedure to establish the lower clearing width boundary. First, read the offset slope distance from the appropriate fill slope angle column (the offset distance given in the fill slope angle column is a slope distance between the road centreline and the toe of any fill slope). Second, include any additional width allowances (such as those for debris disposal on the lower side of the road below the toe of the fill, and to accommodate sight distance), as explained following in Additions to Clearing Width).

### **Adjustments to Road Subgrade Width to Compensate for Cuts and Fills at Road Centreline**

Limit the use of an adjusted road subgrade width in these tables for short sections of anticipated cuts or fills at the road centreline to the obvious locations in the field, such as where cuts are required through small ridges or fills across linear

slope depressions of less than 3.0m deep. For longer sections of road through areas with deep gullies or high ridges, complete a geometric road design and determine the clearing width from these drawings.

To compensate for a cut at the centreline, adjust the road subgrade width as follows: Add 1.0m to the subgrade width for every 0.3m cut increment at centreline to determine the offset slope distance on the cut side of centreline. Subtract 1.0m from the subgrade width for every 0.3m cut increment at centreline to determine the offset slope distance on the fill side of centreline. For example, consider a 0.6m deep cut at centreline on a 6.0m wide unstabilized subgrade (assume surfacing material is not applied to the subgrade). Assume a natural side slope angle of 35% above and below the road centreline, and fill and cut slope angles of 1½H : 1V and 1H : 1V, respectively. In this case, adjust the unstabilized subgrade width by 2.0 m as follows:

- choose the appropriate cut slope angle column from [Table 5-7](#) (8.0 wide unstabilized subgrade) to determine the offset slope distance on the cut side of centreline; the offset slope distance from this table is 12.0m;
- choose the appropriate fill slope angle column from [Table 5-3](#) (4.0m wide unstabilized subgrade) to determine the offset slope distance on the fill side of centreline; the offset slope distance from this table is 5.0m.

In this cut example, the clearing width (magnitude) is unchanged, but is shifted upslope with respect to the road centreline.

If, because of shallow side slopes, the 0.6m cut resulted in a through-cut instead of a fill slope, use the appropriate cut slope angle column from [Table 5-3](#) (4.0m wide unstabilized subgrade) to obtain the required offset slope distance from centreline to the lower clearing width boundary.

To adjust for fills at the centreline, reverse the above procedure. For example, to allow for a 0.6m fill at centreline on a 6.0m wide road, adjust the unstabilized subgrade width by 2.0m as follows:

- choose the appropriate cut slope angle column from [Table 5-3](#) (4.0m wide unstabilized subgrade) to determine the offset slope distance on the cut side of centreline;
- choose the appropriate fill slope angle column from [Table 5-7](#) (8.0m wide unstabilized subgrade) to determine the offset slope distance on the fill side of centreline.

## Additions to Clearing Width

### *Compensate for Surfacing or Ballasting Material*

Before selecting the appropriate unstabilized subgrade width table, compensate for the thickness of surfacing or ballasting material anticipated to be placed over the unstabilized subgrade surface. For example, where surfacing material is



needed to provide a finished road running surface, select a wider unstabilized subgrade width when determining the clearing width from Tables 5-3 to 5-9. For every 0.3m of surfacing depth, allow for an additional 1.0m of unstabilized subgrade width.

For example, to obtain a 4.0m wide finished road running surface on subgrade soils that will require a 0.3m thickness of gravel, select [Table 5-4](#) (5.0m wide unstabilized subgrade).

### ***Compensate for Other Requirements***

Calculate the extra width needed for turnouts, sight distance, snow removal, debris disposal, and similar needs on the fill side of road centreline. To determine the lower clearing width boundary, add this extra width to the offset slope distance (fill side of centreline) given in the tables.

For example, if winter use of the road will require snowplowing, the standing timber should be at least 4.0m or more away from the road shoulder. Since the tables will only provide for a minimum of 3.0m from the road shoulder to the lower clearing width boundary, simply add the additional 1.0 or 2.0m to the offset slope distance. Where natural side slope angles are greater than 20%, convert the extra width allowance to a slope distance, rounded up to the nearest metre, and then added to the offset slope distance determined from the tables.

Tables 5-3 to 5-9:      **Offset slope distances (m) from road centreline to upper (cut side) clearing width boundary and lower (fill side) clearing width boundary**

**Table 5-3 Unstabilized Subgrade Width = 4m**

Natural Side Slope Angle	Fill Slope Angle			Cut Slope Angle				
	1H : 1V	1½H : 1V	2H : 1V	¼H : 1V	¾H : 1V	1H : 1V	1½H : 1V	2H : 1V
0-20	5	5	5	6	7	7	8	10
21-30	5	5	5	6	7	8	9	14
31-35	5	5	5	6	8	8	10	18
36-40	5	5	7	6	8	9	11	Use Table 5.11
41-45	5	5	Use Table 5.10	7	8	10	13	
46-50	5	7		7	9	10	15	
51-54	5	10	Use alternative construction methods	7	10	12	26	Use alternative construction methods
55-57	5	13		7	10	12	34	
58-60	5	19		7	10	13	48	

**Table 5-4 Unstabilized Subgrade Width = 5m**

Natural Side Slope Angle	Fill Slope Angle			Cut Slope Angle				
	1H : 1V	1½H : 1V	2H : 1V	¼H : 1V	¾H : 1V	1H : 1V	1½H : 1V	2H : 1V
0-20	5	5	5	7	7	8	9	11
21-30	5	5	6	7	8	9	10	16
31-35	5	5	8	7	8	9	11	20
36-40	5	6	10	7	9	10	12	Use Table 5.11
41-45	5	7	Use Table 5.10	7	9	10	14	
46-50	5	9		7	10	12	17	
51-54	5	12	Use alternative construction method	7	10	13	29	Use alternative construction methods
55-57	5	16		7	11	14	37	
58-60	6	23		8	11	15	54	

**Table 5-5 Unstabilized Subgrade Width - 6m**

Natural Side Slope Angle	Fill Slope Angle			Cut Slope Angle				
	1H : 1V	1½H : 1V	2H : 1V	¼H : 1V	¾H : 1V	1H : 1V	1½H : 1V	2H : 1V
0-20	6	6	6	7	8	9	10	12
21-30	6	6	6	7	9	10	11	17
31-35	6	6	8	7	9	10	12	22
36-40	6	7	13	8	9	11	14	Use Table 5.11
41-45	6	9	Use Table 5.10	8	10	12	16	
46-50	6	11		8	10	13	18	
51-54	7	15	Use alternative construction methods	8	11	14	32	Use alternative construction methods
55-57	7	19		8	12	15	41	
58-60	8	29		8	12	16	60	

**Table 5-6 Unstabilized Subgrade Width - 7m**

Natural Side Slope Angle	Fill Slope Angle			Cut Slope Angle				
	1H : 1V	1½H : 1V	2H : 1V	¼H : 1V	¾H : 1V	1H : 1V	1½H : 1V	2H : 1V
0-20	7	7	7	8	9	9	10	13
21-30	7	7	8	8	9	10	12	19
31-35	7	7	10	8	10	11	13	Use Table 5.11
36-40	7	8	Use Table 5.10	8	10	12	14	
41-45	7	11		8	11	12	16	
46-50	7	14		8	11	14	20	
51-54	8	18	Use alternative construction methods	9	12	15	35	Use alternative construction methods
55-57	8	23		9	13	16	44	
58-60	9	33		9	13	17		

**Table 5-7 Unstabilized Subgrade Width = 8m**

Natural Side Slope Angle	Fill Slope Angle			Cut Slope Angle				
	1H : 1V	1½H : 1V	2H : 1V	¼H : 1V	¾H : 1V	1H : 1V	1½H : 1V	2H : 1V
0-20	7	7	7	8	9	10	11	14
21-30	7	7	9	8	10	11	12	20
31-35	7	8	11	8	10	12	14	Use Table 5.11
36-40	7	10	Use Table 5.10	8	11	13	16	
41-45	8	12		8	11	14	18	
46-50	8	16		8	12	15	22	
51-54	9	21	Use alternative construction methods	10	13	17	38	Use alternative construction methods
55-57	10	27		10	14	18	49	
58-60	11	39		10	14	19		

**Table 5-8 Unstabilized Subgrade Width = 9m**

Natural Side Slope Angle	Fill Slope Angle			Cut Slope Angle				
	1H : 1V	1½H : 1V	2H : 1V	¼H : 1V	¾H : 1V	1H : 1V	1½H : 1V	2H : 1V
0-20	8	8	8	9	10	11	11	14
21-30	8	8	10	9	11	12	13	21
31-35	8	10	13	9	11	13	15	Use Table 5.11
36-40	8	12	Use Table 5.10	9	12	14	17	
41-45	9	15		10	12	15	20	
46-50	10	19		10	13	16	23	
51-54	10	24	Use alternative construction methods	10	14	18	41	Use alternative construction methods
55-57	11	31		10	15	19	53	
58-60	12	45		11	16	20		

**Table 5-9 Unstabilized Subgrade Width = 10m**

Natural Side Slope Angle	Fill Slope Angle			Cut Slope Angle				
	1H : 1V	1½H : 1V	2H : 1V	¼H : 1V	¾H : 1V	1H : 1V	1½H : 1V	2H : 1V
0-20	8	8	8	9	10	11	12	15
21-30	8	8	11	9	11	12	14	Use Table 5.11
31-35	8	11	15	10	12	13	16	
36-40	9	13	Use Table 5.10	10	12	14	18	
41-45	10	16		10	13	16	21	
46-50	11	21		10	14	17	25	
51-54	12	27	Use alternative construction methods	11	15	19	45	Use alternative construction methods
55-57	13	36		11	16	21	58	
58-60	14	50		11	17	22		

These following two tables are referenced in Tables 5-3 to 5-9

**Table 5-10 Offset slope distance for 2H:1V fill slope angles**

Natural Side Slope Angle	Unstabilized Subgrade Width						
%	4 m	5 m	6 m	7 m	8 m	9 m	10 m
36-38	Use tables above			13	15	17	19
40				16	18	21	23
42	9	13	16	19	22	25	28
44	12	17	22	26	30	34	37
46	20	28	35	41	46	50	
48	44	Use alternative construction methods					

**Table 5-11 Offset slope distance for 2H:1V cut slope angles**

Natural Side Slope Angle	Unstabilized Subgrade Width						
%	4 m	5 m	6 m	7 m	8 m	9 m	10 m
21-25	Use tables above						17
26-28							20
30							22
32				20	21	23	24
34				22	24	25	27
36	19	21	23	25	27	29	31
38	22	24	27	29	32	34	36
40	26	29	32	35	38	41	
42	32	36	39	43	47	50	
44	42	52	Use alternative construction methods				

## Appendix 5.2: Project Tracking Checklist

<i>Project Tracking Checklist</i>		
Use this checklist to prepare a paper trail of key outputs prepared by consultants and sign-offs by BCTS/Timber Pricing and Operations Division.		
Element Being Reviewed & Results Achieved		Date of FLNR sign-off
<b><i>ROAD CONSTRUCTION</i></b>		
Ensured that there was a road design in place prior to construction, signed off by a Qualified Registered Professional. If YES, <b>Professional's Name and Company:</b> _____	YES NO	_____
Ensured that the road design was approved by the BCTS/District engineering specialist	YES NO	_____
Ensured that the road construction was monitored at appropriate intervals by BCTS/District staff to provide ministry oversight of the works	YES NO	_____
<u><b>Statement of Road Construction Conformance</b></u> signed off (P.Eng, RPF, RFT). If YES, <b>Professional's Name and Company:</b> _____	YES NO	_____
Ensured that the completed road was field inspected by the BCTS/District engineering specialist for completeness of the Statement of Construction Conformance and to incorporate as-built information into the applicable data base.	YES NO N/A	_____

### Appendix 5.3: Statement of Road Construction Conformance

TO BE COMPLETED BY QUALIFIED REGISTERED PROFESSIONAL **AFTER** COMPLETION OF THE ROAD CONSTRUCTION

Road Name	Project #	Forest District/Business Area
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I am a (check one) ☐ Registered Forest Technologist, ☐ Professional Engineer or ☐ Professional Forester, registered with the appropriate professional association in British Columbia, and I have undertaken professional responsibility for all field and office reviews required with respect to the construction of this road. I have taken steps as regulated under the Provincial Statute for my profession and required by good practice in order to sign and seal this Schedule.

In my professional opinion, road construction was carried out:

- in general conformance with the approved design and drawings, and any substantial changes were reviewed and agreed to by the designer of the road; and
- without material and adverse effects on forest and other resources, and met the objectives established for this road in the road site plan.

Signature (and seal as appropriate) of Professional	
Name of Professional (please print)	DATE SIGNED YYYY M M DD



## 6. Road and Structure Inspection and Maintenance

### 6.1 Introduction

Road and structure inspection and maintenance are essential activities necessary to maintain the expected safety considerations, service life, economic investment and environmental protection on Forest Service roads.

This chapter describes the activities related to plans, assessments, works, and reports, including the following:

- preparing an annual plan;
- understanding the different required levels of maintenance, and vehicle access objectives;
- road maintenance inspections;
- assigning road maintenance inspection priorities and frequency of inspections based on engineering risk analysis;
- road maintenance works as appropriate, including clearing width, ditch and culvert, road prism, subgrade, road surface, and winter; and
- inspection and maintenance of structures, including bridges, major and other stream culverts, retaining walls, and other engineered structures.

This chapter presents Timber Operations and Pricing Division/BCTS's mandatory requirements and best practices related to road maintenance inspections, and to the associated outputs. It is intended to provide the reader with enough detail to be able to understand the processes and mandatory procedures, as well as carrying out appropriate [best](#) practices to address the applicable regulatory requirements.

Note that for extensive road maintenance works such as major repairs to, or modifying or rebuilding a section of road, many of the practices that are described in the appropriate sections of Chapter 5 Road Construction will be applicable.

### 6.2 Policy

Forest Service roads that are maintained by the ministry, and all FSR bridges, major culverts, and other engineered structures, will be inspected and maintained, taking into consideration their level of use, strength and durability, and potential impacts on user safety and values at risk of damage or loss.

### 6.3 Mandatory Procedures and Best Practices

Following is a table that summarizes in approximate chronological order the mandatory procedures and best practices with respect to the inspection and maintenance of Forest Service roads. Links are provided to direct the reader to the location in the manual text where the tabular item is discussed.

**Table 6-1 Road and Structure Inspection and Maintenance**

Mandatory Procedures and Best Practices <sup>1</sup>	
<p>Results to be achieved:</p> <ul style="list-style-type: none"> <li>• protection of water quality at licensed waterworks (FPPR s. <a href="#">59</a>, <a href="#">60</a>)</li> <li>• working outside of riparian management areas (FPPR s. <a href="#">50</a>)</li> <li>• protection of fish passage and fish habitat (FPPR s. <a href="#">56</a>, <a href="#">57</a>)</li> <li>• protection of the structural integrity of the road prism and clearing width (FPPR s. <a href="#">37</a>, <a href="#">38</a>, <a href="#">54</a>, <a href="#">79</a>)</li> <li>• the drainage systems of the road are functional (FPPR s. <a href="#">79</a>)</li> <li>• the road can be safely used by industrial users (FPPR s. <a href="#">79</a>)</li> <li>• protection of wildlife and other resource features (FPPR s. <a href="#">69</a>, <a href="#">70</a>)</li> </ul>	
B1.	Use the results of an engineering risk analysis to prepare road maintenance inspection schedules and establish priorities for road maintenance inspections. [see <a href="#">Road Risk Ratings Section 6.6.1</a> ]
B2.	For non-industrial use FSRs maintained by Timber Pricing and Operations Division/BCTS, carry out road maintenance inspections in accordance with the frequency levels provided in Table 6-3, and after receiving any reports of potential hazard events along the road or of actual damage to the road, forest resources, or other values. [see <a href="#">Non-industrial use FSRs maintained by Timber Pricing and Operations Division/BCTS Section 6.6.2</a> ]
B3.	Record in a road inspection report any deficiencies observed. [see <a href="#">Road Maintenance Inspection Reports Section 6.6.3</a> ]
B.4	Consult with the ministry bridge engineer when developing the annual strategy and the contracts for routine condition and close proximity bridge and major culvert inspections [see <a href="#">Types of Inspections Section 6.7.1</a> ]
M1.	Unless a professional engineer specifies otherwise, bridges and major culverts composed of steel, concrete, or treated timber <b>must</b> be inspected by a qualified Inspector at least once every three years, unless access to the structure is prevented by a man-made or naturally occurring barricade or blockage, and a record of the inspection made. If stringers are untreated wood and/or the abutments are untreated log cribs, the structure <b>must</b> be inspected at least once every two years, unless access to the structure is prevented by a man-made or naturally occurring barricade or blockage [see <a href="#">Inspection Frequencies Section 6.7.3</a> ]
M2.	All close proximity bridge and major culvert inspections <b>must</b> be carried out by a professional engineer or under a professional engineer's direct supervision [see <a href="#">Close Proximity Section 6.7.1</a> ]
B.5	Ensure that the ministry bridge engineer reviews the inspection reports and determines whether a follow-up professional inspection is warranted [see <a href="#">Structural Deficiencies Section 6.7.2</a> ]
B.6	Where the ministry bridge engineer determines that a bridge will be posted as downrated or a structure is being recommended for closure or removal, the ministry bridge engineer advises the TSM/District Manager accordingly as soon as practicable [see <a href="#">Structural Deficiencies Section 6.7.2</a> ]
B.7	Document all road maintenance inspections using a suitable road maintenance inspection report. Place a hard copy of the report on file for possible future review by the appropriate ministry manager or for review by others in the case of forest practices audits. [see <a href="#">Road Maintenance Inspection Reports Section 6.6.3</a> ]
B.8	Timber Pricing and Operations Division/BCTS staff that travel on FSRs have a responsibility to report to the TSM/District Manager any road maintenance problems that they observe in the course of their duties, and believe are significant. [see <a href="#">Routine Observations Section 6.6.2</a> ]
M3.	The District Manager <b>must</b> advise a new designated maintainer (under RUP) of any chronic or current maintenance issues that may exist along that part of an FSR for which the maintainer is responsible. In those situations where the only industrial users are TSL holders, and the maintainer is a TSL holder, BCTS <b>must</b> collect sufficient data to address those maintenance issues, and provide the information to the District Manager in a timely manner for review and dissemination to the maintainer. [see <a href="#">Industrial Use FSR Section 6.6.2</a> ]

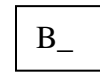
B9.	Ensure that road maintenance inspection reports are reviewed and signed off by the appropriate Timber Pricing and Operations Division/BCTS staff prior to filing. Additionally, enter a record of the road maintenance inspection report into the appropriate computerized road management system. [see <a href="#">Road Maintenance Inspection Reports Section 6.6.3</a> ]
B10.	Where the responsibility for maintenance has been delegated to a Road Use Permit (RUP) holder, forward a copy of the inspection report, along with a District Manager's covering letter highlighting any structural deficiencies, to the RUP holder [see <a href="#">Inspection Reports Section 6.7.5</a> ]
B11.	Retain road inspection reports on file as documented evidence that inspections have been carried out, and to serve as references for future maintenance projects. [see <a href="#">Road Maintenance Inspection Reports Section 6.6.3</a> ]
B12.	After completing a road, bridge, or major culvert inspection, carry out any recommended maintenance works to address deficiencies in a time period that is commensurate with the risk to the road or structure, its users, and forest resources and other values [see <a href="#">Scheduling Maintenance Works Section 6.8</a> ]
B13.	Carry out road maintenance to ensure user safety and stability of the road prism; minimize sediment transport from the road prism; and ensure that the road system will fulfill its designed function until deactivation [see <a href="#">Road Prism Maintenance Section 6.10.3</a> ]
B14.	Carry out stream culvert maintenance to ensure that a structure maintains its capability to pass fish and convey stream flow [see <a href="#">Stream Culvert Maintenance, Section 6.11.2</a> ]
B15.	Carry out surface and structural maintenance of bridges and major culverts in accordance with the inspection reports, and carry out a follow-up inspection of structural repairs to confirm that the work has been done in conformance with the proposed repairs in the inspection report [see <a href="#">Structure Maintenance Section 6.11</a> ]
B16.	Ensure that the necessary steps in the inspection and maintenance processes were undertaken and issues addressed [see <a href="#">Project Tracking Checklist</a> ]

In the above table of chronological events:

Mandatory Procedures are marked



and Best Practices are marked



## 6.4 Road and Structure Maintenance Annual Plan

Identify proposed road and structure maintenance projects on FSRs for budget planning and preparation purposes in an annual maintenance plan.

Three key objectives of a road and structure maintenance plan are to:

- (1) provide a planning mechanism to help identify priorities for road and structure maintenance;
- (2) ensure consistent and efficient allocation of ministry funding; and
- (3) reduce the ministry's liability by prioritizing and allocating funding for road and structure maintenance based on the results of a documented maintenance inspection and engineering risk analysis of the roads and structures.

A ranking procedure involves preparing a list of candidate road and structure maintenance projects that will require funding, and then ranking the projects by priority according to established criteria based on the estimated levels of risk to known values within and adjacent to the road right-of-way, and consideration of vehicle access needs. The list is prepared by reviewing available road and structure maintenance inspection reports on hard copy file or on a corporate

database, and other relevant information, and considering the historical record of annual road and structure maintenance required on individual FSRs.

## **6.5 Road and Structure Maintenance Levels**

Current legislation requires:

- (1) at least a minimum level of road and structure maintenance on all forest roads, called a “wilderness road” level of maintenance; and
- (2) a high level of road and structure maintenance on all industrial use roads, called an “industrial use” level of maintenance.

These two road and structure maintenance levels are briefly defined as:

- Wilderness road level of maintenance includes those road and structure maintenance works required for the protection of forest resources. It excludes vehicle access-related types of surface and structural maintenance, other than installing a barricade to prevent access when the road is unsafe to use, unless such maintenance is necessary to mitigate a moderate to high risk of damage to forest resources and other values.
- Industrial use level of maintenance includes a wilderness road level of maintenance, plus other vehicle access-related types of surface and structural maintenance to ensure that the structural integrity of the road prism and clearing width are protected, the drainage systems of the road are functional, and the road can be used safely by industrial users.

