



Land Procedure Landslide Risk Management

NAME OF LAND PROCEDURE:	Landslide Risk Management
APPLICATION:	This applies to landslide hazards located on Crown land that is administered by the Minister for Forests, Lands and Natural Resource Operations.
ISSUANCE:	Assistant Deputy Minister, Tenures, Competitiveness and Innovation
IMPLEMENTATION:	Ministry of Forests, Lands and Natural Resource Operations
REFERENCES:	<i>Land Act</i> (Ch. 245, R.S.B.C, 1996)
RELATIONSHIP TO PREVIOUS LAND PROCEDURE:	This is a new procedure established in 2014.

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Table of Contents

1. PURPOSE 1

2. BACKGROUND 1

3. DEFINITIONS 1

4. GENERAL PROCEDURES..... 2

 4.1 Landslide Risk Management Steps 3

 4.1.1 Initiation of a landslide risk management project – Step 1..... 3

 4.1.2 Preliminary analysis – Step 2..... 4

 4.1.3 Risk estimation – Step 3 5

 4.1.4 Risk evaluation – Step 4 5

 4.1.5 Risk control – Step 5..... 6

 4.1.6 Action and monitoring – Step 6 7

 4.1.7 Timing..... 7

 4.2 Communication 8

 4.2.1 Communication of Risk Analysis Results 8

 4.2.2 Communication with tenure holders, residents and private
 property owners 8

5. CROWN LAND ADMINISTRATIVE TOOLS..... 8

 5.1 Tenure applications and tenure management..... 8

 5.2 Restricting dispositions and uses on high risk terrain..... 9

6. EMERGENCY MANAGEMENT BC - ROLES AND RESPONSIBILITIES..... 9

APPENDIX A - FURTHER READING..... 11

1. PURPOSE

This Land Procedure (the procedure) is for the use of Ministry of Forests, Lands and Natural Resource Operations (FLNR) staff involved in the administration of Crown land when addressing the management of landslide risks.

The procedure:

- applies to Crown land that may be subject to any landslide hazard, wholly or in part (i.e. including Crown land within a potential initiation, runout or deposition zone);
- provides a framework to assess landslide hazards and risks to public safety, buildings, infrastructure and other key values, when:
 - a landslide event has occurred, or
 - a landslide hazard has been identified which may require administrative or management consideration;
- identifies the major roles and responsibilities of FLNR staff, qualified terrain stability professionals, and other parties; and,
- provides direction for appropriately communicating these hazards and risks to the public, tenure holders and affected stakeholders.

This procedure does not apply to landslide hazards that are a result of tailings pond dam instability or failure.

2. BACKGROUND

The presence of a landslide hazard or the occurrence of a landslide event can potentially result in threats to public safety, and/or damage to buildings, infrastructure and natural resource values. The Ministry of Forests, Lands and Natural Resource Operations (FLNR) recognizes that not all hazards or all landslide events on Crown land need to be addressed. To determine where limited staff and resources should be best allocated a risk-based approach has been adopted, whereby only those situations where the risks are determined to be high enough warrant action by the Ministry.

The risk management steps underpinning the procedure are adapted from the *Landslide Risk Case Studies in Forest Development Planning and Operations* (Ministry of Forests and Range Land Management Handbook 56, 2004). In addition, the procedure closely follows components of the *Post-Wildfire Natural Hazards Risk Analysis Policy*, and the associated *Standard Operating Procedure* (2012). Additional reference materials are presented in Appendix A.

A structured framework for landslide risk management:

- allows for the consideration of the distinct aspects of probability of occurrence, consequence, and risk, rather than probability of occurrence alone; and
- provides a rational basis for informed, explicit, and defensible decisions.

3. DEFINITIONS

Consequence is the effect on human well-being, property, the environment, or other things of value, or a combination of these.

Elements in the context of this document include people, property, the environment, and other things of social or economic value, or any combination of these that are put at risk.

Hazard is a source of potential harm, or a situation with a potential for causing harm, in terms of human injury; damage to health, property, the environment, and other things of value; or some combination of these.

Landslide means the movement of a mass of rock, debris or earth down a slope (as per Cruden and Varnes, 1996).