In addition, Timber Pricing and Operations Division has the responsibility for providing for:

- safe public access to “high value” forest recreation sites and trails or “important” recreational areas (as defined by Ministry of Tourism, Culture and the Arts); and
- safe public access to year-round communities.

## **6.6 Road Maintenance Inspections**

Focus road maintenance inspections on the structural integrity of the road prism and clearing width, the effectiveness of drainage systems, and the condition of the road surface. Also consider road user safety, including signage and any values at risk. In addition, include in any road maintenance inspection a cursory examination of stream crossing structures to capture any visible signs of structural problems, abutment and pier scour, fish passage impediments or sediment deposition.

Before road maintenance inspections are carried out on FSRs, know and understand the level of road maintenance required on the road (e.g., wilderness road, industrial use, recreation access, community access) and the vehicle access objectives.

Prepare a road maintenance inspection schedule (see Maintenance Inspection Schedule) well in advance of the new fiscal year so that inspection costs and necessary staff resources can be budgeted for. A road maintenance inspection schedule includes the road names, the road use category (rural resident and recreation use; environmentally maintained (wilderness road); industrial use), the road risk rating, the scheduled times for planned road maintenance inspections, plus any pertinent comments that may impact schedules and practices.

Identify and prioritize required road maintenance works from field information documented during road maintenance inspections, and from information and incidents supplied by road users. From this information, prepare a road maintenance works plan to schedule and budget for required maintenance works to address the deficiencies.

Refer to the Fish-stream Crossing Guidebook when planning road maintenance inspections and maintenance works at fish-stream crossings.

### 6.6.1 Road Risk Ratings and Maintenance Inspection Priorities

Use the results of an engineering risk analysis to prepare road maintenance inspection schedules (see [Inspection Frequency Levels](#)) and priorities for road maintenance inspections. Risk is the chance of injury or loss, defined as a measure of the probability (likelihood) and the consequence of an adverse effect to health, property, the environment, or other things of value.

A road engineering risk analysis involves estimating levels of risk to known values at risk (such as road user safety, forest resources, and other values as may be appropriate) from potential hazardous and affecting events associated with the road. For example, a road on steep terrain rated as having a “High” risk of damage to water quality from a failure of the road drainage system would likely be assigned a higher inspection priority and scheduled for more frequent maintenance inspections than a road on gentle terrain that is rated as “Low” risk.

Hazard, for assigning inspection priorities based on risk, is a source of potential harm or a situation, danger, or threat with a potential for causing an undesirable consequence. Identify and record hazards during maintenance inspections of roads and structures. For example, hazards within the road corridor or on slopes adjacent to the road corridor may include the following, among others:

- cut and fill slope failures and shoulderslumps;
- washouts;
- poor road running surface;
- brushed-in road corridor;
- an ineffective road drainagesystem;
- blocked ditches and culverts;
- on-going beaver activity at drainagestructures;

- recurring fish passage issues on fish streamculverts;
- soil erosion and sedimenttransport;
- filled in cross-ditches;
- erosion events related to weather;
- damaged guard rails or curbs on bridges;
- deterioration of structuralelements;
- landslides; floods (freshet and heavyrain);
- hazardous spills.

Consequence is an effect on elements at risk. Elements at risk include humans, property, and forest resources [11 values identified in the [Forest and Range Practices Act \(Sec. 149\)](#)] and other values that may be at risk of damage or loss.

Conceptually, consequence is the change, loss, or damage to one or more element caused by a hazard event occurring, and may involve consideration of an element's worth.

"Risk rate" those roads undergoing road maintenance inspections, using a qualitative risk-analysis procedure.

There are many methods of risk analysis. Traditionally, risk (R) has been mathematically expressed as the product of two components: probability (likelihood) of occurrence (P) of a detrimental event, and consequence (C).

$$\text{Risk} = P \times C$$

Risk may also be expressed as the product of partial risk and vulnerability of the element at risk described in [Land Management Handbook 56 \(Sec. 3.6.1\)](#) (Wise et al. 2004):

$$\text{Risk} = P(\text{HA}) \times \text{vulnerability, where}$$

**P(HA)** is partial risk and equal to the product of the probability (likelihood) of a **h**azard event occurring within a given period of time, and the probability that the hazard event will reach or **a**ffect the site occupied by a specific element of concern given that it occurs; and

**vulnerability** of an element (a component of consequence) is the estimated degree of loss to an element at risk, given that the hazard event occurs and reaches or affects the site.

A risk matrix is typically used to combine two risk components to determine qualitative risk ratings: Very High (VH), High (H), Moderate (M), Low (L), and Very Low (VL).

An example of such a matrix is shown in Table 6-2. It is a five-row by three-column qualitative risk matrix that combines relative P(HA) ratings (VH, H, M, L, VL) and relative vulnerability ratings (H, M, L). However, a three-row (H, M, L) by three-column (H, M, L) matrix is often satisfactory for the purpose of assigning road maintenance inspection frequency levels and priorities (and maintenance works priorities).

**Table 6-2 Example of a simple qualitative risk matrix for analyzing risk to visual resources**

<i>Risk = P(HA) x vulnerability, expressed as an annual likelihood of damage to visual resources in a scenic area from a road-associated landslide event<sup>a, c</sup></i>		Vulnerability ratings for visual resources in a scenic area (from <a href="#">Table 6-8</a> in Appendix 6.1)		
		High Damage	Moderate Damage	Low Damage
<b>P(HA)<sup>d</sup>: Annual likelihood of occurrence of a road-associated landslide and it reaching or affecting areas of timber on the slope below the road</b>	<b>Very High</b>	Very high	Very high	High
	<b>High</b>	Very high	High	Moderate
	<b>Moderate</b>	High	Moderate	Low
	<b>Low</b>	Moderate	Low	Very low
	<b>Very Low</b>	Low	Very low	Very low

**Notes: Table 6-2**

<sup>a</sup> The hazard or source of potential harm in this example is a road-associated landslide.

<sup>b</sup> The element at risk is visual resources in a scenic area (see [Table 6-8](#) in Appendix 6.1).

<sup>c</sup> From the table, if P(HA) is High, and vulnerability is Moderate Damage, then the risk is High (expressed as an annual likelihood of damage to visual resources in a scenic area from a road-associated landslide).

<sup>d</sup> It is assumed that for P(HA):

- Very High = the landslide event is expected to occur and affect the landscape in a scenic area (almost certain).
- High = the landslide event will probably occur under adverse climatic conditions and affect the landscape in a scenic area (likely).
- Moderate = the landslide event could occur under adverse climatic conditions and affect the landscape in a scenic area (possible).
- Low = the landslide event might occur under very adverse climatic conditions and affect the landscape in a scenic area (unlikely).
- Very Low = the landslide event is inconceivable (rare), but it would affect the landscape in a scenic area if it occurred.

[Tables 6-4 to 6-9](#) of [Appendix 6.1](#) provide examples of vulnerability tables for the following elements: forest road; domestic water supply; fish habitat; wildlife



(non-fish) habitat and migration; visual resource in scenic area; and timber. The example vulnerability tables express, in terms of three relative qualitative ratings – H, M, and L – the degree of loss to an element at risk because of some hazard event occurring. Use these tables, in whole or in part, or in some modified form as required to reflect specific road and site conditions and elements at risk, to determine an element’s vulnerability for the purpose of assigning inspection priorities based on risk.

After the road has been “risk rated” – that is, as (H, M, or L) or (VH, H, M, L, or VL) – evaluate the risk as being acceptable or unacceptable, and assign maintenance inspection priorities (and frequencies) accordingly. Generally, for a road that has a risk rating of “Moderate” or “High” assign a higher priority for maintenance inspections.

For more information on risk management processes and different methods of risk analysis and risk matrices, refer to the following:

Basic information on qualitative risk analysis:

- B.C. Ministry of Forests. [Managing Risk Within a Statutory Framework](#)
- B.C. Ministry of Forests. [Forest Road Engineering Guidebook](#) (June 2002)

Comprehensive technical references on qualitative and quantitative risk analysis:

- Wise, M.P., G.D. Moore, and D.F. VanDine (editors). 2004. [Landslide risk case studies in forest development planning and operations](#). B.C. Min. For., Res. Br., Victoria, B.C. Land Manage. Handb. No. 56.
- References listed on the website of the [Division of Engineers and Geoscientists in the Forest Sector](#)

## 6.6.2 Road Inspection Frequencies

### Industrial Use FSRs

The District Manager ***must*** advise a new designated maintainer (under RUP) of any chronic or current maintenance issues that may exist along that part of an FSR for which the maintainer is responsible. In those situations where the only industrial users are TSL holders, and the maintainer is a TSL holder, BCTS ***must*** collect sufficient data to address those maintenance issues, and provide the information to the District Manager in a timely manner for review and dissemination to the maintainer.

Carry out additional one-off inspections due to catastrophic events or due to new pertinent site information provided by FLNR staff, public users or other agencies.



### Non-industrial Use “Rural Resident & Recreation Use FSRs”

In accordance with [Table 6-3](#), ensure that the district carries out road maintenance inspections on non-industrial use “Rural Resident & Recreation Use FSRs” at least once per year, plus additional inspections after major storms and prior to annual freshets. Carry out additional one-off inspections due to catastrophic events or due to new pertinent site information provided by FLNR and public users or other agencies.

### Non-industrial use FSRs maintained by Timber Pricing and Operations Division/BCTS

Timber Pricing and Operations Division/BCTS ***must*** carry out road maintenance inspections on those non-industrial use FSRs maintained by Timber Pricing and Operations Division/BCTS in accordance with frequency levels provided in Table 6-3 “[Inspection Frequency Levels for "Environmentally Maintained FSRs](#) (Wilderness Roads)” that vary with road risk ratings. For these roads, Timber Pricing and Operations Division/BCTS ***must*** carry out inspections after receiving any reports of potential hazard events along the road or of actual damage to the road, forest resources, or other values. Often the most revealing time to inspect roads to assess the adequacy of ditches and culverts and the need for improvements (to drainage works, road surfacing, revegetation, and other elements of road integrity and user safety) are during or after the spring freshet, before fall rains, and after extreme weather events. The key criteria applied to determining inspection frequency levels on Environmentally Maintained FSRs (wilderness roads) are:

- for any Environmentally Maintained FSRs (wilderness roads) that have not received a road risk rating, the Inspection Frequency Level defaults to 1 in Table 6.3 (i.e., at least once a year plus additional inspections after major storms and prior to annual freshets);
- usually, the assignment of an Inspection Frequency Level for an Environmentally Maintained FSR (wilderness road) is based on the highest level that would be achieved for individual road sections along that road (modified as appropriate to account for locations of hazards along the road);
- a road inspection may dictate the need to vary the future Inspection Frequency Level due to changed site conditions.

**Table 6-3 Inspection Frequency Levels for FSRs Maintained by Timber Pricing and Operations Division/BCTS**

Minimum Inspection Frequency Level for Non-industrial Use Environmentally Maintained FSRs (Wilderness Roads)	Road Risk Ratings
<p><b>1</b></p> <p>At least once a year plus additional inspections after major storms and prior to annual freshets</p>	A current road risk rating of <b>Moderate, High, or Very High</b>
<p><b>2</b></p> <p>At least once every two years</p>	A current road risk rating of <b>Low or Very Low</b>
<p><b>3</b></p> <p>At least once every three years</p>	A current road risk rating of <b>Low or Very Low AND</b> where the road is closed to public access by a man-made or naturally occurring barricade or blockage

Notes:

- For the purposes of Table 6-3, an inspection is one for which an Inspection Report is completed (see [Maintenance Inspection Report](#))
- Table 6-3 does not preclude the need for one-off inspections due to catastrophic events or due to new pertinent site information provided by FLNR and public users or other agencies.

### Collision-Related Road and Bridge Inspections

Where a District Manager (DM) or a Timber Sales Manager (TSM) learns that a serious motor vehicle collision has occurred on a Forest Service Road (FSR), it is recommended that the manager holding administrative responsibility for the road, direct engineering staff to conduct and document a road and or bridge inspection for the identified road. The road inspection should occur as soon as possible, especially if there has been a report of injury or death. It is important to note that road inspections are not intended to be “collision investigations” to determine causal effects. Collision investigation is a specialized area of expertise and ministry engineering staff would not be typically trained in this area. Collision investigations may be conducted by the RCMP, WorkSafe BC, insurance agency or others who have the expertise to do so.

The focus of ministry road and bridge engineering program inspections is to assess the road and/or bridge for safe travel and use, and to identify and address any observed maintenance or safety issues. Road inspections should extend in both directions well beyond the area that may be causal to an investigation of the scene of the reported collision. The inspector must document inspection observations and findings, and place the report on the appropriate corporate file. Inspection reports should contain detailed descriptions and photographs of what the local road and/or bridge and weather conditions were like at the time of the collision. It may be the case that this inspection report will be referenced in future litigation.

In some instances Worksafe BC (WSBC) may order FLNRO to undertake an investigation subsequent to an incident. While WSBC has the authority to compel any employer to undertake an investigation these orders do not generate any authority for FLNRO to compel or access information. Accordingly, FLNRO may only explore the circumstance from the perspective of its own role as road administrator, maintainer or as a workplace owner, according to the circumstances. Most commonly we would be the road administrator or possibly the maintainer. Note resource roads that are being used for transportation or travel do not constitute a workplace however construction sites on the road are workplaces as are the vehicles traveling on the road. Investigative authorities of WSBC, coroner's office, insurance agency and the RCMP must be respected including acknowledging the limitations these authorities may have on sharing of information that is under investigation.

Where industrial maintenance issues are found on Forest Service Roads, they should be brought to the attention of the maintainer. Where there is no maintainer, the DM or TSM will need to address as appropriate in consideration of industrial, public and environmental safety. For serious maintenance issues of potential non-compliance, it may be appropriate to refer the findings to Compliance and Enforcement for follow-up.

Consistent with the Safety Management System, Incident Response Guide, for serious incidents, an Information Note should be developed and provided to the Assistant Deputy Minister such that senior managers and the ADM are apprised and not caught off-guard.

### **Routine Observations**

Timber Pricing and Operations Division/BCTS staff that travel on FSRs have a responsibility to report to the TSM/District Manager any road maintenance problems that they observe in the course of their duties, and believe are significant.

#### **6.6.3 Road Maintenance Inspection Reports**

Road maintenance inspections cover key road components. Record in an inspection report any deficiencies observed. Where major problems are identified, take photographs to accompany the inspection reports. Assess and evaluate the following when a road maintenance inspection is carried out:

- user safety;
- structural integrity of the road prism and clearingwidth;
- drainage systems;
- potential for transport of sediment from the road prism;
- road and bridge surfaces;
- fish passage at stream crossings; and
- any upgrade requirements necessary for proposed industrial use.

Document all road maintenance inspections using a suitable road maintenance inspection report. Place a hard copy of the report on file for possible future review by the appropriate ministry manager or for review by others in the case of audits. The review of past reports can be helpful for identifying road segments or drainage structures that:

- (1) have recurrent problems and should receive a higher road risk rating, or
- (2) should receive more frequent inspections or be scheduled earlier for maintenance works.

Ensure that road maintenance inspection reports are reviewed and signed off by the appropriate Timber Operations and Pricing Division/BCTS staff prior to filing. Additionally, enter a record of the road maintenance inspection report into the appropriate computerized road management system.

A sample road maintenance inspection report is provided (see [Maintenance Inspection Report](#)). Use the sample inspection report (or other equivalent report formats) to document maintenance inspections of roads and minor drainage structures.

Include in the road maintenance inspection reports:

- the current and revised (if any) road risk rating;
- the date of the inspection (to establish a time frame for maintenance works, to have on hand for future reference, and to provide a better inspection history record);
- the name of the person doing the inspection (for accountability and for future reference);
- details about the weather conditions at the time of the inspection (to explain observed surface runoff conditions that have occurred with prolonged or intense rainfall events before or during culvert inspections);
- the road name and project number (to identify where the inspection took place);
- the purpose of the inspection (scheduled, post-storm event, user complaint, other);
- the location of the inspection by geographic coordinates or station (e.g., “km 0.0 through to km 6.35,” to identify the exact location of any concerns);
- the locations of individual problems by geographic coordinates or station, and all relevant data for each issue;
- description of problems using Inspection Codes;
- good quality site photographs taken from a logical point of view or perspective;

- a recommended reasonable time frame for repairs to be completed, and a rationale for that time frame (e.g., maintenance work should be carried out before fall rains to reduce soil erosion and sediment transport); and
- any further description of the works required should be placed in the Comments section for each location.

As a result of the inspection, identify those works to be entered into either the current or the future maintenance works plan. When possible and commensurate with the priorities of Timber Operations and Pricing Division/BCTS, address deficiencies within an appropriate time frame.

Prepare a road maintenance works plan and prioritize maintenance works in accordance with the risks identified in the inspections. Retain the inspection reports on file as documented evidence that inspections have been carried out, and to serve as references for future maintenance projects. Reviews of past reports and records can assist forest road managers in identifying recurrent problems and identifying those road sections to be assigned a higher risk rating.

## **6.7 Bridge and Major Culvert Inspections**

### **6.7.1 Types of Inspections**

Bridge and major culvert inspections can be broadly categorized into two types: routine condition and close proximity inspections. Consult with the ministry bridge engineer when developing the annual strategy and the contracts for routine condition and close proximity bridge and major culvert inspections.

#### **Routine Condition Inspections**

Routine condition inspections involve visual and physical (non-destructive) testing of log stringer, steel, concrete, or glulam bridge components, or major concrete, log, or steel culverts. Ensure that these inspections are completed by qualified Inspectors who have appropriate training and experience in inspecting bridge and major culverts and interpreting the results, with the mandatory knowledge and skills requirements listed under service category T07 ([Technical Bridge and Major Culvert Condition Inspection](#)) of the ministry's [Engineering Equipment and Services \(EES\) Directory](#).

For example, if rot is found in wood components, have the Inspector assess the significance of the rot relative to the structure's integrity, and evaluate whether the structural integrity of the components is at risk, considering the amount of rot, component type and use, and location of the rot in the component being inspected. Have the Inspector determine whether structural deficiencies require evaluation by a professional engineer or can be simply rectified with suitable minor repairs.

#### **Close Proximity Inspections**

Close proximity inspections are generally carried out to review complex, larger structures or where deficiencies have been noted in routine condition inspections.

Typically, an increasingly higher level of expertise is used in interpretation of results as the inspection progresses. Primary structural components receive a detailed inspection and specialized access equipment is often required to enable the close inspection of structural elements at close range. All close proximity inspections ***must*** be carried out by a professional engineer or under a professional engineer's direct supervision. Ensure that the professionals providing this service have the mandatory knowledge and skills requirements listed under service category P06 ([Professional Condition Inspection and Evaluation of Forest Road Bridges and Major Culverts](#)) of the ministry's [Engineering Equipment and Services \(EES\) Directory](#).

### 6.7.2 Structural Deficiencies Noted in Inspections for FSR Structures

A sequence for identifying and correcting structural deficiencies in bridges and major culverts is:

- a qualified Inspector identifies and records possible structural deficiencies and specifies on the inspection forms if a follow-up inspection by a professional engineer is required to evaluate the deficiencies. Bring any structural deficiencies which may pose an immediate risk to users to the attention of the TSM/District Manager, as soon as possible;
- ensure that the ministry bridge engineer reviews the inspection reports and determines whether a follow-up professional inspection is warranted. If the decision is no, ensure that the ministry bridge engineer generates a letter to the local office, stating the findings and making recommendations as appropriate. If a follow-up professional inspection is required, ensure that the professional engineer who subsequently carries out the field review recommends, as applicable:
  - the work to be carried out to correct the deficiencies; or
  - the need to protect road users by either:
    - installing signs detailing the load rating prepared by the professional engineer (see [Warning Load Limit sign FS 639a](#)); or
    - closing the bridge to traffic or removing the structure.
- Where the ministry bridge engineer determines that a bridge will be posted as downrated or a structure is being recommended for closure or removal, the ministry bridge engineer advises the TSM/District Manager accordingly as soon as possible.

### 6.7.3 Clarification of GVW as Applicable to Bridge Load Rating

Gross Vehicle Weight (GVW) is the total weight of the vehicle including cargo. Load rating for a structure typically involves complex calculations and judgement and then distilling the results down to a simple number (typically a maximum GVW). Because of the limited information included on a load rating sign, users can often misinterpret the load restriction. This bulletin is intended to provide clarity for the meaning of Gross Vehicle Weight, as applicable to bridge load rating.

Gross Vehicle Weight (GVW) load ratings for bridge structures are typically based on the BCFS L-series design vehicles. The BCFS L-series design vehicles are not “real” vehicles but are intended to be “envelope” logging truck vehicles which capture the force effects of the population of “normal” logging trucks. Force effects from load configurations consisting of other types of vehicles, such as yarders and excavators, are not typically captured by the design vehicles. Equipment crossings of this nature should be evaluated by a professional engineer on a bridge by bridge basis.

The L-series design configurations were founded on imperial (“short”) tons (as opposed to “long” metric tonnes and kilograms). For example, a BCFS L-75 has a GVW of 75 imperial tons which is equal to 68 tonnes or 68,040 kilograms.

There are a number of design vehicle configurations which have been utilized over time. Some of these are no longer used to design new structures. There are, however, existing structures which were designed using these configurations that are still in service. Primary examples include the BCFS L-45 and BCFS L-60.

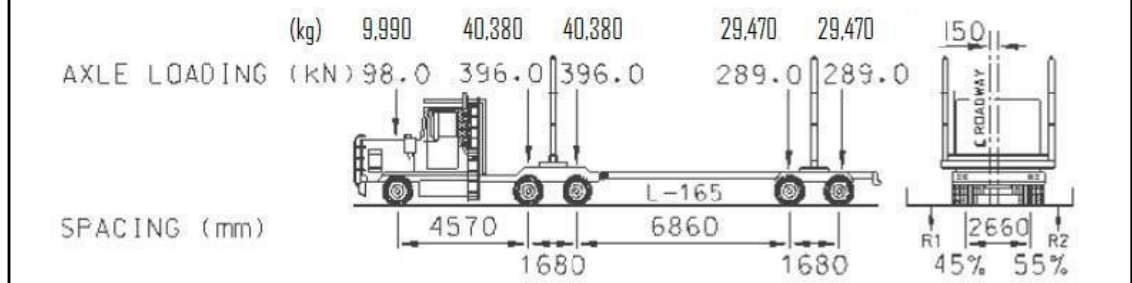
The CL 625 and BCL 625 highway vehicle design configurations are exceptions to typical logging truck configurations. These configurations are drawn from the Canadian Highway Bridge Design Code (CSA S6) and BC Ministry of Transportation and Infrastructure. These highway vehicle configurations were adopted by the Ministry of Forests, Lands and Natural Resource Operations in order to be consistent with MoTI design configurations for highway loads. Bridges designed to these loads are considered to have sufficient capacity to support provincial highway legal loads.

The following table provides a comparison of different design vehicle GVW ‘s for short (English) tons, kilonewtons, kilograms and long (metric) tonnes.

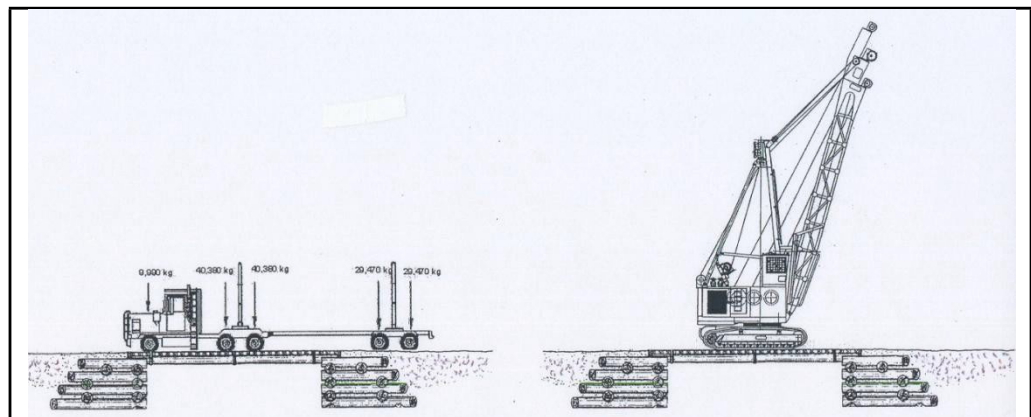
Design Vehicle Configuration	Gross Vehicle Weight			
	Tons (Imperial)	Kilonewtons (KN)	Kilograms (Kg)	Tonnes (metric)
BCFS				
L-45	45	408.2	40,820	41
L-60	60	533.8	54,430	54
L-75	75	667.2	68,040	68
L-100	100	889.6	90,680	91
L-150	150	1334.6	136,090	136
L-165	165	1468	149,700	150
CSA-S6 Canadian Highway Bridge Design Code				
CL-625	70	625	63,732	64
Ministry of Transportation – modified from CSA-S6				
BCL-625	70	625	63,732	64

A bridge structure that is load rated to a specified GVW does not mean that the structure can safely pass any vehicle with a weight equal to or lesser than the GVW. A load rating is dependent on the assumed axle configuration and weight distribution between axles. The design vehicles on which the GVWs are based have their load distributed over a number of axles over the length of the vehicle. A bridge that is shorter than the design vehicle would not have all of the axles of the vehicle on the bridge simultaneously and thus the full vehicle GVW would not be on the bridge. The force effect is dependent on the axle or axle group loads on the bridge rather than the overall GVW. Further, the bridge may not have the capacity to support a concentrated load of equal weight to the posted maximum GVW, such as a large tracked machine.

#### Example Design Vehicle Loading Diagram - BCFS L-165 (GVW 149,700 KGs)



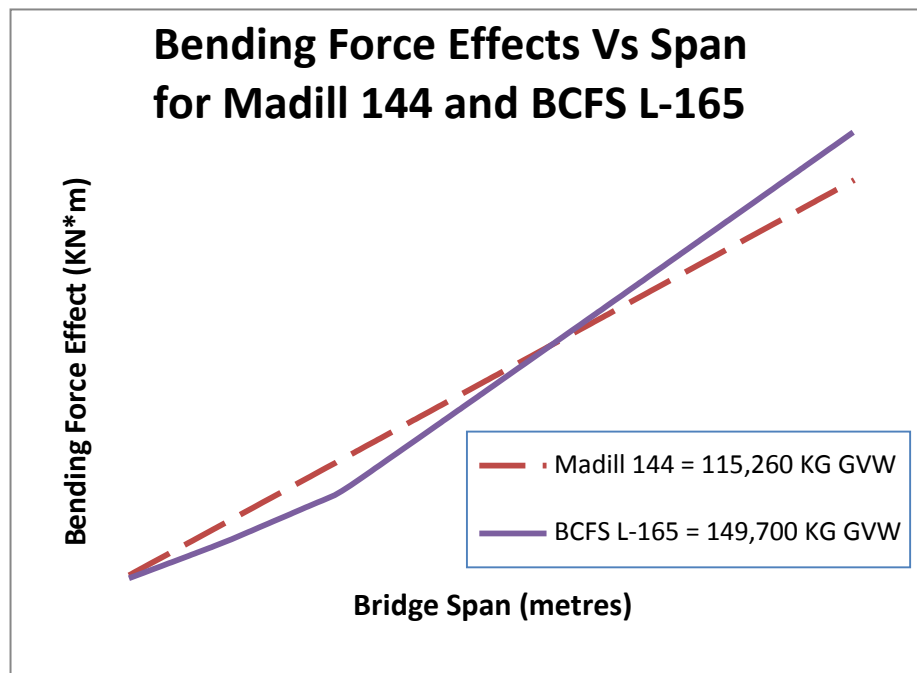
#### Forest Effects of Design Vehicles Versus Concentrated Equipment Loads



The graphic above shows a 10 metre span bridge with a L-165 truck on the left and a 144 Madill Yarder on the right. The vehicles are positioned where the maximum bending force effect would occur on the bridge. As you can see, the truck only has the front three axles (with a combined weight of 90,680 kilograms) on the bridge, whereas the full yarder (GVW 115,620 kilograms) is on the bridge at its centre. The yarder generates a force effect of 2,168 kN\*m while the truck only generates 1,670 kN\*m. The yarder bending force effect is 130% of the logging truck. A 10 metre bridge designed for L-165 loading would not have adequate capacity for a Madill 144 yarder.



The following graph of bending force effects versus bridge span is provided for illustrative purposes only and is not to be used to interpret allowable loads for application to any actual structure.



The graph shows the bending force effects arising for a 144 Madill yarder with a GVW of 115,260 kilograms as compared to a BCFS L-165 logging truck configuration with a GVW of 149,700 kilograms. Although the yarder has a significantly lower GVW, the resulting bending force effects are significantly greater than that of the heavier L-165 logging truck for shorter span bridges. This result is due to the concentration of the weight of the yarder over a shorter length. In contrast, the logging truck does not have all of its axles on the shorter span bridges. As the bridge length increases, more truck axles come into play on the bridge, resulting in the bending force effects of the logging truck surpassing those of the yarder.

### Road Network Design Vehicle Load Rating

Typically, road networks have a specified design vehicle load configuration identified. All bridge structures would be designed for the specified design vehicle load. There have been incidents where a bridge with a lower design load has been installed at the beginning of the road network. This can effectively result in the lower design load restricting access on the full road network.

The design vehicle load configuration for Forest Service Roads would ideally be posted at the commencement and other entrances to the road. Only bridges which were not capable of meeting that design vehicle load would be posted with a sign specifying an allowable safe GVW which has been determined by a Professional Engineer. New guidance is being developed for road signage and will be available in the foreseeable future.

## Safe Vehicle Passage

Any concerns for safe capacity of bridge structures should be brought to the attention of a ministry field engineer. Where it is uncertain whether a particular vehicle can safely cross a bridge, a professional engineer should be consulted to assess the structure for the specific vehicle. For any structure that has been down rated, professional engineering advice is critical to avoid errors in interpretation. Failure to assess the carrying capacity of a bridge can have disastrous results as exemplified in the picture below.



### 6.7.4 Bridge and Major Culvert Inspection Frequencies

For the purposes of determining inspection frequencies, ministry bridge structures are categorized as “Permanent” or “Temporary” - see [Chapter 4.2 Introduction. Definitions.](#)

Unless a professional engineer specifies otherwise:

- Permanent bridge structures and major culverts (excepting log / woodbox culverts) **must** be inspected by a qualified Inspector at least once every three years, and a record of the inspection made, unless access to the structure is prevented by a man-made or naturally occurring barricade or blockage.

**Note:**

Provided that its stringers or girders are comprised of permanent materials, a bridge is categorized as a permanent structure even though it may have untreated timber deck cross-ties and / or untreated timber sills bearing on an abutment that is comprised of permanent materials.

- Temporary bridges and log / woodbox culverts that are defined as major culverts (Section 4.2 - log stringer/gravel deck structure with a span less than

6 m and a design discharge of 6 m<sup>3</sup>/s or greater) **must** be inspected at least once every two years, and a record of the inspection made, unless access to the structure is prevented by a man-made or naturally occurring barricade or blockage.

In addition to regular scheduled inspections, inspect structures after severe storm events.

Where warranted, crossing structure inspection frequency can be increased to be more often to provide for increased monitoring, such as when a bridge structural element is nearing the end of its service life, or where conditions exist which merit more frequent inspections as may be suggested by an inspector or determined by a professional engineer.

### 6.7.5 Bridge and Major Culvert Inspection Reports

Include the following in the inspection record of a bridge or major culvert:

- date of the inspection;
- a condition assessment of the components of the structure, including the approaches, and considering among other things the length of time a bridge has been at its current site;
- a recommendation for any repairs that may be required and a schedule for those repairs;
- the date of the next scheduled inspection provided by the reviewing professional engineer;
- inspector's signature; and
- professional engineer's signature and date.

The inspection records are used to identify current maintenance requirements as well as track the condition of the structure and required maintenance over time. Take illustrative photos during the inspection and provide a visual aid for the professional engineer evaluating the structure condition. Photos of deficiencies or suspect problems are particularly useful. The photos also provide an opportunity to track progression of condition of various bridge and major culvert components over time such as abutment erosion.

Retain inspection records for bridges and major culverts for one year beyond the actual life of the structure, or for portable superstructures, the records should be retained with the superstructure records for one year beyond the actual life of the superstructure. Should a structure fail, these records will be useful in any subsequent investigation. Use the inspection records as a reference to determine the type of structures that are cost-effective and environmentally suitable for similar streamcrossings.

Review the recommendations to ensure that the maintenance works comply with legislation. Ensure that the appropriate electronic bridge register is updated, that

signed original inspection reports are provided for the project files, and that the local FLNR manager is advised of any structural issues that would impact ongoing use.

For bridge inspections, use the applicable ministry form available from the ministry form index: [FS1337A - Log Stringer or Timber Stringer Bridges](#); [FS1337B – Bridges Except for Log Stringer or Timber Stringer Bridges](#); [FS1337C - Culvert Inspection](#). Place copies of the completed inspections, signed by the inspector and professional engineer, on the appropriate Operational Records Classification System (ORCS) files and/or entered into the bridge register.

Where the responsibility for maintenance has been delegated to a Road Use Permit (RUP) holder, forward a copy of the inspection report, along with a District Manager's covering letter highlighting any structural deficiencies, to the RUP holder. Where structural deficiencies are such that there is a risk to users, advise the RUP holder immediately, in the most expedient way, that there is a problem with the structure.

When structural repairs are completed, ensure that an inspection of the completed works is carried out and a new inspection report generated for review by a ministry bridge engineer. Where time is not of the essence, consider carrying out the inspection of these works as part of a future road inspection.

#### **6.7.6 Bridge and Major Culvert Inspection Documentation**

Place signed originals of final bridge and major culvert inspection reports on the hardcopy project file. Also, place any follow-up documentation on the file.

### **6.8 Scheduling Maintenance Works**

After completing a road, bridge, or major culvert inspection, carry out any recommended maintenance works to address deficiencies in a time period that is commensurate with the risk to the road or structure, its users, and forest resources and other values, as determined by the appropriate manager upon review of the inspection report.

Specify the time frames for road maintenance works in the inspection report (see Maintenance Inspection Report). It shows that the time frames may be expressed as "urgency ratings" (VH = within 1 week; H = within 30 days; M = preferably within current field season but before the next field season; L = reassess situation next inspection). "Reasonable time" to carry out maintenance works varies according to the specific site and problems identified. For example, waiting until equipment is in the area is inappropriate if the road fill is already failing and washing into a stream. However, waiting for equipment may be appropriate where a raveling cut slope is filling in a ditch that has a low likelihood of transporting sediment to a stream.

Ensure that the ministry bridge engineer describes the time frames for bridge and major culvert repair/remedial works in the comments section, to differentiate critical works from more routine works.

Consider the guidelines for road works shutdown indicators when maintenance works are being carried out on FSRs. These indicators, and the procedures for shutting down operations, are presented in [Chapter 5: Road Construction](#).

## **6.9 Road User Safety Considerations**

### **6.9.1 During Maintenance Works Operations**

Where FSRs are open to traffic, post high-visibility, reflective “Crew and Equipment Working” signs such as:



or other applicable signs from the BC MoT Traffic Control Manual for Work on Roadways (specified as the standard reference by WorkSafeBC) at appropriate locations along the road to warn approaching traffic of any maintenance operations.

Place the signs in such a manner that they provide drivers with sufficient lead time to react – particularly when the road has many blind curves. Consider installing an additional warning sign at the beginning of the road. Remove these signs whenever crews are not working.

Erect and maintain temporary signs and barricades, with lights or traffic cones if necessary, at the site of any hazards and where any maintenance works are left uncompleted or unattended.

Advertise locally any maintenance projects that will require closing an FSR to traffic, both in advance of the project starting and during the project term, in the form of newspaper advertisements or radio announcements. Provide the public with key information such as the exact location of the work, travel restrictions if any, start and completion dates, and the name of a ministry contact for further information.

If the local ministry office has a “road conditions” page on its public website, update the page to reflect the changed conditions.

## **6.10 Routine Types of Road Maintenance Works**

### **6.10.1 Clearing Width Maintenance**

Clearing width maintenance includes brushing and vegetation control, and dangerous treefalling.

#### **Brushing and Vegetation Control**

Carry out brushing when one of the following conditions occurs:

- The sight distance and/or the usable road width are dangerously impeded or reduced, such that the design speed of the road cannot be safely maintained.
- The useable road width is dangerously reduced to the point that vehicles cannot safely pass each other at road widenings or turnouts or the road cannot be driven at the design speed.
- Drainage systems are functioning below acceptable levels and roadside vegetation is a major contributing factor.
- The presence of roadside vegetation is impeding drying out of the road surface.
- Snow cannot be readily removed.

For example, potential hazards exist where brush limits visibility at the inside of a curve or at bridge approaches, or where heavy snow loads on roadside trees may cause the trees to bend over the road surface, restricting use of the road and creating a user safety hazard.

Manual methods for removing trees, brush, and other vegetation may include the use of axes, machetes, sandvik axes, chainsaws, or gasoline- or air-powered circular saws. These methods are labour-intensive and require close supervision to ensure good production and worker safety.

Mechanical methods may include the use of crawler tractors, graders, hydro-axes, hydro-mowers or attachments for graders, front-end loaders, and excavators. The higher cost of operating mechanical equipment is usually offset by increased brushing productivity and user safety when compared to manual brushing and vegetation control methods. Better clean-up and dressing of gentle cut and fill slopes during construction improves the likelihood of being able to use mechanical methods of brushing after construction.

Use site chipping or mulching to minimize the fire hazard and increase the rate of decomposition. Leave mulch material in the ditchline, as it will usually flush out and through cross-ditch culverts.

Use of chemical defoliants and herbicides is tightly regulated under the province's [\*Integrated Pest Management Act\*](#). The user will possess a valid pesticide applicator's licence and have a valid permit for the pesticide being used.

Be aware that brushing projects can create hazards, such as:

- Accumulated cut vegetation can plug culvert intakes and should be cleaned by hand concurrently with the brushing operation.
- Accumulated vegetation can plug ditchlines and should be either cleaned by hand or by a follow-up machine concurrent with brushing operations.
- Serious physical injury or equipment damage can occur when debris being cut by a machine shatters and flies in unpredictable directions. Appropriate



roadway control (such as flaggers and warning signs) should be used during operations.

### **Dangerous Tree Falling**

In addition to brushing and vegetation control, remove all snags and leaning or overhanging trees that are a safety concern for road users or workers. This is usually accomplished by hand falling. Such trees are known as “dangerous trees” and are defined by the Workers’ Compensation Board of BC (WorkSafeBC), in [Occupational Health and Safety Regulation \(Sec. 26.11\)](#).

## **6.10.2 Ditch and Culvert Maintenance**

Probably the most critical aspect of any road maintenance project is maintenance of the drainage systems. Implement the following types of maintenance works to minimize the likelihood of clogged or damaged drainage systems which can potentially cause roadwashouts:

- Clean and grade ditches.
- Clean and repair culvert inlets, outlets, catch basins, trash racks, flumes, and transition areas from the ditchline to catch basins.
- Replace or repair ditchblocks, small culverts, flumes and rip rap, head walls, and spillways, particularly during and after major storms and after yarding and loading operations.
- Shape and grade off-take ditches to drain away from the road prism.

### **Ditch Maintenance**

Road side ditches have two major functions: first, they collect moisture from the road surface, the cut slope, and the road base, directing the water to suitable discharge locations; and second, they provide a snow storage area.

Implement the following steps:

- Clean and grade ditches to keep them clear of obstructions that might impede drainage flow. Vegetation or other debris that is hindering the flow of water should be removed. However, grass or low vegetation lining the ditches is desirable to minimize scour and sediment transport. Where necessary, installing ditch erosion prevention materials may be necessary to accomplish this. Lining the ditch perimeter with shot rock, boulders, vegetation, or fabric are some of the methods used. Near licensed waterworks, maintain ditches by removing rock falls and any slumping or ravelling material, while retaining as much grass cover or other low vegetative cover as is practicable.
- Ensure that ditch water can enter culverts freely and directly. Ditches should be free of standing water to prevent saturation and weakening of the road subgrade, which can result in surfacerutting.
- Keep the ditch elevation below the level of the subgrade to ensure the free

drainage of the road base. The ditch gradient will be sufficient to maintain a continuous flow.

- When cleaning ditches, do not undermine ditch slopes, cutbanks, road shoulders, and culvert catch basins, and do not block the ends of culverts.
- Do not use material excavated during ditch cleaning for widening road shoulders. Typically, this material is unsuitable for use as fill in the road prism because it contains too many fines and is usually too wet to place and compact. Left on the road shoulder, this material could prevent free drainage of granular sub-base materials and cause roadside sloughing. Material that cannot be used as surfacing or sidecast should be hauled to a designated disposal site.
- Where a grader cannot be used, opt for articulated ditch-cleaning machines (such as Gradalls) because they usually provide a cleaner, smoother finish. Rubber-tired front-end loaders and excavators are often preferred for cleaning ditches of loose rock.
- Take extra care when working around culverts to prevent damage to intakes and outlets. Ditches should be kept unobstructed by tall vegetation, so that maintenance equipment operators can see the ditches and drainage structures. Culverts are often damaged because the grader operator cannot see the culvert ends through the vegetation growing in the ditches.

### **Culvert Maintenance**

Include in routine culvert maintenance operations:

- cleaning and repairing culverts and ancillary drainage works to provide for flow of water;
- repairing inlets, outlets, ditch blocks, catch basins, and flumes;
- replacing cross-drain culverts, flumes, and rip rap; and
- installing additional cross-drain culverts and ditch blocks where required [usually made evident where standing water or erosion (scour) is observed in the bottom of the ditches].

Carry out these maintenance works at a time and in such a way as to minimize the potential for sediment transport to streams.

Consider implementing the following additional maintenance works:

- dispose of floating debris that could be lifted by the headwater pool during a high flood;
- clear debris barriers and trash racks regularly;
- remove accumulated debris from the inlet settling basin;
- backfill scour holes;
- ensure that the stream channel leads directly to the culvert entrance;



- repair or replace rip rap alongside pipe to retain fills;
- repair aprons, headwalls, and flumes; and
- cut brush and clear away debris at inlets.

Using a simple hand shovel is probably still a very effective way of maintaining culverts during the spring runoff period. Carry out hydraulic flushing of drainage structures only when approved by the appropriate environmental agency. If an existing cross-drain culvert cannot be unplugged in place, consider removing and cleaning it, and then re-installing the culvert. Replace irreparable culverts.

During cold weather operations, hot water generators, steam generators, or compressed air are probably the fastest and most effective methods of thawing culverts.

### **6.10.3 Road Prism Maintenance**

Carry out road maintenance to ensure user safety and stability of the road prism; minimize sediment transport from the road prism; and ensure that the road system will fulfill its designed function until deactivation.

Methods to maintain the road prism include:

- stabilizing the road cut and fill slopes, repairing of minor scours and washouts, and improving drainage systems before more serious problems occur;
- stabilizing landslides, rockfalls, and other sites of significant hazard;
- removing loose rocks, stumps, or other unstable materials (including dangerous trees) that present a hazard to road users; and
- seeding all exposed soil that will support vegetation, by hydro-seeding or dry seeding, and reseeded of bare spots as required.

Assess the reasons the above problems are occurring and determine long-term corrective measures.