Probability is an estimate of the chance for a landslide hazard to occur. An estimate of probability is expressed quantitatively, using a number between 0 (an event will not occur) and 1 (an event will certainly occur), or as an equivalent percentage from 0 to 100%. The term **likelihood** is used to provide a qualitative estimate of probability, referred to as a probability rating. Likelihood estimates are typically expressed using relative qualitative terms such as very low to very high or very unlikely to almost certain.

Qualified terrain stability professional means a professional engineer or professional geoscientist registered with the Association of Professional Engineers and Geoscientists of British Columbia that has the appropriate level of education, training and experience to conduct landslide assessments. This can include government and non-government staff.

Land manager means a manager within the Ministry of Forests, Lands and Natural Resource Operations (FLNR) that has responsibilities for Crown land management, and may include authorization managers and district managers.

Risk is the chance of injury or loss as defined as a measure of the probability of landslide hazard occurrence and the severity of an adverse effect to health, property, the environment, or other things of value.

4. GENERAL PROCEDURES

Landslide risk analysis involves estimating the *probability* of a landslide occurring and the *consequence* of such an occurrence. Probability of occurrence (qualitatively referred to as *likelihood*) is an estimate of the chance of a landslide occurring. Consequence is the effect, or expected effect, of the landslide on a specific element. Landslide risk evaluation compares the results of the risk analysis with acceptable or tolerable thresholds of risk.

The framework for managing landslide risk provides information to support FLNR land manager and staff to evaluate the results of risk analysis and assessment, make decisions to control risk if necessary (refer to section 4.1.5), and monitor activities where appropriate (refer to section 4.1.6).

There may be situations where addressing a landslide hazard is the responsibility or partial responsibility of another provincial agency or local government. For instance, for a landslide hazard on Crown land that poses a risk to a highway or to highway users, Ministry of Transportation and Infrastructure would be responsible for managing the risks to the highway. If dwellings and other buildings are also at risk, local government may also be involved. Local government requirements are typically focussed on protection of

existing improvements and future developments through development permitting, zoning and bylaws.

Managing landslide risks may require a collaborative effort by all levels of government, especially where more than one agency has jurisdiction or interest over an element or set of elements at risk. The level of responsibility of affected agencies will depend on specific circumstances and should be confirmed amongst agencies early in the process. It may be prudent for affected agencies to form a panel and appoint a lead agency. The cooperation of stakeholders can be a significant factor when attempting to reach a satisfactory solution for each circumstance.

Establishing Priorities

For any event or hazard identified that poses a high risk to people and/or high value public infrastructure Emergency Management BC (EMBC) must be notified immediately (refer to section 6 for information on EMBC responsibilities). For other situations the actions to be taken by the Ministry or under the direction of the Ministry will depend on the resources available. It is recognized that not all identified hazards, risks or landslide events will be actioned, especially not beyond initial steps. It is important to stress that while FLNR may have the legal authority to take action, the practical ability to act will always be affected by the need to prioritize in light of limited resources while balancing other key responsibilities.

It is common practice to focus on matters having potential to cause immediate harm to people and property when investigating matters related to hazard. However, determining which specific situations warrant action is best accomplished by following the procedure below.

4.1 Landslide Risk Management Steps

The six key steps in the decision making process for “Landslide Risk Management” are described below (i.e. based on the Ministry of Forests and Range Land Management Handbook 56 - *Landslide Risk Case Studies in Forest Development Planning and Operations*, 2004). A flowchart which summarizes these steps is provided in Appendix 1.

The descriptions provide a general summary of the tasks that are involved, as well as show how they relate to the roles and responsibilities of FLNR staff. A number of the steps listed below must be carried out by qualified terrain stability professionals. It is recognized that the actual detailed processes that the qualified terrain stability professional uses when carrying out landslide management projects will be based on professional standards and requirements. The Association of Professional Engineers for BC (APEGBC) provides guidelines that, while not strictly applying in all situations covered in this procedure, do provide a good source of information for registered professional engineers and geoscientists.