### **6.10.4 Subgrade Maintenance**

Subgrade maintenance is necessary to ensure that the road system will fulfill its designed function until deactivation. Measures to consider include:

- repairing chronic soft subgrade areas and problematic frost sections by excavating and replacing the unsuitable soils with granular material, including use of geosynthetics where appropriate;
- replacing or repairing the running surface if the road has chronic problems with ruts, potholes, and a broken surface that renders the road unable to support design loads;
- cleaning up slides, slumps, rock falls, and other sites where potential hazards are evident; and implementing measures to stabilize the site (if materials

generated by the work cannot be otherwise used or sidecast on site, they should be removed and disposed of in designated disposal sites); and

- correcting the potential failure of stream-crossing approach fills.
- re-locating the road (may require a new design);

### **Subgrade Repair**

Maintenance items such as scours, slope failures, and rockfalls will be dealt with on a site-specific basis, usually requiring professional expertise.

To repair frost heaves, carry out the following steps:

- Excavate at least 1 m deep and remove the unsuitable soil. If an excess flow of water is encountered, a drain of perforated culvert pipe may be required.
- Place a 300 mm lift of clean sand into the excavated area. It will act as a filter and prevent any contamination or pumping of underlying silt into the upper granular material. Alternatively, consider using a suitable geotextile fabric.
- Refill the excavation with clean, coarse gravel. Compact and grade it. Gravel used for refilling should be free of sand and silt to prevent water from rising through capillary action.
- If working in a roadway, ensure that the road side ditch is deep enough to ensure that ditchwater does not seep into the granular backfill of the subgrade.

## **6.10.5 Road Surface Maintenance**

### **Grading**

Standing water can soften or weaken a road's subgrade. Water running on the road surface can erode expensive surfacing material and deposit sediment in adjacent drainages. Grading involves using specialized, heavy equipment to smooth out the running surface of the road and eliminate rough spots and potholes. One of the main objectives of grading is to prevent water from standing or running down the road in wheel ruts or because of a lack of crowning. (A windrow is an accumulated pile of road fill or surfacing material left on the road shoulders during grading. Windrows are the result of poor grading practices. They are different from berms, which may be beneficial in directing water off the road surface.)

Grade roads to maintain structural integrity or to protect the subgrade from damage. Grading can also help reduce the costs of maintenance for those vehicles using the road, and can improve both the comfort and safety of road users.

If the subgrade is to be protected, grade roads before the road surface:

- reaches severe stages of wash-boarding or pothole formation; or
- begins to trap water in windrows or ruts.

In most instances, slightly crown the road, not leaving any windrows left after the final pass. This facilitates storm water and meltwater drainage, minimizing erosion and transport of sediment from the road surface. However, a crowned road is not always desired. Consider insloping or outsloping for surface water management.

Restoring a severely damaged road surface can be a major undertaking and may require ripping the surface to below the pothole depth and recompacting the surface material. Grade roads when moisture conditions are suitable, and not when the road is either too wet or too dry. Minimize the grading of material over the banks or into ditches, as this material may be difficult to retrieve.

Grade and shape the existing traveled way and shoulders (including turnouts) to produce a surface that is smooth, uniform, consistent to grade, and crowned or cross-sloped as indicated by the character of the existing surface.

It is recommended that a grading pattern should be established to provide:

- a uniform driving surface;
- retention of the surfacing material on the roadbed;
- a thorough mixing of the materials within the completed surface width; and
- no mixing of contaminated ditch material with any processed surfacing material.

Final grade such that no disturbed material such as gravel, cobbles, and boulders protrudes more than 50 mm above the road surface. If it does, remove the material and place it outside the running surface of the road so as not to obstruct drainage ways or structures. Scatter this material off the roadbed if there is free drainage. Do not leave any windrows remaining after the final pass.

Material should roll freely across the blade of the grader. For best results, carry out grading under moist, but not saturated, road conditions. This provides optimum moisture content for compaction, while eliminating dust and loss of fines.

Under dry soil conditions, the road surface should be blade-roughened to remove small ruts and depressions without disturbing the lower road surface.

For roads with pit run surfacing material, to eliminate potholes, cobbles, and washboard, scarify the entire rough section to a depth below the deepest pothole or surface imperfection or largest cobble size over the full road width and then regrade, compact with a suitable roller, and, if feasible, apply a dust palliative. Also, use this procedure for regravelling a hard-packed surface.

Reshaping requires a cut deeper than normal grading to obtain the proper cross-section. Tilt the blade back sufficiently to remove any washboard or other irregular conditions, and take special care to “crown” the centre of the road.

Because reshaping requires cutting down into the grade, ensure that there is sufficient moisture to:

- (1) ensure the fines and binder material are not lost or blown away when brought to the surface; and
- (2) provide for sufficient compaction of the re-shaped gravel. In most areas this dictates that reshaping should be scheduled for the spring and fall.

Leaving windrows is a bad grading practice. It keeps surface runoff on the road and leads to washouts. During dry conditions, when the hard road surface is difficult to grade, leave a windrow on the upper side of the road where there is no crown. Do not leave windrows on the lower side of the road, because these can deflect water and eventually cause the road to wash out.

## **Resurfacing**

Resurface gravel roads when the existing surfacing material is no longer sufficient to support traffic loading or when there is not enough material available for grading purposes. Over time, surfacing material can break down and is lost from the road surface. Spot-gravel roads where short sections of the road surface are failing or have a potential for failure, or where potholes that cannot be satisfactorily graded out are evident.

Surface with materials of sufficient strength, durability, and gradation so that at completion of the surfacing application, the surface will not rut when subjected to the loading exerted by the rear axles of a fully loaded tandem truck on the completed surface. Suitable sources of gravel materials include:

- material from existing pits that have proven performance;
- gravels with 10%-15% fines; and
- materials that do not easily rut, washboard, or break down when wet.

## **Dust Suppression**

Dust from unpaved roads is not only a nuisance, but can create a safety hazard by reducing a driver's visibility. It may be necessary to apply a dust suppressant product to eliminate the dust problem by sealing the surface of the road. However, these products are not a permanent solution and their effectiveness decreases with time. Carry out further applications of the products if dust suppression is to be maintained.

To properly select the appropriate product, it is important to understand the primary factors that generate dust, including:

- vehicle speed;
- number of wheels per vehicle;

- number of vehicles;
- vehicle weight;
- particle size distribution (gradation) of the surface material;
- restraint of the surface fines (compaction, cohesiveness/bonding, durability); and
- surface moisture (humidity, amount of precipitation, amount of evaporation).

In selecting the proper dust abatement program consider not only the above factors, but also the total long-term cost and environmental impacts of that program. Long-term costs include road improvement, road preparation, application of the dust suppressant in conjunction with the number of times the product needs to be applied, and expected change in maintenance practices. Environmental considerations typically include impacts to the water quality, aquatic habitat, and plant community.

A wide variety of dust suppressants are available on the market. They fall into seven basic categories:

- water;
- water-absorbing products;
- petroleum-based products;
- organic non-petroleum-based products;
- electrochemical products;
- polymer products; and
- clay additive products.

Regardless of the type used, the criteria for an acceptable dust suppressant product are that they:

- be environmentally compatible (i.e., without there being any adverse environmental effects);
- be easily applied with common road maintenance equipment;
- be workable and respond to surface or structural maintenance;
- provide reasonable retention and dust control;
- provide little loss of riding quality and be cost competitive; and
- be approved by the Ministry of Transportation and Infrastructure.

### **6.10.6 Winter Operations: Snowplowing and Sanding**

#### **General**

Serrated grader blades will cut ice and snow much better than ordinary blades, and the rough surface left by a serrated blade usually improves traction.

Restrict snow removal to the usable traveled way having roadbed support.  
Reshape over-width plowing as necessary to define the usable width.

Do not excavate into the gravel surface or remove surfacing materials along with the snow.

Breach snow berms frequently enough to allow road surface runoff from snowmelt to have a safe place to drain.

Before allowing snow removal from any road is allowed to take place, identify all road-related fixtures that might be at risk from snow removal operations (such as culvert markers, signs, bridge delineators, bridge guard logs, cattleguards, and fencing) and notify the snow removal operators.

In an area of daylighted cuts, plow the road from the inside of the cut to the outside (in the direction away from the cut slope) to avoid plugging culverts and ditches with snow.

Plow roads to a firm surface before sanding.

Fine crushed gravel as a sanding medium is superior to pit-run sand. The sharp angular material provides better traction and breaks up an icy surface by rolling under vehicle tires.

Do not stop the spreading of sand in the middle of a curve, halfway up a hill, or at any other potential roadway hazard.

As a general rule, spread sand only along the centre of the road. Vehicle wheels will spread the sand full width. Use spinners or other power spreaders where available.

### **Snow Removal at Rail Crossings**

When conducting snowplowing operations at rail crossings, ensure that snow removal crews that are responsible for Forest Service road maintenance are aware of the following snow removal guidelines:

1. When snowplowing at rail crossings, the snowplow blade **must** be raised before going over the crossing surface to ensure that the blades do not damage the rails.
2. Windrows **must** not be left between the rails or within 8 metres of the track. Leaving windrows can result in unsafe conditions with reduced sightlines at the crossing and increased potential for trains or other rail vehicles impacting windrows and derailling or which could result in injuries to pedestrians and or damage to nearby motor vehicles caused by thrown snow and ice.
3. Snow **must** not be piled up in close proximity or restrict sightlines at the crossing.

As road crossings are licensed by the rail companies, improper snow removal practices at rail crossings, or an accident at any rail crossing caused by improper snow removal practices may result in a crossing license being revoked and the crossing permanently closed.

Ensure that emergency contact information for the railway company is available in the event of an incident involving snow removal or other reason at a rail crossing. **Any incident involving damage to signage, crossing surface or rails at a crossing should be called in to the emergency number immediately.**

### 6.10.7 Spring Break-Up: Temporary Vehicle Weight Restrictions

Where it is necessary to impose vehicle weight restrictions to protect Forest Service Roads from considerable damage during spring break-up, the restrictions may vary from 30% to 50% (or more) of the legal axle loading. Restrictions normally extend from about mid-March to mid-May, depending on the weather conditions and the susceptibility of the subgrade to frost.

Certain indicators provide a guide to the timing of restrictions. These indicators are tied to the stages of spring break-up:

- **Incipient stage** – the stage at which the surface starts to thaw and turn muddy; usually most of the ice and snow will be gone from the surface and along the road; and
- **Advanced stage** – the stage at which the subgrade starts to thaw; most likely the surface will appear quite dry.

Impose the restrictions towards the end of the incipient stage. The road's bearing strength is substantially reduced when thawing of the subgrade occurs during the advanced stage. This is the time the road is most susceptible to damage.

Since there are not any specific indicators or guides for when restrictions should be lifted, local knowledge is critical. Therefore, utilize the output of the local offices of the Ministry of Transportation and Infrastructure, who determine when to impose and lift restrictions, and provide criteria for any exemptions. Central tire inflation research has been conducted by FERIC, a division of FPInnovations, on [Tire Pressure Control Systems](#) in conjunction with log haulers and the Ministry of Transportation and Infrastructure which has implemented various trials allowing log haul on roads that would normally be shut down due to 'breakup'. Consult with engineering branch staff prior to implementing a log haul program of this nature.

Publish notice of impending or imposed restrictions in local newspapers and/or announce restrictions on local radio stations before they are imposed.

When temporary vehicle weight restrictions on roads are posted for FSRs, use the ministry's warning load limit posters: [Poster - Warning Load Limit - Percentage Max Allow Weight \(FS 639\)](#) or [Poster - Warning Load Limit \(FS 639a\)](#).

## **6.11 Routine Types of Structure Maintenance Works: Bridges and Stream Culverts**

### **6.11.1 Bridge Maintenance**

Bridge maintenance involves two main categories of works: structural maintenance and surface maintenance. These two categories are reasonably consistent with the maintenance items contained in the Coast and Interior Appraisal Manuals under Detailed Engineering Cost Estimate and Road Management respectively.

#### **Structural Maintenance of Bridges**

Structural maintenance involves repairing or replacing structural members of a bridge, based on the results of inspections made by a qualified Inspector. In some critical circumstances where the intended work may need to be adjusted due to unpredictable site conditions, carry out the maintenance works under the supervision of a professional engineer. In any event, carry out a follow-up inspection of structural repairs to confirm that the work has been done in conformance with the proposed repairs in the inspection report.

Examples of structural maintenance are:

- tightening the bolts connecting timber members;
- installing shims to ensure adequate load transfer where there is loss of contact between piles, pile caps, stringers, crib timbers, needle beams, or other structural elements;
- replacing stringers or girders;
- repairing or replacing damaged bridge structural members (e.g., abutments, piers, ties, stringers, needle beams, structural curb beams);
- repairing stream channel and scour protection;
- replacing dilapidated bridges and major culverts that are unable to carry the service loads; and
- repairing major culvert headwalls and spillways.

#### **Surface Maintenance of Bridges**

Surface maintenance involves repairing or protecting parts of the bridges and approaches that do not directly affect structural integrity.

Examples of surface maintenance:

- repairing and replacing bridge signage including delineators;
- keeping the waterway opening free of logs and debris;
- keeping the girder flanges and bearing surfaces, including plates, anchor bolts, and neoprene pads, free of gravel and dirt;



- keeping wood stringers free of dirt accumulations;
- resetting nails protruding from running planks;
- replacing missing or damaged running planks;
- eliminating pot holes on bridge approaches;
- repairing or replacing damaged guardrails or curbs; and
- removing gravel build-up on concrete or timber decks.

Do not allow gravel and debris to accumulate on the deck. Remove build-up of soil material on the bridge decking in a manner that prevents it from entering the waterway below.

In accordance with any deficiencies noted in the inspections, repair or replace all deteriorated running planks, riser blocks, or guardrails, and check and retighten all fasteners and replaced any that are missing or damaged.

### 6.11.2 Stream Culvert Maintenance

In addition to the guidelines for maintenance related to fish habitat set out in the [Fish-stream Crossing Guidebook](#), carry out stream culvert maintenance to ensure that a structure maintains its capability to pass fish and convey stream flow.

Examples of stream culvert maintenance:

- repairing damaged inlets and outlets;
- repairing armouring around inlets and outlets to reduce sediment transfer, particularly near licensed waterworks;
- removing debris blocking or obstructing culvert inlets;
- replacing culverts where the bottoms are rusted out and where damage has occurred from water seepage; and
- repairing major culvert headwalls and spillways when necessary, to protect the structures and the streams.

**Note:** Before beaver dams are removed, contact the Ministry of Environment for appropriate procedures. Consider installing beaver protection devices.

For additional information in replacing culverts at stream crossings, refer to the [Fish-stream Crossing Guidebook](#).

### 6.11.3 Bridge and Major Culvert Replacement on Forest Service Roads

Where maintenance responsibility has not been delegated to a permittee, bridge replacements can generally only be accomplished by Timber Operations and Pricing Division/BCTS.

For requirements and guidance on bridge or major culvert replacements carried out by Timber Operations and Pricing Division/BCTS, for requirements and guidance please refer to [Chapter 4: Design and Construction of Bridges and Major Culverts](#).

## **6.12 Other Types of Road and Structure Maintenance Works**

### **6.12.1 Fords**

Remove debris and sediment build-up on fords and approaches to minimize the impact on downstream resources. Where a ford is exhibiting signs of failure, establish or restore those site conditions that are vital for the successful operation of a ford. For additional information on fords, refer to [Appendix 3.6: Ford Design and Construction on Non-Fish Streams](#) in Chapter 3.

### **6.12.2 Weirs**

Where weirs are installed in a stream to maintain water levels for fish passage, inspect and maintain them to ensure that the fish passage objectives are being met.

### **6.12.3 Fences**

Repair or replace range fences that have been damaged as a result of activities on the road. The Range Section in the local district office can advise on acceptable fence construction specifications and practices.

### **6.12.4 Cattleguards**

Carry out the following steps:

- Repair broken welds or tie rods promptly.
- Check and replace sills and foundations if any crushing has occurred.
- Keep rails, fences, posts, and gates in good condition to ensure that the cattleguard fulfils its function.
- Clean the pit under the cattleguard periodically.
- Clean cattleguards in those situations where the Ministry has agreed with the landowner to do so, repair them, or replace them if repair is neither practical nor cost-effective.

### **6.12.5 Signs**

Repair or replace damaged or vandalized signs and posts. Carry out sign maintenance, including cleaning and regular hand brushing and snow removal around them, to ensure they can be seen in all conditions. Replace illegible signs at the earliest opportunity.

One of the ways that sign maintenance can be reduced is to install signs high enough so that they are difficult to reach. While this cannot be done in all instances (such as with bridge delineators) it has been effective in reducing

damage from spray paint or gunshots. This method also limits the impact that vegetation and accumulations of snow can have on sign visibility.

### **6.13 Resources and Suggestions for Further Reading**

British Columbia Institute of Technology (BCIT). 1995. Surface maintenance: course manual. RRET 3328. Burnaby, B.C.

\_\_\_\_\_. 2001. Bridge maintenance: course manual. RRET 3324. Burnaby, B.C.

\_\_\_\_\_. 2001. Culvert maintenance: course manual. RRET 3322. Burnaby, B.C.

BC Ministry of Forests. 2002. [Fish-stream crossing guidebook](#). For. Prac. Br., B.C. Min. For. Victoria, B.C.

## APPENDICES

### Appendix 6.1: Example Qualitative Vulnerability Tables

**Table 6-4 Example vulnerability ratings for a forest road**

Examples of factors to consider:

Important factors include the type of hazard event(s), utilization of the road, duration of disruption, availability of alternative routes, direct and indirect costs, and extent of damage.

Vulnerability Ratings	Examples
High Damage	Destruction of, or extensive (not easily reparable) damage to, active forest road, OR Long-term (> 1 week) disruption to forest road.
Moderate Damage	Moderate (easily reparable) damage to active forest road, OR Excessive damage (non-reparable) to non-active forest road, OR Short-term (1 day – 1 week) disruption to forest road.
Low Damage	Minor (inconvenient) damage to forest road, OR Moderate (reparable) damage to non-active forest road, OR Very short (< 1 day) disruption to forest road.

**Table 6-5 Example vulnerability ratings for water supply through licensed water intakes**

Examples of factors to consider:

Important factors include type of hazard event(s), amount of sedimentation, duration of sedimentation, water quality and quantity, extent of damage to works, intake and storage, effect on chlorinating, cumulative effects (previous slides), and availability of alternative sources of water supply.

Vulnerability Ratings	Examples
High Damage	Permanent loss of quality, short-term loss of supply.
Moderate Damage	Short-term disruption of quality, short-term loss of supply.

Vulnerability Ratings	Examples
Low Damage	Water quality degraded but potable; no disruption or damage to water supply infrastructure, effect < 1 day.

**Table 6-6 Example vulnerability ratings for fish habitat (includes riparian management area)**

Examples of factors to consider:

- Important factors include type of hazard event(s), amount of sedimentation, duration of sedimentation, hydraulic connectivity, location of affected area relative to fish stream or watercourse connected to fish stream, deposition zone size/volume, and type of deposition material.
- For a high vulnerability rating:
  - consider where the permanent loss is located (directly or indirectly downslope of a failure site);
  - consider the stream channel and the riparian zone; and
  - consider the requirements of the federal *Fisheries Act*.

Vulnerability Ratings	Examples
High Damage	Permanent loss of habitat, likely not feasible to restore habitat, but sediment should be controlled at source.
Moderate Damage	Habitat damaged but can be restored through intervention; source of sediment can be controlled.
Low Damage	Limited habitat damage that can be eliminated or controlled through natural processes within 1 year. Source of sediment can be restored to pre-landslide condition through minor work (e.g., grass seeding, silt fences).

**Table 6-7 Example vulnerability ratings for wildlife (non-fish) habitat and migration**

Examples of factors to consider:

- For a landslide hazard, important factors include landslide path, area of landslide track, and type of deposition material. Other factors to consider include landslide path, area of landslide track, type of deposition material,

species present, species status (red to yellow), rarity of affected habitat, and size of home range.

- The major effect of a landslide event on wildlife is on the habitat of that species, or on the habitat of the species on which it depends. Effects on migrating wildlife are minimal.
- Is rehabilitation/mitigation possible? Successful mitigation depends on species and habitat.

Vulnerability Ratings	Examples
High Damage	The affected species is rare, endangered, or a management concern (e.g., identified wildlife), OR Permanent loss of habitat or migration route; likely not feasible to restore habitat, OR Permanent adverse effects on wildlife population need to be assessed, OR The affected area is large relative to the locally available habitat and/or the affected habitat is rare (there is no suitable adjacent habitat).
Moderate Damage	Habitat damaged or migration route temporarily interrupted but can be restored through intervention, OR Wildlife populations are disrupted but there are no permanent effect on population, OR The affected species is not rare or endangered, although it may be of management concern (e.g., identified wildlife), OR The affected area is being managed for wildlife, has been set aside for wildlife, or has been identified as wildlife habitat (in a resource plan).
Low Damage	Limited damage to habitat; no disruption to migration route, OR Damage could be restored through natural processes within one growing season, OR The wildlife species is not of management concern (e.g., it has not been designated as rare or endangered, or as identified wildlife), OR The affected area is not being managed for wildlife, has not been set aside for wildlife, and has not been identified as wildlife habitat (in a resource plan).

**Table 6-8 Example vulnerability ratings for visual resources in a scenic area**

Examples of factors to consider:

- For a landslide hazard important factors include expected landslide path, size and numbers of landslides in perspective view area, and duration of visible adverse effects on scenic areas.

- Applies only where there is reasonable expectation for visible alteration of the landscape in scenic areas (there are no legal obligations to manage visual resources outside a scenic area).
- Criteria used to develop Visual Sensitivity Class (VSC) ratings include: visual absorption capability (the measure of the landscape's ability to accept change), biophysical rating (measure of topographical relief and vegetation variety), viewing condition (viewing duration and proximity), and viewer rating (numbers of people and their expectations).

Vulnerability Ratings	Examples
High Damage	Visible site disturbance of any amount within a scenic area designated as Visual Sensitivity Class (VSC) 1 or 2.
Moderate Damage	Visible site disturbance up to 7% of the landform area as measured in perspective view (for both in-block and landform situations) within a scenic area designated as Visual Sensitivity Class (VSC) 3 or 4, and where visible adverse effect on a scenic area should have disappeared by the time visually effective green-up is achieved.
Low Damage	Visible site disturbance up to 15% of the landform area as measured in perspective view (for both in-block and landform situations) within a scenic area designated as Visual Sensitivity Class (VSC) 5, and where visible adverse effect on a scenic area may not have disappeared by the time visually effective green-up is achieved.

**Table 6-9 Example vulnerability ratings for timber**

Examples of factors to consider:

- For a landslide hazard, an important factor is landslide size. Other factors to consider include the age of merchantable timber, and time remaining to reach a harvestable state.
- It is assumed that areas of high-value timber directly correlate to areas of high soil productivity.

Vulnerability Ratings	Examples
High Damage	Destruction of mature harvestable timber stands and the timber value is in the top one-third for the region (implies a high site productivity area), and the ground area adversely affected by the landslide is large.

Vulnerability Ratings	Examples
Moderate Damage	<p>Destruction of mature harvestable timber stand and the timber value is in the middle third for the region, and the ground area adversely affected by the landslide is large, OR</p> <p>Destruction of juvenile timber stands that are within about 20-35 years of potential harvest and the future timber value at a harvestable stage will be in the top or middle third for the region, and the ground area adversely affected by the landslide is large.</p>
Low Damage	<p>Destruction of mature harvestable timber stands and the timber value is in the top third for the region, and the ground area adversely affected by the landslide is small, OR</p> <p>Destruction of mature harvestable timber stands and the timber value is in the bottom third for the region (implies a low site productivity area), and the ground area adversely affected by the landslide is large, OR</p> <p>Destruction of juvenile timber stands that are more than 35 years away from potential harvest and the future timber value at a harvestable stage will be in the top or middle third for the region, and the ground area adversely affected by the landslide is large.</p>



## Appendix 6.2: Sample Forest Service Road Maintenance Inspection Schedule

\_\_\_\_\_DISTRICT/BUSINESS AREA

### FOREST SERVICE ROAD MAINTENANCE INSPECTION SCHEDULE

FISCAL \_\_\_\_\_

FSR NAME	PROJ#	ROAD USE CAT. (check one)	RD. RISK RTG. OR N/A if Industrial	INSP. FREQ. LEVEL (1-3) OR N/A if Industrial	PROPOSED INSPECT. DATE (month or N/A)	COMMENTS (e.g., barricaded, new hazard, stabilized, new maintainer, etc.)
		Rural Residence and Recreation Access (Community Access and Recreation Use) Environmentally Maintained Industrial			<input type="checkbox"/> _____ N/A	_____ _____
		Rural Residence and Recreation Access (Community Access and Recreation Use) Environmentally Maintained Industrial			<input type="checkbox"/> _____ N/A	_____ _____
		Rural Residence and Recreation Access (Community Access and Recreation Use) Environmentally Maintained Industrial			<input type="checkbox"/> _____ N/A	_____ _____
		Rural Residence and Recreation Access (Community Access and Recreation Use) Environmentally Maintained Industrial			<input type="checkbox"/> _____ N/A	_____ _____
		Rural Residence and Recreation			<input type="checkbox"/> _____	_____

Access (Community Access and Recreation Use)			N/A	_____
Environmentally Maintained				
Industrial				
Rural Residence and Recreation Access (Community Access and Recreation Use)			<input type="checkbox"/> _____ N/A	_____ _____
Environmentally Maintained				
Industrial				
Rural Residence and Recreation Access (Community Access and Recreation Use)			<input type="checkbox"/> _____ N/A	_____ _____
Environmentally Maintained				
Industrial				
Rural Residence and Recreation Access (Community Access and Recreation Use)			<input type="checkbox"/> _____ N/A	_____ _____
Environmentally Maintained				
Industrial				
Rural Residence and Recreation Access (Community Access and Recreation Use)			<input type="checkbox"/> _____ N/A	_____ _____
Environmentally Maintained				
Industrial				
Rural Residence and Recreation Access (Community Access and Recreation Use)			<input type="checkbox"/> _____ N/A	_____ _____
Environmentally Maintained				
Industrial				
COMPLETED BY:				
_____		_____		
(Name of FLNR Official)		(Signature)		

*Note: The above information is that detailed in section 6.7.2 in this Chapter ([see Road Inspection Frequencies](#))*

### Appendix 6.3: Sample Forest Service Road Maintenance Inspection Report

<b>Forest Service Road Maintenance Inspection Report</b>							
Date:	Y	M	D	File No:	Road Name:	Road Project Number:	
Forest District/Business Area:						Road Risk Rating:	
Reason for Inspection (check one): <input type="checkbox"/> scheduled <input type="checkbox"/> post-storm event <input type="checkbox"/> user complaint							
GPS Co-ordinates or Stations– Start and End of Inspection:						Weather:	
Location (Km) or GPS Co-ordinate	Problems Noted (Code)	Recommended Maintenance Works			<b>Urgency Rating</b> VH = within 1 week H = within 30 days M = preferably within current field season but before the next field season L = reassess situation next inspection	Comments	
		Code	Code	Code			
<i>Miscellaneous Inspection Comments and/or Maintenance Works Comments:</i>							
Inspector:						Y	M
						D	

## Inspection Codes

(To be used in conjunction with the Sample 1 Report under the column “Problems Noted”)

<b>Inspect for the following items:</b> (Inspection is not limited to these items)				
<b>Structural Integrity:</b>	<b>Code</b>	<b>Drainage Systems:</b>	<b>Code</b>	
Tension cracks visible	SI-01	Natural drainage patterns	DS-01	
Cut slope failures	SI-02	Culverts partially or fully plugged	DS-02	
Fill slope failures	SI-03	Culverts washed out	DS-03	
Slides or mass land movements	SI-04	Damaged culverts	DS-04	
Shoulder slumps	SI-05	Culvert markers	DS-05	
Frost boils	SI-06	Fill over culverts	DS-06	
Subgrade unable to support wheel loads	SI-07	Ditch blocks	DS-07	
Washouts	SI-08	Cross-drain culvert frequency	DS-08	
<b>Road Surface:</b>		Cross-drain or stream culvert sizes	DS-09	
Depth of surface material	RS-01	Ditch scour	DS-10	
Potholes	RS-02	Ditches obstructed	DS-11	
Washboard	RS-03	Ditch line sloughing	DS-12	
Rutting from vehicle wheels	RS-04	<b>Safe Fish Passage:</b>		
Windrows	RS-05	Fish stream culvert inlets and outlets	FP-01	
Surface stabilization	RS-06	Inadequate structure	PF-02	
Damage from cattle	RS-07	<b>Road Safety:</b>		
Road surface erosion	RS-08	Site distances	SA-01	
Sediment transport from road prism	RS-09	Brushing	SA-02	
Dust control	RS-10	Snags and danger trees	SA-03	
		Other road hazards (loose rocks, stumps, etc.)	SA-04	
		Traffic control signs	SA-05	
		Road radio frequencies posted	SA-06	

## Maintenance Codes

(To be used in conjunction with the Sample 1 Report under the column “Recommended Maintenance Works”)

<b>Carry out the following maintenance works:</b> (Maintenance works are not limited to these items)			
Correct to specification	CA	Revegetate	DN
Certify structures	CB	Licensee inspections required as per Plan	MA
Rectify hazards	CD	Carry out brushing	MB
Install or repair cross-ditches	DA	Clean ditches	MD
Install or repair	DB	Clean culvert inlets and outlets	ME
Remove cross-drains/stream culverts	DD	Grade surface	MF
Clean or repair cross-drains/stream culverts	DE	Stabilize subgrade	MG
Back up cross-drains/stream culverts	DF	Replace planks, delineators, etc.	MH
Repair/replace bridges	DH	Replace or repair cattleguard	MI
Outslope road	DJ	Replace signs	MJ
Install/repair sediment basins	DM	No action	NAC

## Appendix 6.4: Project Tracking Checklist

<i>Project Tracking Checklist</i>		
<b>Use this checklist to prepare a paper trail of key outputs prepared by consultants and sign-offs by FLNR.</b>		
<b>Element Being Reviewed &amp; Results Achieved</b>		<b>Date of FLNR sign-off</b>
<b><i>ROAD INSPECTION AND MAINTENANCE</i></b>		
Ensured that a road risk analysis was carried out to determine the inspection schedule (or determined that the appropriate rating was to default to inspection level 1)	YES NO	_____
Ensured that the road was inspected in accordance with the inspection schedule, and the maintenance inspection report was completed	YES NO	_____
Reviewed the inspection report and entered the information on the file and the road management system	YES NO	_____
Ensured that a new maintainer (under RUP) was advised of any chronic or current maintenance issues	YES NO N/A	_____
Carried out road maintenance works in general conformance with the maintenance schedule	YES NO	_____
<b><i>BRIDGE AND MAJOR CULVERT INSPECTION AND MAINTENANCE</i></b>		
Ensured that the ministry bridge engineer was consulted when developing the annual bridge inspection strategy and contracts	YES NO	_____
Ensured that the routine and close proximity inspection frequencies were established by bridge materials (2year vs. 3 year) or determined otherwise by a professional engineer	YES NO	_____
Ensured that the bridge/major culvert close proximity inspections were carried out by a professional engineer or under an engineer's direct supervision. If YES, <b>Professional's Name and Company:</b> _____	YES NO	_____
Ensured that bridge and major culvert inspection reports were reviewed and signed off by the ministry bridge engineer and that the TSM/District Manager was advised as soon as possible of any structural deficiencies	YES NO	_____

Ensured that a road use permit holder who is the maintainer was forwarded a copy of the inspection report as well as any other details regarding structural deficiencies	YES NO	_____	_____
Ensured that surface and structural maintenance works on the bridges/major culverts were carried out in conformance with the inspection report	YES NO	_____	_____
<b><u>Statement of Maintenance Conformance</u></b> signed off (P.Eng, RPF, RFT)	YES NO	_____	_____

## Appendix 6.5: Statement of Maintenance Conformance

TO BE COMPLETED BY MINISTRY SPECIALIST **AFTER** COMPLETION OF THE INSPECTION AND MAINTENANCE OF ROADS, INCLUDING BRIDGES AND MAJOR CULVERTS

Road Name	Project #	Forest District/Business Area
-----------	-----------	-------------------------------

I am a (check one) ☐ Registered Forest Technologist, ☐ Professional Engineer or ☐ Professional Forester, registered with the appropriate professional association in British Columbia, and I have undertaken professional responsibility as the Coordinating Professional for all field and office reviews required with respect to the inspection and maintenance of this road. I have taken steps as regulated under the Provincial Statute for my profession and required by good practice in order to sign and seal this Schedule.

### Road Inspection and Maintenance:

In my professional opinion:

- The road has been inspected by the ministry at the appropriate frequency, and data properly recorded;
- Where the ministry is the maintainer, the road has been maintained in accordance with the inspection report

### Bridge and Major Culvert Inspection and Maintenance:

In my professional opinion:

- The bridges/major culverts have been inspected by the ministry at appropriate times, and data properly recorded;
- Inspection reports have been reviewed by a professional engineer
- The local manager was advised promptly of any structural deficiencies
- The bridges/major culverts have been maintained in accordance with the inspection report and/or direction from the manager

Signature (and seal as appropriate) of Professional	
Name of Professional (please print)	DATE SIGNED YYYY M M DD



## 7. Road Deactivation

### 7.1 Introduction

The intent of road deactivation is to place a road in a self-maintaining state that will indefinitely protect adjacent resources. Road deactivation requirements typically include removing bridges and stream culverts, stabilizing the road prism, and barricading the road surface width in a clearly visible manner to prevent access by motor vehicles (other than all-terrain vehicles).

This chapter describes the objectives of road deactivation, as well as mandatory procedures and best management practices for developing deactivation prescriptions and carrying out the works. It also presents a number of road deactivation techniques that address the province-wide range of terrain, soils, and climatic conditions, and assists ministry staff in achieving the statutory and regulatory requirements in the [Forest and Range Practices Act](#), and the [Forest Planning and Practices Regulation](#).

### 7.2 Policy

When no longer required, Forest Service Roads (FSRs) that are the responsibility of either Timber Operations and Pricing Division or BC Timber Sales (BCTS) will be deactivated in a planned manner that considers future access needs, road user safety, cost efficiency, and values at risk of damage or loss.

### 7.3 Mandatory Procedures and Best Practices

Following is a table that summarizes in approximate chronological order the mandatory procedures and best practices with respect to the deactivation of Forest Service roads. Links are provided to direct the reader to the location in the manual text where the tabular item is discussed.

**Table 7-1 Road Deactivation**

<p>Statutory/regulatory results to be achieved:</p> <ul style="list-style-type: none"> <li>do not cause landslides that would have a material adverse effect on forest resources (FPPR s. <a href="#">37</a>)</li> <li>no gully processes or fan destabilization on the Coast that would have a material adverse effect on forest resources (FPPR s. <a href="#">38</a>, <a href="#">54</a>)</li> <li>revegetate exposed soils where sediment may enter streams or otherwise have a material adverse effect on other forest resources (FPPR s. <a href="#">40</a>)</li> <li>protection of fish passage and fish habitat (FPPR s. <a href="#">56</a>, <a href="#">57</a>)</li> <li>protection of water quality (FPPR s. <a href="#">59</a>)</li> <li>no deposition or transport of deleterious materials into licensed waterworks drinking water (FPPR s. <a href="#">60</a>)</li> <li>address general wildlife measures, and resource or wildlife habitat features (FPPR s. <a href="#">69</a>, <a href="#">70</a>)</li> <li>deactivation measures achieved (FPPR s. <a href="#">82</a>)</li> <li>road is safe for industrial use during deactivation works (FPPR s. <a href="#">83</a>)</li> <li>notice of works to licensed water users or purveyors in community watersheds (FPPR s. <a href="#">84</a>)</li> </ul>
<p>B1. Notify road users about proposed significant changes to road access and to solicit input [see <a href="#">Planning, Section 7.4</a>].</p>

- B2. For FSRs that are the responsibility of Timber Operations and Pricing Division, carry out the deactivation in accordance with the ministry's business area funding policy [see [Planning](#), [Section 7.4](#)].

Legislation supported: FPPR sections [37](#), [38](#), [40](#), [50](#), [54](#), [56](#), [57](#), [59](#), [60](#), [70](#), [82](#), [83](#), [84](#): all road deactivation – related items

- M1.** A Qualified Registered Professional *must* sign and seal the deactivation prescription for the project [see [Prescription](#), [Section 7.5.1](#)].

- B3. Ensure that any deactivation prescription is reviewed by the BCTS/District engineering technician for conformance to objectives [see [Prescription](#), [Section 7.5.1](#)].

- B4. Ensure that any concerns about residual risk that are identified in a deactivation prescription are brought to the attention of the District Manager [see [Content](#), [Section 7.5.2](#)].

Legislation supported: FPPR sections [37](#), [38](#), [54](#), [57](#), [59](#), [70](#): do not cause sediment transport that will impact user safety or have a material adverse effect on forest resources

- B5. Intercept road surface and ditchline water and convey it across the road onto stable, non-erodible slopes below the road [see [Road Deactivation Techniques](#), [Section 7.10](#)].

- B6. Consider insloping the road surface to direct road surface water toward the road cut and away from unstable or erodible road fill materials, or outsloping the road surface to direct water across the road and onto the road fill in a dispersed fashion [see [Insloping/Outsloping Road Surface](#), [Section 7.17.1](#)].

- B7. Remove existing culverts while creating the least amount of sedimentation possible [see [Stream Culvert Removal](#), [Section 7.10.1](#)].

- B8. During road deactivation works, minimize sedimentation while short-term vehicle access is required [see [Armoured Swales](#), [Section 7.17.1](#)].

- B9. Ensure that road deactivation works do not cause fan destabilization on the Coast that will result in material and adverse effects on other resources [see [Soil Erosion](#), [Section 7.9.1](#)].

- B10. Where there is potential for unstable road cut or fill slopes to develop during periods of inattention, consider using partial or full road fill pullback and gully restoration [see [Road Fill Pullback Techniques](#), [Section 7.17.2](#)].

Legislation supported: FPPR section [40](#): revegetation

- B11. Consider using soil bioengineering systems to:
- drain excess moisture that may be creating slope instability;
  - reduce slope angles relative to the growth of vegetation and prevent raveling of fill slopes; or
  - control erosion along watercourses.
- [see [Revegetation Techniques](#), [Section 7.17.3](#)].

- B12. Seed or plant, in the first growing season after deactivation, all exposed soils that will support vegetation [see [Revegetation Techniques](#), [Section 7.17.3](#)].

Legislation supported: FPPR section [83](#): hazard warning

- B13. Erect warning signs at appropriate locations during the period of road deactivation activities to warn potential users of the road of the hazards that can be expected on the whole road or at a particular location [see [Deactivation Hazard Warning Signs](#), [Section 7.8](#)].

Legislation supported: FPPR sections [37](#), [38](#), [40](#), [50](#), [54](#), [56](#), [57](#), [59](#), [60](#), [70](#), [82](#), [83](#), [84](#): all road deactivation – related items

B14. Ensure that a Qualified Registered Professional completes the Statement of Road Deactivation Conformance for those projects identified in the deactivation prescription as needing such sign-off [see <a href="#">ORP Statement Appendix 7.3</a> ].
B15. Based upon the risk to other resources as a result of poor deactivation work, consider carrying out a subsequent field inspection of the completed project [see <a href="#">Statement of Works Conformance, Section 7.6.4</a> ].
B16. Ensure that the necessary steps in the road deactivation processes were undertaken and issues addressed [see <a href="#">Project Tracking Checklist Appendix 7.4</a> ]

## 7.4 Planning Road Deactivation

Consider carrying out road deactivation projects on non-industrial use FSRs where a planning process identifies the roads as being candidates for road deactivation, or where the roads need to be closed to protect public safety and the cost of deactivating these roads is less than the cost of carrying out maintenance to a wilderness road level of maintenance over the period of expected closure. Deactivation of FSRs is usually limited to in-block roads and cutblock access roads, or to roads that provide duplicate access to areas. Ensure that for FSRs that are the responsibility of Timber Operations and Pricing Division, deactivation is carried out in accordance with the ministry's business area funding policy

Notify road users about proposed significant changes to road access and to solicit the public's and First Nations' input into road closure and related access issues. Ensure that the District Manager solicits and considers input from local stakeholders (e.g., licensees, public, First Nations, miners) before making a decision on whether to deactivate an FSR.

Deactivation is typically carried out with the expectation that a road will receive no further field inspections or maintenance, and due to the inherent risk to vehicle users and to any deactivation structures along the road, deactivation is expected to result in the elimination of motor vehicle access. This will be particularly applicable along road segments where unstable road fill is pulled back and where stream culverts and bridges are removed or deep cross-ditches are installed across the road running width. However, for roads that cross flat or gentle terrain with no stream crossings, little work may be necessary to deactivate the roads. In this case, motor vehicle access may be both possible and acceptable, provided that the District Manager approves the variance from any legislative requirements to barricade the road.

A deactivated FSR that has fulfilled all legal requirements reverts to the status of vacant Crown land or provincial forest. In other words, after the FSR is deactivated, it has no road status and the responsibility for stability of the area shifts to the Crown, instead of FLNR as the representative of the Crown. Retaining the old road location (with expired tenure) on atlas maps does no harm, as the former route may be useful in some emergency.

For FSRs that are the responsibility of Timber Operations and Pricing Division, deactivation ***must*** be carried out in accordance with the ministry's [Policy for Operating Funds Road & Structure Maintenance and Road Closure](#).

## 7.5 Deactivation Prescriptions

### 7.5.1 Prescription Requirements

A Qualified Registered Professional (RFT, RPF, PEng or PGeo) ***must*** prepare and sign and seal the deactivation prescription for the project, and provide the results of any assessments in the letter or report that accompanies the deactivation prescriptions. Ensure that the deactivation prescription is reviewed by the BCTS/District engineering technician for conformance to objectives.

A deactivation prescription is a written document that clearly communicates the objectives and the works to be performed, in accordance with the regulatory requirements in the [Forest Planning and Practices Regulation \(Sec. 82\)](#). Ensure that any deactivation prescription:

- defines the objectives of the planned deactivation work, the vehicle access requirements (if an exemption under legislation has been granted to permit access by motor vehicles), and the techniques to be performed by station; and
- reports special requirements (e.g., worker safety and slope stability issues).

When a prescription is being prepared, ensure that the following are retained:

- original field notes;
- final deactivation maps, tabular summary, and letter or report, as applicable; and
- any relevant correspondence.

As described in the sections below, site specific information, detail and complexity of a deactivation prescription varies with site conditions and the work required to achieve the deactivation goals. Such prescriptions may be as simple as providing directions to an operator with a basic map or may be as complex as having a detailed prescription of individual steps and site specific work requirements.

Use simple deactivation prescriptions where there are no perceived hazards from the deactivation to worker safety and public infrastructure, or where the prescribed work is not expected to create adverse environmental impacts. In these situations, provide basic directions to an operator with a signed and sealed map of the prescribed work area.

As the complexity of the site increases where there are fish streams, terrain stability hazards along or adjacent to the road system, or potential consequence to public infrastructure, provide a greater detailed and prescriptive signed and sealed report with definitions/sketches, as well as maps/drawings referenced to stations in the field to assist an operator in completing the work. In such situations, field reviews will likely be required as the work progresses to confirm site conditions and to provide quality assurance of the work.

Carry out all required referrals to other government agencies at appropriate stages during development of prescriptions, and incorporate, where feasible, the requirements of those agencies. As well, obtain approvals for any works in and about a stream, as are required from the Ministry of Environment [[Water Regulation \(Part 7\)](#)], under the [Water Act \(Sec. 9\)](#) and [Department of Fisheries and Oceans Canada](#) (migratory fish). For information related to deactivation of crossings of fish streams, refer to the [Fish-stream Crossing Guidebook](#).

### 7.5.2 Phases of Prescription Development

Base road deactivation prescriptions on suitable office review of available relevant information and on field assessment. Prescriptions include a deactivation map, as well as other documentation necessary to ensure that the works are successfully conducted and the objectives of deactivation are achieved. These phases are discussed briefly below.

#### Office Review

Prior to field work, conduct an office-based review of existing information including local knowledge to help identify the potential resources at risk, terrain stability/landslide concerns (especially below the road corridor), sediment hazards, and consequences at and adjacent to the road.