4.1.1 Initiation of a landslide risk management project – Step 1

Initiation of a landslide risk management project follows the recognition of some level of landslide hazard or risk that may need to be managed, along with the identification of the elements that may be at risk (e.g. adjacent or downslope elements / values).

Information on potential hazards may come from a variety of sources, including existing inventories (e.g. forestry terrain stability maps), and formal or informal reports of

unstable slopes and landslide occurrences. Information may also be provided through agency referral responses or from formal terrain stability assessments which may be carried out as part of a land application, or other authorization process (refer to section 5.1 -Tenure Applications and Tenure Administration).

A land manager usually initiates the project in consultation with a FLNR qualified terrain stability professional to determine how best to proceed. If the FLNR qualified terrain stability professional is unavailable to carry out the project, and a pre-existing eligibility list is available, they can provide the names of appropriate non-government qualified terrain stability professionals (i.e. consultants) that could carry out the work.

At this stage, the purpose and scope of managing the landslide risk should be established. There should also be consideration given to assigning responsibility for the different aspects of the project (e.g., analysis, evaluation, control, action, and monitoring).

Any situations that could be considered urgent warrant contacting the FLNR qualified terrain stability professional as soon as possible, particularly if the hazards or anticipated risks are significantly different from those previously analyzed or known or if there is a risk to human health and safety or high-value elements (e.g. permanent industrial, commercial or residential improvements, transportation infrastructure, utilities). If an urgent situation is reported to the ministry, EMBC must be informed. Communication with the general public will rest primarily with the local authority (e.g. regional district or municipality), with support from government agencies.

An initial list of stakeholders will need to be developed, which can be refined as the project unfolds. It is important to initiate communication with stakeholders in this step of the risk management process. It is the land manager's responsibility to ensure that continued communication with stakeholders is built into each step in the process. The effort to communicate should be commensurate with the level of risk involved. There is also a legal requirement in some cases to inform stakeholders, i.e. where there is a high risk of significant harm to people or property. Refer to section 4.2 – Communication, for further information.

4.1.2 Preliminary analysis – Step 2

Preliminary analysis involves confirming whether a landslide risk exists that warrants further analysis, determining some initial landslide characteristics and possible trigger mechanisms, and identifying the study area for the analysis, as well as the elements that may be potentially at risk.

Typically, most of this work is carried out by a qualified terrain stability professional (i.e. a consultant or a FLNR terrain specialist) often using available information such as air-photos, maps, resource inventory information, overview terrain stability mapping, LiDAR, preliminary development plans / designs, historic reports, and previous local experience.

It is important to determine the type, scope, and scale of landslide hazard or risk analysis required. For example, during the initial stages of development planning, reconnaissance-level hazard analysis (such as terrain stability mapping) may be sufficient to qualitatively determine areas of likely landslide occurrence, with little consideration of elements potentially at risk. More detailed risk analyses may be needed

as development proceeds, to estimate the probability of occurrence of landslides and the consequence at specific sites where development is planned, or when a landslide event has occurred.

The method of analysis will depend upon the elements potentially at risk, e.g. where there is potential damage to fish habitat it may be different from the risk analysis to determine the expected costs to repair a secondary highway affected by a landslide. Analyses may also differ depending on the spatial extent of the assessment area, the hazard or risk acceptability criteria used, the options available for risk control and the amount of funding available to undertake work. Decisions regarding these factors are typically made by the land manager assisted by a qualified terrain stability professional and various resource specialists (e.g. fisheries biologist, professional forester, etc).

If the preliminary analysis shows that the hazard or risk is low, the decision could be to simply document the overview assessment and not do a more detailed investigation.

4.1.3 Risk estimation – Step 3

Estimation of landslide risk is the second stage in risk analysis. Usually, a qualified terrain stability professional carries out risk estimation, which involves visiting the site to estimate:

- potential landslide trigger mechanisms;
- type, size, and characteristics of the potential landslide(s); and
- probability (likelihood) of landslide occurrence and travel path, based on terrain conditions, evidence of previous instability, and proposed development activities.