#### Field Assessment

Carry out a field assessment and prescribe deactivation techniques at specific locations. This task typically involves:

- traversing the road corridor and identifying potential stability and drainage hazards;
- evaluating the risk to resources; and
- marking prescription activities in the field.

When developing prescriptions, consider both the landslide hazard associated with the road and the risk to downslope and downstream resources.

Before choosing a deactivation technique (or combination of techniques), evaluate the following items:

- if any access by motor vehicles is permitted, the type of vehicle access following deactivation;
- the stability of the road cuts and fills, the condition of culverts and bridges, the performance of the existing road drainage system, existing sediment sources, and the potential for further deterioration of road structures and prism;
- the stability of the terrain below (and, in some cases, above) the road corridor; and
- any existing access problems that may prevent or impede equipment access to the end of the road to start the deactivation work (e.g., locations where large landslides have destroyed the road grade in gully areas, large cut slope

landslides, existing deactivation work, etc.).

Collect and record other useful site data that provides rationale for the prescriptions, including, for example:

- surficial materials and geomorphologic processes;
- angles of natural and constructed slopes;
- length of fill slopes;
- height of cut slopes;
- road gradient;
- existing structures;
- streams, seepages, and road drainage controls.

Consider using a standard field data form to enhance the consistency and quality of data gathering. In [Appendix 7.1: Example Data Form for Deactivation Field Assessments](#) is shown.

### **Preparing Maps, Tabular Summary, Letter or Report**

Provide a deactivation map (or work plan) to scale to accompany a deactivation prescription, plus one or more of the following:

- a summary (in table form) of prescribed techniques, by station; and
- a letter or report.

These requirements are more fully discussed below. See examples showing the linkage between various site and project conditions, and the minimum content of a road deactivation prescription in [Appendix 7.2: Example Road Deactivation Prescription Content Requirements](#).

#### ***Content of Deactivation Map (Work Plan)***

Provide a map at 1:5000 scale or other suitable scale. Consider the following for illustration on the map, as deemed appropriate to effectively communicate the design requirements to equipment operators and supervisory personnel:

- proposed vehicle usage after deactivation (4-wheel drive (with no barricades), all-terrain vehicle, no access);
- topographic information;
- additional relevant planimetric information (e.g., streams, bodies of water, legal boundaries, landslides, utilities, highways);
- additional supporting information such as stream classifications, and timing windows and measures for work in and around stream crossings (where applicable);
- special site access requirements;
- sites of potential concern for worker safety;

- requirements for terrain stability field reviews by a Qualified Registered Professional;
- special requirements for work carried out within a community watershed;
- location of all prescribed deactivation techniques by station (road chainage and prescription symbol), including the type and locations of hazards (e.g., record road segments that may be unstable before, during, or after road deactivation work);
- legend for prescriptionsymbols;
- date of the assessment;
- name of the assessor; and
- scale bar and north arrow.

**Note:** Provide some of the items above in a tabular summary rather than on the 1:5000 scale map if this would more clearly depict the work.

### ***Content of Tabular Summary***

Use a tabular summary where:

- more detail is given to communicate the requirements of the project to forestry operations personnel;
- the risk of damage to adjacent resources is moderate or high; or
- it may be necessary to re-establish the fieldmarkings.

In the tabularsummary, provide:

- the measured chainage along the road;
- the associated recommended actions;and
- detailed comments about such items as:
  - site conditions;
  - worker safety issues;
  - key reference points;
  - rationale for road fill pullback;and
  - depth and width of cross-ditches.

Use the tabular summary as a tool to assess the results of the risk analysis, and to help estimate the costs of road deactivation works.

### ***Content of Letter or Report***

Provide a report to accompany and complement deactivation maps and tabular summaries if:

- there is a high risk to the environment;
- the project is large or complex; or
- the road traverses areas of moderate to high likelihood of occurrence of

landslides.

in the report, provide an estimate of the expected level of residual risk at the project site if the works are carried out in overall conformance with the prescriptions. Residual risk is the amount of risk remaining following the implementation of all hazard or risk control measures specified in the prescriptions, because it cannot practicably be further reduced. Ensure that any concerns about residual risk are brought to the attention of the District Manager, who determines if and how the district may manage the residual risk after the road is deactivated.

Generally for small projects, use a brief letter rather than a report. Provide in a letter or report the following topics, as relevant:

- geographical location information (watershed name and number, harvesting tenure);
- background information;
- description of deactivation objectives;
- prescription methodology;
- road reactivation considerations (such as road reconstruction, wet crossings, and safety issues);
- site level information;
- results and recommendations; and
- site plans and illustrations.

## **7.6 *Involvement of Professionals in Road Deactivation***

Use the services of a specialist professional to carry out a terrain stability assessment and prepare the applicable portion of the road deactivation prescription if any of the following apply:

- terrain stability mapping indicates that the road is located on terrain that is unstable or potentially unstable;
- terrain stability mapping has not been done, and the road is located on terrain with slopes greater than 60%;
- the road is located on terrain where there are indicators of slope instability;
- the areas downslope or upslope of the road (or adjacent to or connected to it) contain elements at risk of damage or loss from a landslide, and the road crosses areas having a moderate or high likelihood of landslide occurrence;

### **7.6.1 Professional Field Reviews: Quality Assurance**

Generally, for the more complex projects, state the rationale for a field review by a Qualified Registered Professional in the deactivation prescription, and describe any specific concerns and the potential consequences of not carrying out



professional field reviews. As well, identify in the rationale the timing and number of the professional field reviews.

**Note:** The cost to carry out road fill pullback a second time to repair deficiencies can be much higher than the cost of the original pullback work. Thus, thorough field reviews are prudent where full road fill pullback is being planned for areas located above high-value resources such as highways and residential development.

### **7.6.2 Professional Field Reviews – Unanticipated Subsurface Conditions**

Unanticipated subsurface conditions may be encountered during deactivation works. In such an event, and if potential material adverse impacts to adjacent resources are identified, ensure that a Qualified Registered Professional conducts a field review before the project continues.

### **7.6.3 Modification of Prescriptions**

To address unforeseen site conditions, it may be necessary to modify the prescription. If there are reasonable grounds to believe that the changes to the prescription would not adversely impact forest resources or other values, the required changes can be made without further approval. At the start of the project, it is often useful to establish a protocol for the types of changes that can be made on site.

For prescriptions that have been prepared by a Qualified Registered Professional, ensure that that person or another similarly qualified person approves all changes to the prescription.

### **7.6.4 Statement of Works Conformance**

Ensure that a Qualified Registered Professional signs and seals a Statement of Works Conformance after completion of the works for those projects identified in the deactivation prescription as needing such sign-off. A standard form has been prepared for this purpose: see [Appendix 7.3: Statement of Works Conformance](#). Preferably, this person will be the same Qualified Registered Professional who prepared the prescription.

Based upon the risk to other resources as a result of poor deactivation work, consider carrying out a subsequent field inspection of the completed project.

## **7.7 Road Deactivation Works**

### **7.7.1 Project Management**

Ensure that the person carrying out deactivation project management has the appropriate training and experience to coordinate and manage projects, including carrying out the following activities:

- making all required referrals to government agencies, obtaining all required approvals and permits, and providing all required written notification at

appropriate stages of the project;

- if applicable, retaining and coordinating the activities of the appropriate team of technical and professional consultants as required for the project;
- if applicable, preparing suitable contract documents for technical and professional services related to activities such as prescription development, field reviews, and post-works inspections; and preparing suitable contracts for works and supervision of the works;
- if applicable, coordinating purchase and delivery of required materials for the project;
- administering and retaining copies of all required documentation;
- coordinating and appropriately scheduling the timing of works; and
- undertaking other administrative and technical project duties as necessary.

### 7.7.2 Cost Estimate of the Planned Works

Include in the prescriptions for road deactivation a cost estimate for the works, with the appropriate extensions of unit costs or phase lump sum costs.

### 7.7.3 Carrying out the Works

All road deactivation works ***must*** be carried out in accordance with the requirements of a road deactivation prescription that has been accepted by the appropriate manager.

Ensure that suitable on-site inspection is provided as required during the deactivation works, and upon completion of the works.

### 7.7.4 Submission Requirements after Completing the Works

Upon completion of the works, place a hard copy of all as-built prescriptions on file, including the Statement of Works Conformance, deactivation maps, tabular summaries of prescriptions, letters, and reports. In addition, incorporate as-built information into the applicable data base.

**Note:** *If there are not any substantive changes to the prescriptions, mark the original prescriptions, maps, reports, etc., as the “as-built” information.*

Ensure that the person who signs the Statement of Works Conformance provides a letter to confirm or clarify where required:

- the level of residual hazard or residual risk following completion of the deactivation work if it is different from estimates provided in the prescriptions;
- the limitations of the works; or
- other site-specific explanatory information not covered in the Statement of Works Conformance form.

### **7.7.5 Inspections after Deactivation**

The district can accept the recommendations of the TSM as to the adequacy and suitability of the works. No further inspections are necessary. Proceed with close and discontinue after this point in time.

## **7.8 Deactivation Hazard Warning Signs**

Before deactivation activities begin, erect warning signs at appropriate locations during the period of road deactivation activities to warn potential users of the road (either open or closed to traffic) of the hazards that can be expected on the whole road or at a particular location. Where an entire drainage or system of roads is being deactivated, post the signs at the earliest location to warn of the upcoming hazards. Repair or replace damaged or missing signs as required during the period of the works. There is no legal requirement to leave signs in place upon completion of deactivation works. Normally the deactivation works (barricading, water barring etc) can serve as sufficient warning to potential users that a road has been deactivated.

## **7.9 Road Deactivation Objectives**

For elements at risk – including forest resources and social and economic values – within and adjacent to the road location, ensure that deactivation minimizes the risk from hazards such as landslides, gully processes, fan destabilization, uncontrolled soil erosion, and sediment transport. Ensure that prescriptions and works for road deactivation consider a range of techniques (see [7.10: Road Deactivation Techniques](#)) to meet the following objectives:

- place the road in a self-maintaining state that will protect indefinitely the elements at risk;
- stabilize the road prism and clearing width;
- maintain natural surface drainage patterns on the area within the road right-of-way and in adjacent or connected areas affected by the works both during and after deactivation activities;
- minimize the impact of silt and sediment transport on other forest resources;
- prevent adversely impacting water quality in community watersheds or in streams diverted for human consumption by a licensed waterworks (also, ensure that at least 48 hours notice of impending deactivation work is provided to water licensees or water purveyors in community watersheds)
- for a fish stream, provide for safe fish passage and protection of fish habitat immediately upstream and downstream, both in the timing and extent of the works;

### **7.9.1 Achieving Deactivation Objectives**

The choice of water management, road fill pullback, and revegetation techniques to stabilize the road prism or clearing width depends on the terrain, slope gradient, soils, and climatic conditions of the area. Apply deactivation measures most

aggressively where roads traverse areas of steep terrain or erodible soils, especially in geographical areas that receive high levels of precipitation.

### **Water Management**

Maintain surface drainage patterns so that they are consistent with natural drainage patterns. Achieve this by applying some or all of the following techniques:

- Remove cross-drain culverts and replace them with cross-ditches to re-establish drainage patterns, especially on steep road grades and side hills. If the likelihood of failure is minimal or the consequences of a failure are low, consider leaving the cross-drain culvert intact, provided it is backed up with a cross-ditch or armoured swale as necessary.
- Install cross-ditches or waterbars where there are steep grades, heavy groundwater seepages, switchbacks or road junctions, ditches prone to plugging, places where ponding may occur, and other potential drainage problem areas.
- Remove or breach windrows on the road surface.
- Outslope or inslope the road surface as appropriate.
- Install trench drains, blanket drains, French drains, fords, and armoured swales.

### **Soil Erosion and Sediment Control and Road Prism Stabilization**

Activities to minimize the impact of silt and sediment transport on forest resources include erosion control measures (such as grass seeding, vegetation planting, soil bioengineering, and installation of erosion control blankets) and sediment control measures (such as silt fence, catch basins, and check dams). See [Chapter 5: Road Construction](#) for examples of surface soil erosion and sediment control techniques, as well as for works shutdown indicators and procedures.

For roads that have been built on fans, ensure that care is taken to minimize erosion and sediment transport during the deactivation works; in particular, avoid any non-essential excavation of the stream channel or banks.

Where the road prism is unstable, consider using partial or full road fill pullback and cut slope buttressing or other measure to suitably address the landslide hazard and risk of damage or loss to values. As well, take measures to remove organic material (stumps, roots, embedded logs, and topsoil) that may reasonably be expected to fail and destabilize the road fill.

Take care in verifying indicators of slope instability. For example, tension cracks or minor slumps in the road surface may indicate a failing road fill, rather than signaling unstable terrain. Consider using a partial pullback of the road fill to stabilize the road prism and protect users of the road and adjacent resources. However, if the slope instability indicators occur outside the road prism (e.g., a small slide) or the instability within the road prism has the potential to affect

adjacent resources (e.g., debris from a potential fill slope failure could reach a fish stream), consider the area to be unstable.

## **7.10 Road Deactivation Techniques**

To reduce potential adverse effects on adjacent forest resources, there are a number of common techniques available for water management, road fill pullback, and revegetation. Refer to the [Best Management Practices Handbook \(BMP\): Hillslope Restoration in British Columbia \(Chapter 3\)](#) for more details on each technique.

### **7.10.1 Water Management Techniques**

Maintain surface drainage patterns consistent with natural drainage patterns by employing one or more of the following water management techniques:

#### **Cross-Ditch Across an Intact Road**

The purpose of a cross-ditch is to intercept road surface and ditchline water and convey it across the road onto stable, non-erodible slopes below the road ([Figure 7-1](#)).

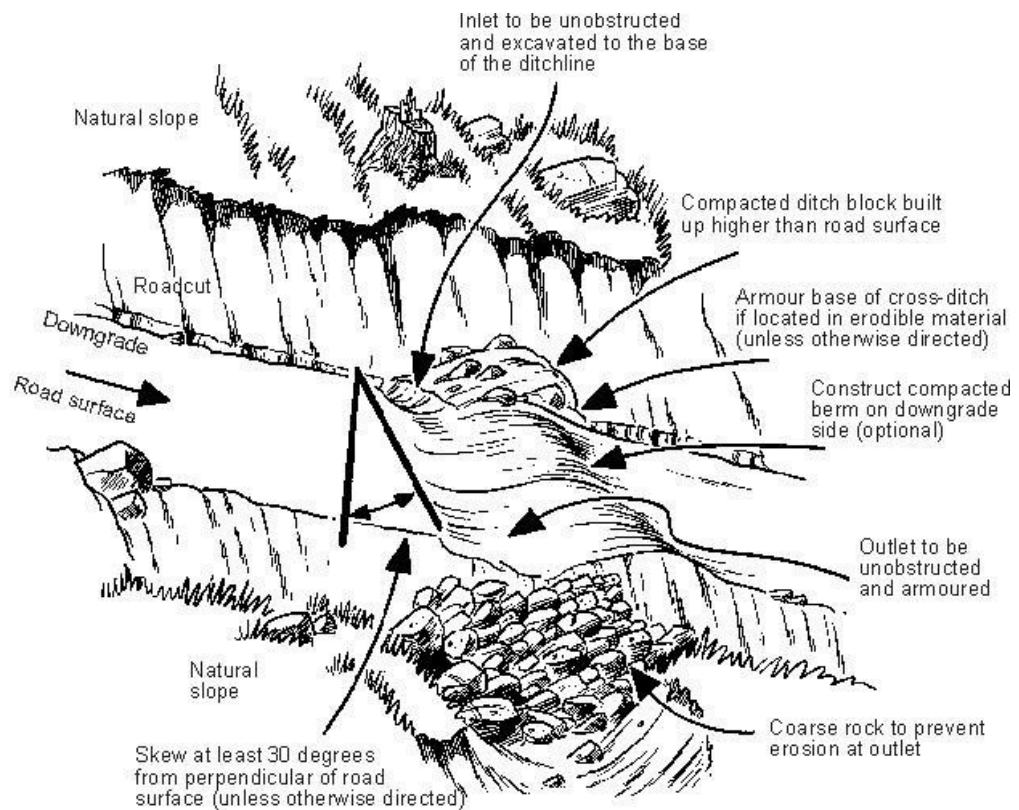
A cross-ditch is a ditch across a road excavated to a depth equal to, or greater than, the depth of the ditch at the road cut. Cross-ditches generally have a berm on the lower side, and a compacted ditchback.

Install a well-compacted ditch block immediately downgrade of the cross-ditch inlet. Ensure that the ditch block is:

- higher than the road surface;
- large enough to divert all expected flows into the cross-ditch; and
- non-erodible and relatively impermeable.

Where ditchwater converges at low points in the road, construct the cross-ditch as a broad gentle swale so that no ditch block or berm is required. If constructed properly, cross-ditches are maintenance free.

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.1\)](#) for further details.

**Figure 7-1 Cross-ditch installation across an intact road**

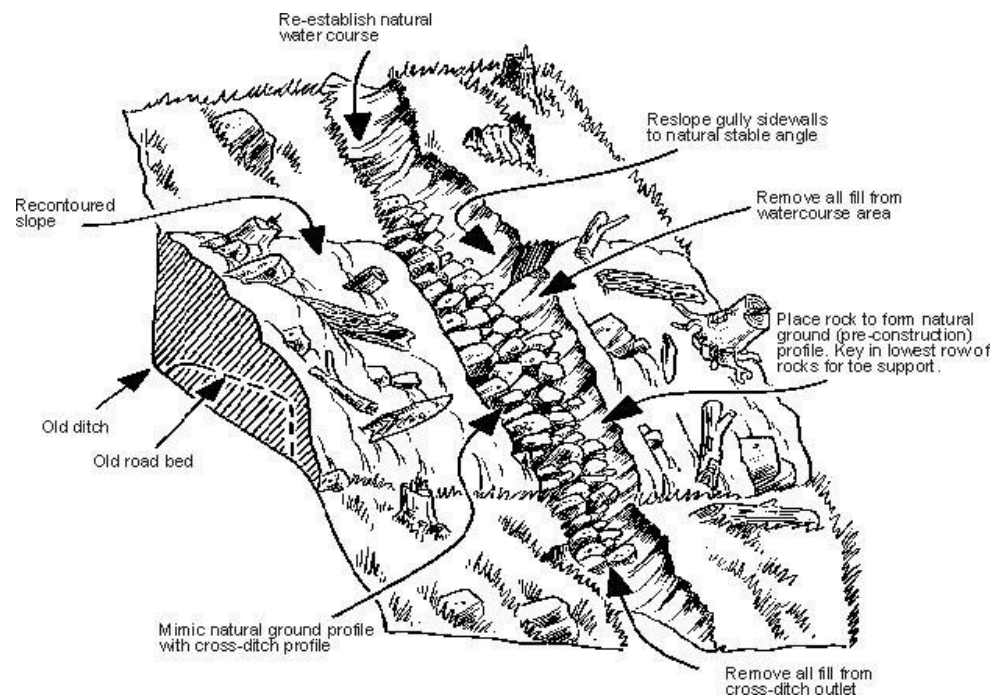
Note: Refer to Typical Road Deactivation Prescriptions Drawings in Appendix III

### Cross-Ditch in Full Pullback

The purpose of a cross-ditch located within segments of full road fill pullback is to restore the natural drainage paths to pre-construction (historic) locations along the hillslope ([Figure 7-2](#)). Since water flow along the surface is not possible in areas of road fill pullback, fewer cross-ditches are needed in pullback than for roads where pullback is not carried out.

A cross-ditch in pullback is a ditch across the old roadbed connecting a natural hillslope drainage path (streams, gully channels, and swales with flow). Excavate cross-ditches in pullback down to natural (undisturbed) non-erodible material.

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.2\)](#) for further details.

**Figure 7-2 Cross-ditch installation across full road pullback**

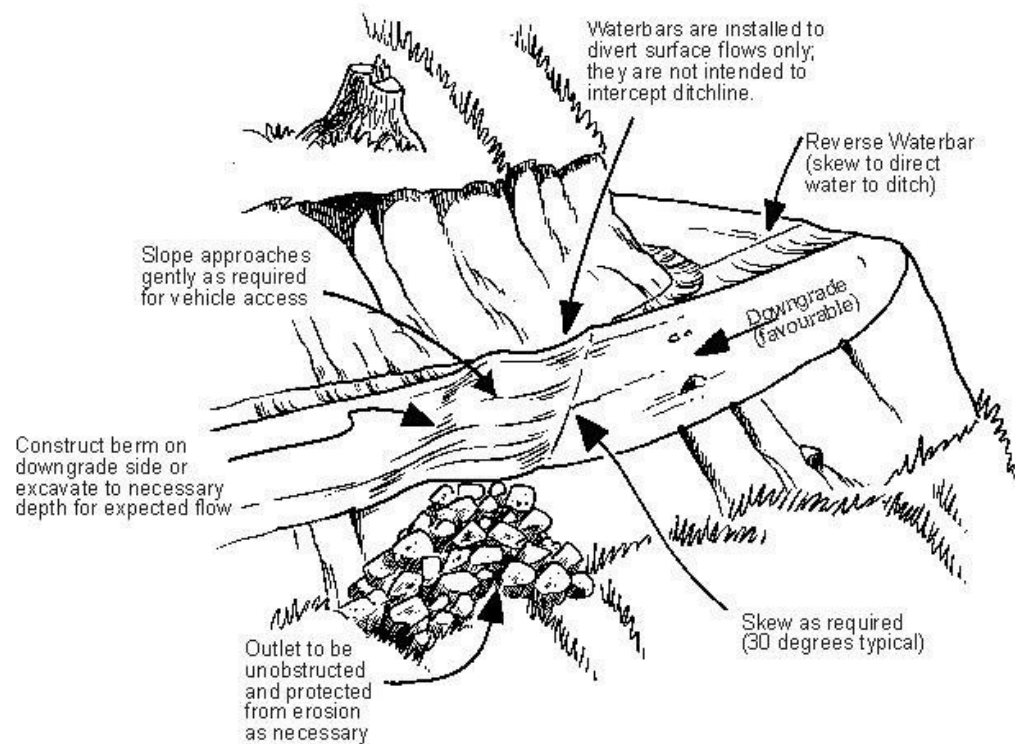
### Waterbars

The purpose of a waterbar is to intercept surface water on the road and convey it across the road onto stable slopes below the road. Also, use waterbars to reduce the flow energy along the grade. Reverse waterbars direct flow off the road into the drainage ditch ([Figure 7-3](#)).

A waterbar is a shallow ditch across a road, skid trail, or backspur trail to prevent excessive flow down the road surface (or trail). Waterbars are not intended to intercept ditchlines; thus, the base of the waterbar is above the base of the ditch and a ditchblock is not required.

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.3\)](#) for further details.

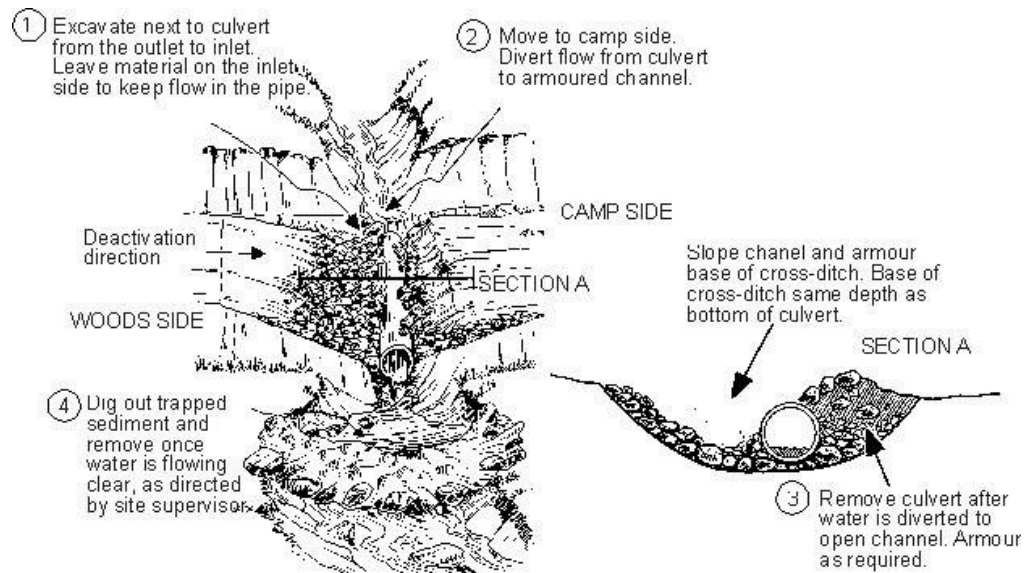


**Figure 7-3 Waterbar installation**

### Stream Culvert Removal

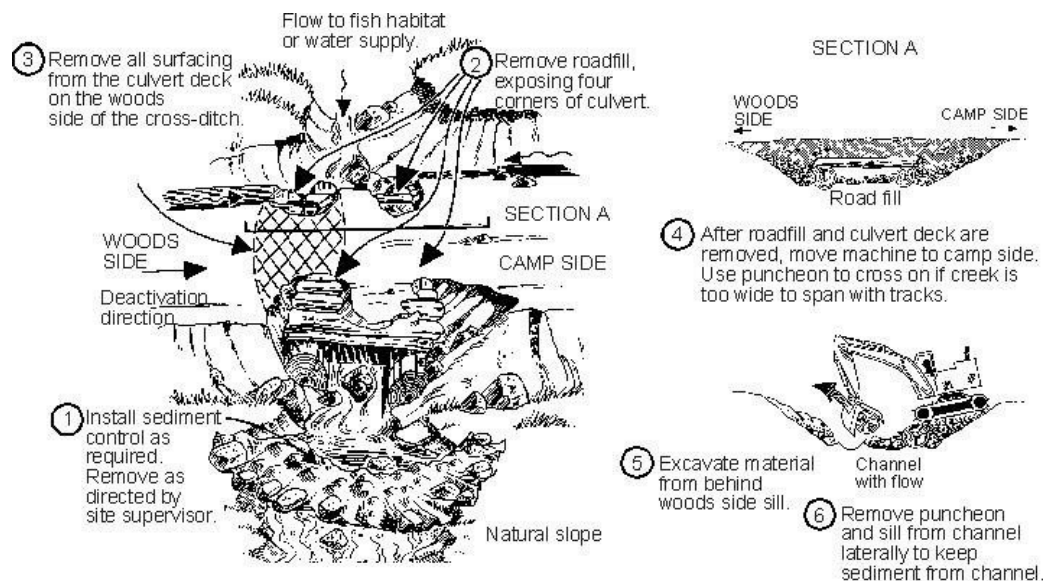
Remove stream culverts (metal or plastic pipes or log culvert stringers) and reconstruct the channel, to remove the existing culvert while creating the least amount of sedimentation possible and leaving a cross-ditch. Re-establish the natural width and gradient of the stream, and armour the streambanks (sides of the cross-ditch) and the base of the channel. The size, depth, and shape of the re-established stream crossing depend on the hillslope and creek/gully contours and expected flows. [Figure 7-4](#) and [Figure 7-5](#) show techniques that can be used to remove a pipe or log culvert where running water is present in the channel and the stream is hydraulically connected to fish habitat or community water supplies.



**Figure 7-4 Metal or plastic pipe stream culvert removal (non-fish stream)**

At challenging sites, explore the range of practical options with fisheries agencies, to ensure that the potential for sedimentation is reduced to acceptable levels.

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.4\)](#) and [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.5\)](#) for further details.

**Figure 7-5 Log stream culvert removal (non-fish stream)**

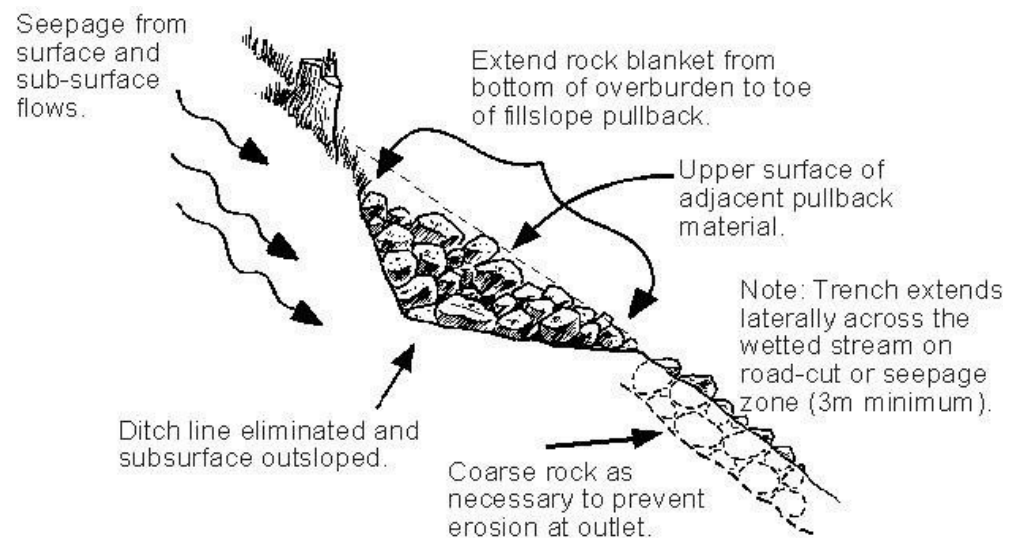
## Trench Drains

Consider prescribing trench drains in areas of full (heavy) pullback; they are particularly useful where it is necessary to use all the space on the road bench for placement of road fill pullback.

A trench drain is a cross-ditch in road fill pullback that is filled with coarse rock to carry water from seepage areas on the road and/or small surface flows. The purpose of a trench drain is to allow both surface and seepage flow to pass across road fill pullback ([Figure 7-6](#)).

Refer to [BMP: Hillslope Restoration in British Columbia Chapter \(3.5.6\)](#) for details.

**Figure 7-6 Trench drain**



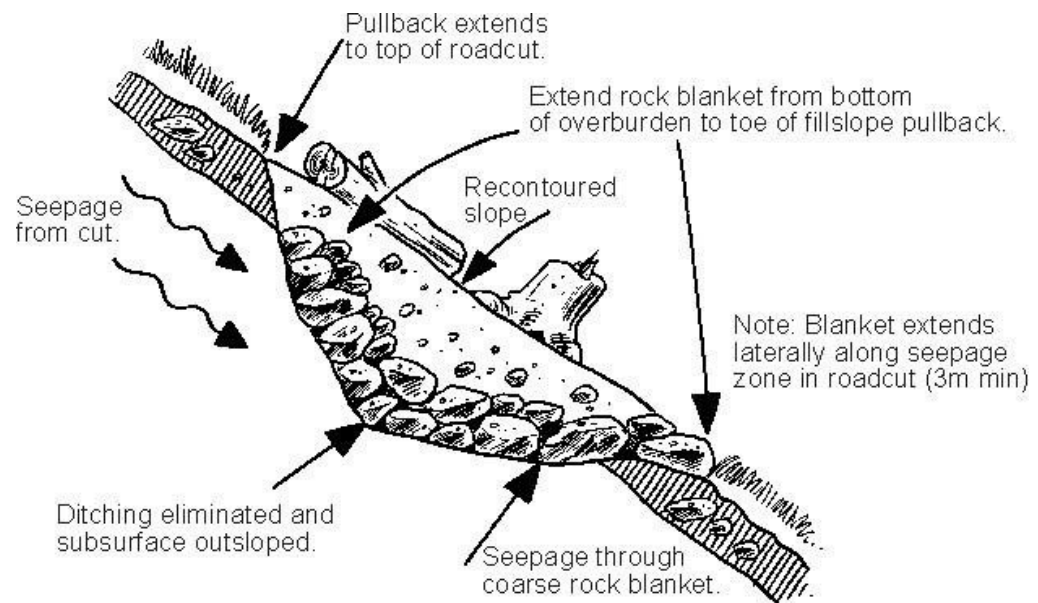
### Blanket Drains

The purpose of a blanket drain is to disperse point seepage or subsurface flow under the road fill pullback. Blanket drains disperse flow rather than concentrate the flow at one hillslope locations, and are not intended to convey surface flows or replace open cross-ditches in areas of substantial flow.

A blanket drain consists of a layer of cobbles or shot rock placed against the seepage zone in the road cut. The blanket extends down the cutslope and across the decompacted road surface to the ground surface. Road fill is placed on top of the road cut to the bottom of the blanket. The blanket of shot rock does not extend to the top of the road cut, but only to the top of the seepage zone.

A blanket drain has a wider “footprint” in plan than a trench drain: it commonly extends a greater lateral distance along the road, providing increased flow capacity ([Figure 7-7](#)).

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.7\)](#) for further details.

**Figure 7-7 Blanket drain**

### French Drains

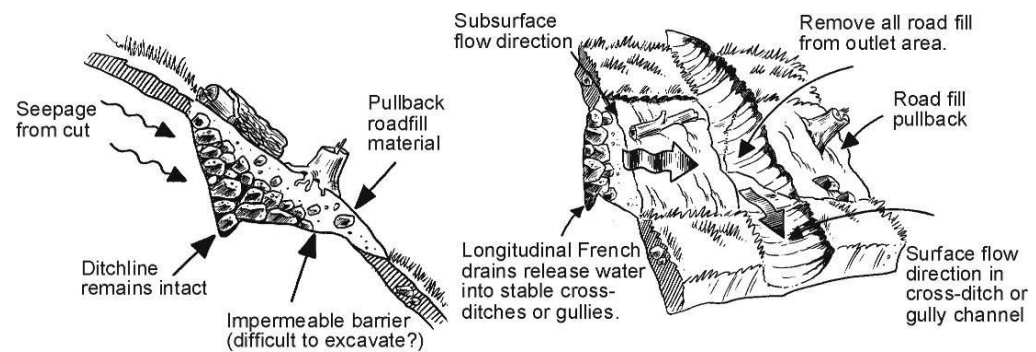
The purpose of a French drain is to divert flow along the base of a cut slope and discharge it into a stable location, such as a creek or gully. Use French drains where road fill pullback or bank sloughing may block the ditch and cause water management problems. These drains also provide some degree of water management if the road cannot be decompacted to below ditchline depth. The rock-filled French drain extends down the ditchline until it intersects, and is hydraulically connected with, a cross-ditch or gully.

Consider using a French drain where a cross-ditch is impractical, specifically:

- where the seepage zone is extensive in length;
- the retrieved road fill will be impermeable when placed against the road cut; and
- the stability of the road fill material may be compromised if it becomes saturated.

Normally, use French drains in conjunction with road fill pullback ([Figure 7-8](#)).

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.8\)](#) for further details.

**Figure 7-8 French drain**

## Fords and Armoured Swales

Fords and armoured swales provide erosion-resistant and storm-proof wet crossings for motor vehicles. A ford is used to cross a stream, whereas an armoured swale is constructed where a cross-ditch would normally be used.

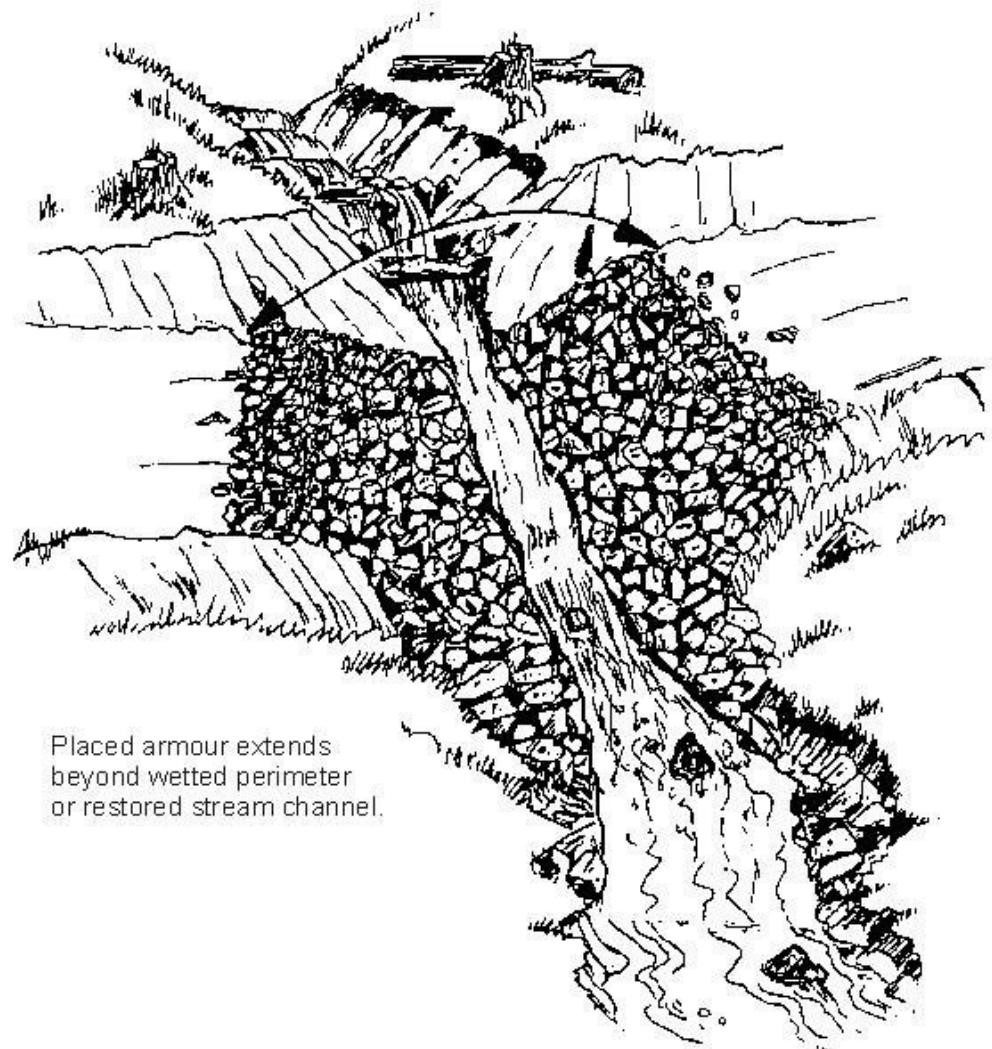
### Fords

A ford is a dip in a road, constructed to cross a perennial or ephemeral stream, normally designed and built as a permanent feature ([Figure 7-9](#)). Fords are a suitable road deactivation option where vehicle access is to be maintained. Fords are restricted to non-fish streams unless otherwise approved by the fisheries agencies. For deactivation, consider protecting the running surface of the ford using rock armour where the natural stream bottom will not support the intended vehicle loads.

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.9\)](#) for further details.



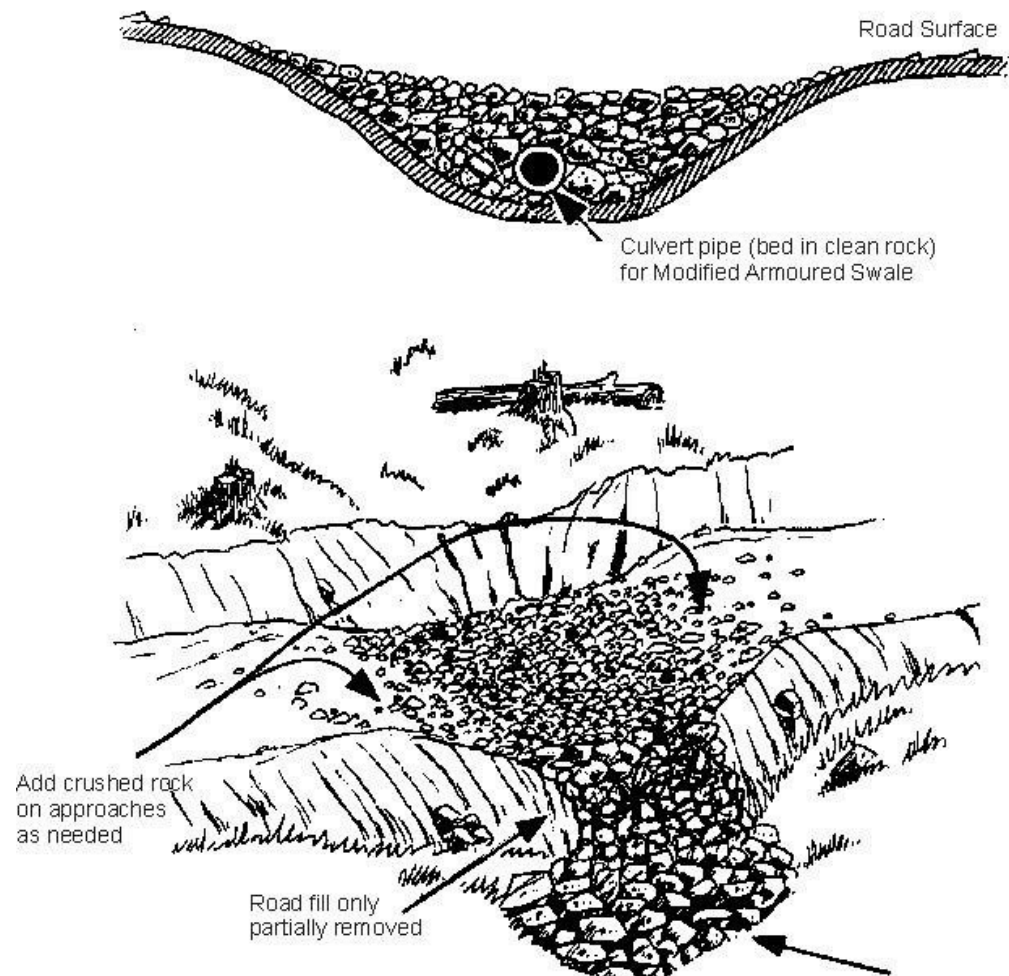
**Figure 7-9 Example of a ford installed on a non-fish-bearing stream**



### ***Armoured Swales***

An armoured swale is a dip in the road grade, installed to convey road surface runoff, ditchwater, or cutbank seepage across a road during works such as road deactivation, where it is critical to minimize sedimentation while short-term vehicle access is required ([Figure 7-10](#)).

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.9\)](#) for further details.

**Figure 7-10 Example of an armoured swale**

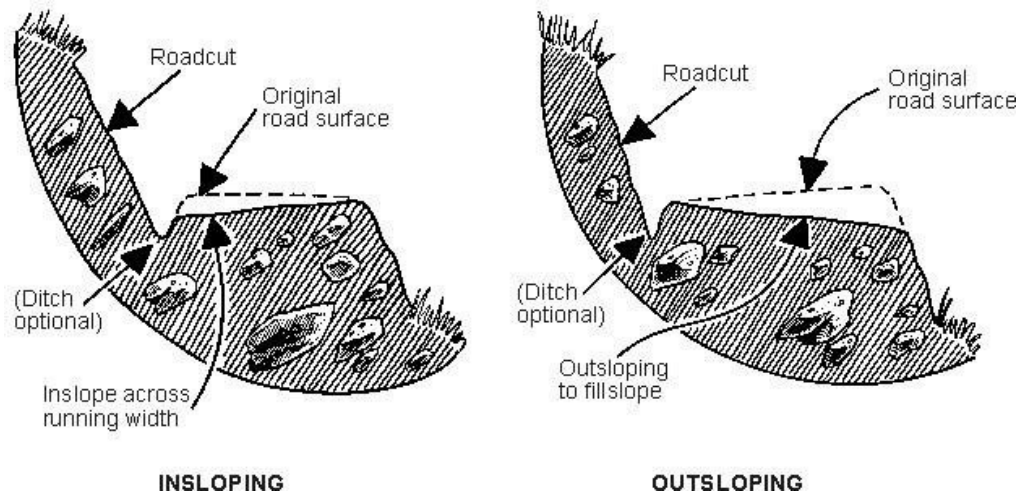
### Insloping/Outsloping Road Surface

The purpose of insloping or outsloping the road surface is to control water without using ditches or cross-ditches ([Figure 7-11](#)).

Insloping is the sloping (reshaping) of the road surface to direct road surface water toward the road cut and away from unstable or erodible road fill materials. Outsloping is the sloping (reshaping) of the road surface to direct water across the road and onto the road fill in a dispersed fashion.

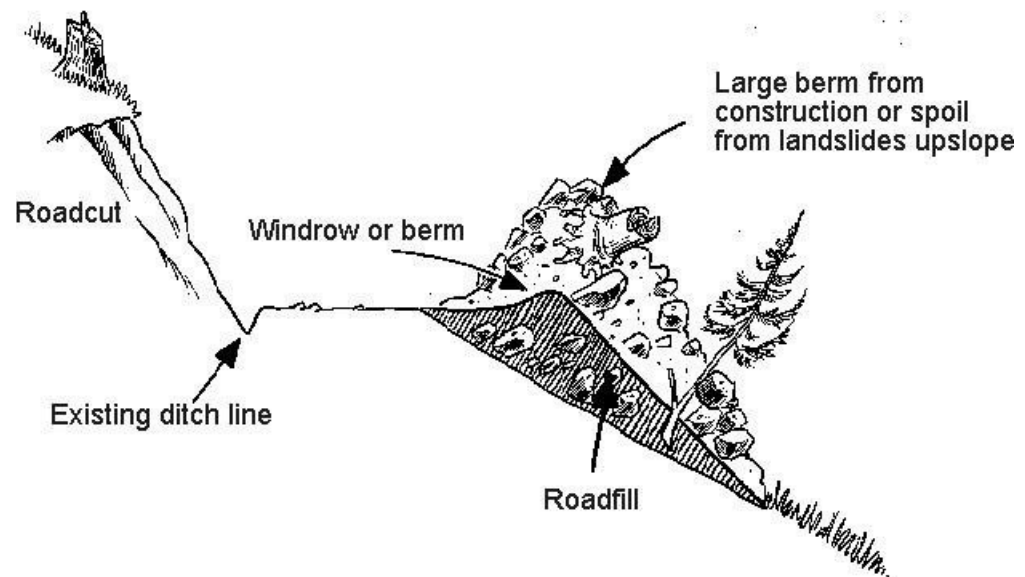
This technique is more effective on roads where there is no vehicle traffic. However, where deactivated roads receive vehicle traffic, the insloping or outsloping will disappear with road use.

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.10\)](#) for further details.

**Figure 7-11 Insloping and outsloping the road surface****Windrow or Roadside Spoil Pile Pullback**

The purpose of windrow or roadside spoil pile pullback is to restore natural hillslope drainage paths where road maintenance activities have left a continuous soil berm on the edge of the road. Pull back larger berms to reduce the weight on the outside edge of the road, or to meet silviculture objectives ([Figure 7-12](#)).

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.11\)](#) for further details.

**Figure 7-12 Grader windrow and spoil pile berm (site conditions before fill pullback)**

### 7.10.2 Road Fill Pullback Techniques

Where there is potential for unstable road cut or fill slopes to develop during periods of inattention, consider using road fill pullback. This removes marginally stable sidecast fill that has a high risk of failure, and effectively adds a weighting berm to the toe of the road cut.

#### Full Road Fill Pullback

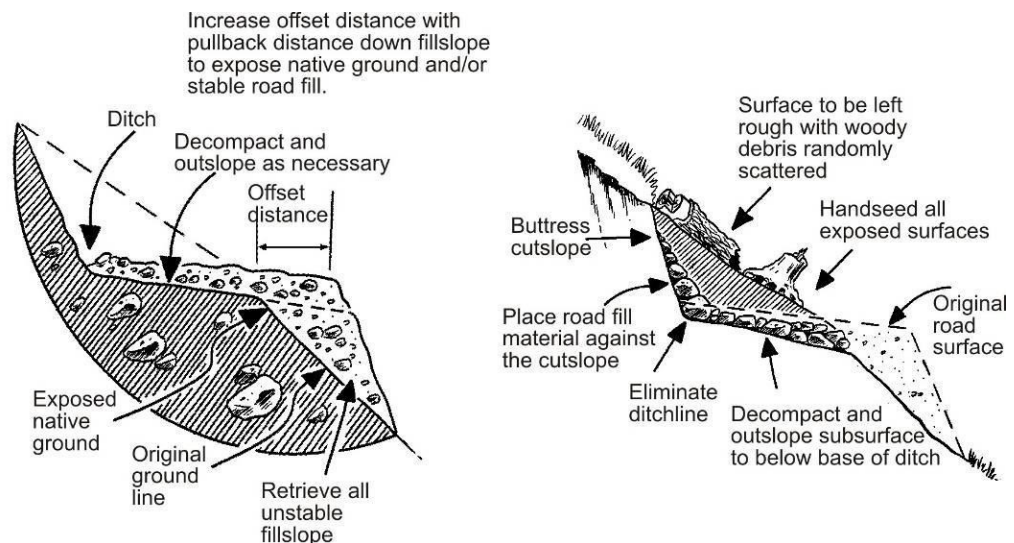
The purpose of full road fill pullback is to retrieve all potentially unstable sidecast material and place it tight against the road cut, thereby reducing the landslide hazard to the greatest extent possible. Usually no access – or only limited access for foot or all-terrain vehicle traffic – is possible after full road fill pullback ([Figure 7-13](#)).

Full road pullback is the deconstruction (also known as “re-contouring” or “de-building”) of the road subgrade to restore the original hillslope profile and contours.

Decompaction may also be necessary. This involves breaking up road fill materials to a depth equal to, or greater than, the depth of the ditch, and removing this material to outslope the surface before pullback material is placed overtop.

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.14\)](#) for further details.

**Figure 7-13 Example of full road fill pullback**



#### Partial Road Fill Pullback

Partial road pullback may be appropriate to maintain motor vehicle access if the road is open to traffic or if road access is needed in the future. Full road fill pullback may be required at some future date to provide long-term stability of the road prism.

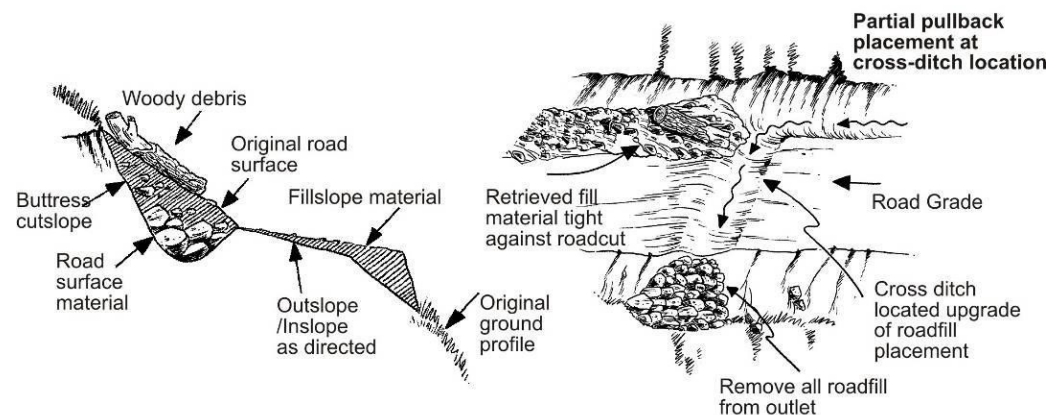


Partial road pullback ([Figure 7-14](#)) retrieves the currently or imminently unstable portions of the road fill and leaves those portions with no evidence of immediate instability intact. Retrieved road fill is placed tightly to the road cut with organic soil and woody debris on top to promote revegetation.

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.13\)](#) for further details.

Endhaul the pullback material when the unstable volumes of road fill exceed the available room in the ditchline. This is the process of removing excess road fill and placing it in an approved waste area. Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.6.1\)](#) for further details.

**Figure 7-14 Partial road fill pullback**



## Gully Restoration

Gully restoration is carried out during full road fill pullback to decrease the landslide hazard along the road approaches on the side walls of the gully.

Gully restoration involves pulling back all the fill material out of a gully channel. The size, depth, and shape of the pullback should mimic the natural ground profiles and contours of the gully system above and below the road. Armouring the gully channel and endhauling are often used together. Consider using similar techniques for entrenched creeks. Refer to the [Gully Assessment Procedure Guidebook](#) for detailed technical information on the deactivation of road crossings of gully systems.

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.6.1\)](#) for further details.

### 7.10.3 Revegetation Techniques

To control surface soil erosion and sediment transport, seed or plant, in the first growing season after deactivation, all exposed soils that will support vegetation.

Establish vegetation by the end of the second growing season. Consider prolonging this time period or varying the process for revegetation if it seems apparent that the change will adequately manage and conserve the forest resources. Consider natural revegetation as an appropriate option if it can be suitably established within two growing periods. Revegetation is considered to be successful when there is uniform coverage on the ground. Spotty or clumpy patches of vegetation are not considered adequate.

Consider the following in assessing the adequacy of revegetation efforts:

- the mixture of the grass seed used;
- the time and rate at which the seed was applied;
- the appropriateness of the fertilizer and mulch used; and
- the number of attempts made to establish the vegetation.

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.8\)](#) for further details.

#### Grass and Legume Seeding

Seeding is the most common and usually the most cost-effective means of treating deactivated roads to prevent erosion.

Refer to [Chapter 5.12: Road Construction](#) and to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.8.1\)](#) for further details.

#### Scarification

To grow trees for soil erosion control purposes in areas that are not part of the net area to be reforested (but where trees can be reasonably expected to grow), it may be necessary to supplement grass seeding by scarifying the road surface, re-using local topsoils, or employing other similar measures.

**Note:** Scarification is for reforestation purposes, whereas decompaction during fill pullback activities is for deactivation/water control purposes.

Scarification (also known as “silvicultural fluffing”) is designed to enhance revegetation. It involves breaking up the road surface to a minimum depth equal to about twice the length of the teeth on an excavator bucket (about 400mm, or 16-20 inches).

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.5.12\)](#) for further details.

## Woody Species Establishment

In addition to grass seeding of all deactivated roads where necessary, consider the localized re-use of topsoil to grow trees for soil erosion control purposes.

Consider planting pioneering species such as alder, willow, and, in some cases, lodgepole pine and Douglas-fir on areas of full road fill pullback or on areas that have been scarified. These species are important early colonizers of disturbed sites, and prepare the site for later succession forest species such as spruce, cedar, and hemlock. Before any planting activities on a permanently deactivated road are undertaken, consult with the professional forester responsible for silviculture activities in the area to ensure that such planting is consistent with silviculture prescriptions prepared for the area.

Use topsoil and tree planting to achieve revegetation (outside the net area to be reforested) on a permanently deactivated road simply for controlling soil erosion. There is no requirement to reforest all permanently deactivated roads, even where such reforestation is feasible. The choice to reforest rests with the person required to deactivate the road.

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 3.8.2\)](#) for further details.

## Soil Bioengineering

Consider using soil bioengineering systems if the objective is to:

- drain excess moisture that may be creating slope instability (e.g., live pole drains, live silt fences, live bank protection, live gully breaks, and live staking);
- reduce slope angles relative to the growth of vegetation and prevent raveling of fill slopes (e.g., wattle fences, modified brush layers, brush layers in a cut); or
- control erosion along watercourses (e.g., live gravel bar staking, and live shade).

Soil bioengineering is a term that describes the use of living plant materials to build drains, slope breaks, low slope support walls and other similar living systems for water management and soil erosion control on steep slopes. It may also be an effective technique for riparian restoration.

Refer to [BMP: Hillslope Restoration in British Columbia \(Chapter 6\)](#) for further details.

## Control of Noxious Weeds

During deactivation assessment, consider the presence of knapweed and other noxious weeds that are found along many old logging roads. Consult with a forester, agrologist, or biologist to minimize the likelihood of spreading these

problem weeds through machine travel or seed disturbance, if scheduling deactivation work outside the seed maturity time is not possible.

### **7.11 Resources and Suggestions for Further Reading**

BC Ministry of Forests. 1997. [Soil rehabilitation guidebook](#). Victoria, BC.

\_\_\_\_\_. 1999. [Mapping and assessing terrain stability guidebook](#). Victoria, BC.

\_\_\_\_\_. 2001. [Gully assessment procedure guidebook](#). Victoria, BC.

\_\_\_\_\_. 2002. [Fish-stream crossing guidebook](#). Victoria, BC.

BC Ministry of Forests and Range. 2004. [Effectiveness evaluation of road deactivation techniques on the west coast of Vancouver Island](#). Victoria, BC. For. Res. Ext. Note: EN-020.

Grainger, Bill. 2004. [Terrain stability field assessments in “Gentle over Steep” terrain of the southern interior of British Columbia](#). Grainger and Associates Consulting Ltd. Salmon Arm, BC.

Wise, M.P., G.D. Moore, and D.F. VanDine (editors). 2004. [Landslide risk case studies in forest development planning and operations](#). BC Min. For., Res. Br., Victoria, B.C. Land Manage. Handb. No. 56.

Vanbuskirk, C.D., R.J. Neden, J.W. Schwab, and F.R. Smith. 2005. [Road and terrain attributes of road fill landslides in the Kalum Forest District](#). BC Min. For. and Range, Res. Br., Victoria, BC. Tech. Rep. 024.

Additional website resources:

[References listed](#) on the Division of Engineers and Geoscientists in the Forest Sector

[Region Research Sections](#) listed for the BC Ministry of Forests, Lands and Natural Resource Operations

## APPENDICES

## Appendix 7.1: Example Data Form for Deactivation Field Assessments

Road name / Project No.: \_\_\_\_\_  
 Date: \_\_\_\_\_ Record  
 ed by: \_\_\_\_\_  
 Weather conditions: \_\_\_\_\_

Page: \_\_\_\_\_ of \_\_\_\_\_

Road station: start/end	Prescription symbol for deactivation technique	Comments	Terrain / soils	Natural $\angle$ upslope (%)	Natural $\angle$ downslope (%)	Road gradient (%)	Road width (m)	Fill slope length (m)	Fill slope angle (%)	Cut slope height (m)	Cut slope angle (%)	Stability/ surface erosion problems?

**Legend:**

<b>Data Entry Field</b>	<b>Description</b>
Road station: start/end	Road station (e.g., 1+250)
Estimated construction difficulty and/or estimated equipment time	Optional data entry field: If necessary, give relative ranking of difficulty to carry out the major works prescribed, and or estimated equipment time to carry out the prescribed action. This information may be useful to estimate unit costs (e.g., easy, average, difficult)
Prescription symbol for deactivation technique	Examples: X (cross-ditch), RMC (remove metal culvert), P9 (pull 9 m). Symbols are often combined at specific locations. For example, at a single culvert location the deactivation prescription may be "Remove metal culvert" and "cross-ditch"
Comments	Important observations, which may include, for example: areas of seepage; width/length of tension cracks; hazard/consequence/risk of damage to neighbouring resources; requirement for professional field reviews; armouring requirements; source of armour; current motor vehicle access conditions; locations where access <b>must</b> be restored; locations of required benching and ramping for road fill pullback; worker safety concerns; condition of pipe and wood box culverts; condition of bridges; evidence of scour on road; evidence of unstable cuts/fills; landslides; vegetative cover; composition of cut and road fill materials; evidence of woody debris in road fill; evidence of temporary woody debris-supported materials along toe of road fill; location of large gravel pits; landings, etc.
Terrain/soils	Surficial material types of natural terrain (colluvium, bedrock, till, etc.) and texture of natural soils (sand, silt, sand and gravel, etc.)
Natural $\angle$ Upslope (%)	Slope angle of natural terrain above road cut
Natural $\angle$ Downslope (%)	Slope angle of natural terrain below toe of road fill
Road gradient (%)	Average gradient of road
Road width (m)	Width of road
Fill slope length (m)	Length of fill slope below outer edge of road
Fill slope angle (%)	Slope angle of fill slope
Cut slope height (m)	Height of cut slope
Cut slope angle (%)	Slope angle of cut slope
Stability/surface erosion	Examples: TC (e.g., tension crack), SE (e.g., surface erosion), FF (e.g., fill failure), LS (e.g., landslide)

## **Appendix 7.2: Example Road Deactivation Prescription Content Requirements**

Examples are presented below showing the linkage between various site and project conditions and the minimum content of a road deactivation prescription.

### **Example 1:**

The road traverses gentle terrain with no landslide hazard. There are a few crossings of S6 streams and some cross-drain culverts on the road. The risk of damage to adjacent resources is low or minimal. Deactivation measures are limited to water management techniques (such as installation of cross-ditches or waterbars) and revegetation of exposed soils using a suitable grass seed and legume mixture.

Example Prescription Content Requirements:

- a 1:5000 scale topographic map showing the locations of recommended actions (and corresponding to the chainages of field markings) for communication of the required works to field crews (and review and acceptance by the District Manager, if required).

### **Example 2:**

The road traverses gentle to moderate terrain with no landslide hazard. There are many culvert and bridge crossings of S5 and S4 stream, and many cross-drain culverts along the road. The soils are fine-grained and prone to erosion. The area is in a wet belt. The risk of sediment transport to aquatic resources and aquatic habitat from sediment sources is high. Deactivation measures include water management techniques (such as installation of cross-ditches or waterbars, removal, and removal or back-up of stream culverts) and other measures such as repair of bridges and revegetation of exposed soils using a suitable grass seed and legume mixture.

Example Prescription Content Requirements:

- a 1:5000 scale map (or other suitable scale) showing the locations of the actions corresponding to the chainages of field markings; and
- a tabular summary (spreadsheet) to accompany and complement the map. The tabular summary provides more detailed information such as general site conditions, the size of existing culverts and bridges, sediment transport hazards and consequences, and methods to control sediment transport, including the measured chainages along the road and the corresponding actions. In this example, ensure that the prescription clearly identifies the fish streams and the timing windows for working in and about a stream.

**Example 3:**

The road is located on a mid-slope and traverses steep terrain and areas having a moderate to high likelihood of landslides. There are visual indicators of road fill instability, surface soil erosion, and previous road fill washouts along the road. The road is located in a wet belt and receives high annual precipitation. The road crosses many deeply incised S5 streams contained in gullies tributary to an S2 stream downslope of the road. Deactivation measures include water management techniques such as installation of cross-ditches, creation of long segments of partial road fill pullback to maintain motor vehicle access, and revegetation of exposed soils using a suitable grass seed and legume mixture. There is an existing high risk of potential damage to public utilities, a highway, and the S2 stream from potential fill slope failures.

**Example Prescription Content Requirements:**

- a 1:5000 scale map showing the locations of the actions corresponding to the chainages of field markings;
- a tabular summary (spreadsheet) to accompany and complement the map; and
- a detailed letter or report. The prescription clearly identifies the timing windows for working in and about streams that are tributary to the S2 stream, and includes deactivation prescriptions for unstable terrain and the need for any field reviews by a Qualified Registered Professional during the deactivation work.

### Appendix 7.3: QRP Statement of Road Deactivation Conformance

TO BE COMPLETED BY QUALIFIED REGISTERED PROFESSIONAL **AFTER** COMPLETION OF THE ROAD DEACTIVATION WORKS

<b>Road Name</b>	<b>Project #</b>	<b>Forest District/Business Area</b>
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I am a (check one) ☐ Registered Forest Technologist, ☐ Professional Engineer, ☐ Professional Geoscientist or ☐ Professional Forester, registered with the appropriate professional association in British Columbia, and I have undertaken professional responsibility for all field reviews<sup>1</sup> required with respect to this road deactivation project. I have taken steps as regulated under the Provincial Statute for my profession and as required by good practice, in order to sign and seal this Statement of Works Conformance.

In my professional opinion:

- the road deactivation work was carried out in general conformance with the road deactivation prescriptions for this project, including any other relevant documents and design amendments;
- sufficient field reviews of the work at the project site (considered necessary by me, and at my discretion, to confirm that the completed work is in general conformance with the accepted prescriptions and other supporting documents prepared for this project) have been carried out at appropriate times during the deactivation work by me or under my professional direction; and
- significant revisions to the prescriptions and supporting documents prepared for this project, including all prescription amendments, have been documented and recorded on a set of drawings (maps) marked “as-built” and, where necessary, described in supporting documents.

Signature of Qualified Registered Professional		(please affix professional seal here)
Name of Qualified Registered Professional ( <i>please print</i> )	Date Signed YYYY MM DD  	
EMPLOYER'S NAME AND ADDRESS ( <i>please print</i> )		
Phone No.:	Fax No:	Email address:



## Appendix 7.4: Project Tracking Checklist

<b>Project Tracking Checklist</b>		
<b>Use this checklist to prepare a paper trail of key outputs prepared by consultants and sign-offs by BCTS/Timber Pricing and Operations Division.</b>		
<b>Element Being Reviewed &amp; Results Achieved</b>		<b>Date of FLNR sign-off</b>
<b>ROAD DEACTIVATION</b>		
Ensured that road users were notified about proposed significant changes to road access and to solicit input	YES NO	_____
For FSRs deactivated by the District, ensured that deactivation was carried out in accordance with the ministry's funding policy	YES NO	_____
Ensured that the Qualified Registered Professional who prepared a deactivation prescription signed and sealed the final deactivation prescription for the project. If YES, <b>Professional's Name and Company:</b>	YES NO	_____
Ensured that the deactivation prescription will not result in sediment transport that will impact user safety or have a material adverse effect on forest resources	YES NO	_____
Ensured that the deactivation prescription was approved by the BCTS/District engineering specialist	YES NO	_____
Ensured that revegetation was applied to the deactivation areas as appropriate	YES NO	_____
Ensured that hazard warning signs were placed on the road to warn users of the ongoing deactivation works	YES NO	_____
<u><b>Statement of Road Deactivation Conformance</b></u> signed off (P.Eng, RPF, RFT). If YES, <b>Professional's Name and Company:</b> _____	YES NO	_____
Where potential risk to other resources was considered high, ensured that the deactivated road was field inspected by the BCTS/District engineering technician for acceptability	YES NO N/A	_____
Ensured that the as-built prescription information was placed on the file, and incorporated into the applicable data base	YES NO	_____