When consequence is estimated, resource specialists (e.g. professional biologists, foresters and engineers) are often involved in identifying elements potentially at risk and estimating their vulnerability. Methods for risk estimation are typically selected based on the type of landslide risk analysis necessary and the applicable thresholds for acceptable or tolerable risk. Methods can also vary, depending on the amount and reliability of the site data and the accuracy required for the analysis. Risk estimation may be carried out using quantitative or qualitative analysis methods, depending on the type and scope of the analysis.

Risk estimates should be communicated in clear and direct terms to the land manager and other stakeholders. It is important to present the results in a manner that allows for simple comparison with established thresholds of acceptable or tolerable risk, if present. Qualified terrain stability professionals and resource specialists involved in estimating risk should clearly document their assumptions, methodologies, and rationales. While specific aspects of the risk estimation may be highly technical in nature, professionals and specialists with similar expertise should be able to understand the conclusions and recommendations based on the information in the report. Senior management (or external) review is desirable, and where high-value elements or human health and safety are at risk, or potentially at risk, specifically warranted.

4.1.4 Risk evaluation – Step 4

The risk evaluation step is the last stage of risk assessment. In this step, the results of the risk analysis (preliminary analysis and risk estimation) are compared with thresholds of acceptable or tolerable risk. Thresholds of acceptable or tolerable risk may be

established by legislation or regional policies, implied through generally accepted guidelines (e.g. those used in other jurisdictions), or previous acceptable practices and standard operating procedures, or by societal norms. Based upon the risk evaluation, one of five outcomes is possible:

1. the landslide risk is acceptable or tolerable;
2. the landslide risk is not acceptable or tolerable, but can be managed by reducing the probability (likelihood) of landslide occurrence (e.g. altering proposed development), thereby reducing the estimated landslide risk;
3. the landslide risk is not acceptable or tolerable, but can be managed by reducing the consequence to the elements (i.e. by risk control methods as per 4.1.5 below) and thereby reduce the estimated landslide risk;
4. the landslide risk does not meet the thresholds of acceptable or tolerable risk and cannot be managed by risk control methods (note that this is part of an iterative process with bullet 2 above); or
5. additional risk analysis is needed to better estimate the existing risk or the residual risk.

The land manager typically carries out risk evaluation, which may rely heavily on the recommendations of the qualified terrain stability professional. Risk reduction methods generally require specialist services. Advice should be sought from government agency representatives, resource specialists, and/or other stakeholders to determine if the risk is acceptable or tolerable in situations where the thresholds are implied, or close to known thresholds. For such cases it is important to state the assumed acceptable or tolerable risk thresholds as part of the risk assessment.

4.1.5 Risk control – Step 5

Risk control should be considered where the estimated risk is evaluated as not acceptable or not tolerable. This step involves developing options to reduce the landslide risk through mitigation. Risk control can be based on:

- avoiding unstable or landslide-prone terrain;
- preventing landslides by designing measures or operating procedures to reduce the probability of landslide occurrence; or
- protecting elements at risk by implementing measures to reduce the consequence of the potential landslide.

The land manager and the terrain stability professional typically work together, along with stakeholders, to develop options for landslide risk control. As appropriate for each alternative option, the level of hazard and risk reduction, the residual hazard and risk, and the associated cost and operational constraints of each alternative should be considered.

There are numerous methods to control or mitigate landslide risk. For example, for a road development, road design and construction mitigation measures could include, full bench with end-haul, engineered fills, erosion-resistant structures, or increased inspections. In other cases, it may be more cost-effective to protect the elements at risk using structures to stop, deflect, or contain potential landslide events. When analyzing measures to control or mitigate landslide risk, it is important to consider other potential

issues that may be associated with such measures, e.g. costs to government or stakeholders, ongoing maintenance requirements (such as sediment removal, etc). Determining who will be responsible for, and pay the costs of, risk control must also be determined. This will vary depending on the specific circumstances and parties / stakeholders involved. Where it is not clear who has responsibility, legal services should be contacted for advice.

If the estimated residual risk with proposed control is acceptable or tolerable, and the land use proposal proceeds, the risk control may need to be incorporated into the development plan or management plan associated with the land tenure. In some cases the preferred control option may be to avoid an area and not allow any proposed development, which could lead to disallowance of a tenure application or cancellation of an existing tenure (refer to section 5.1 'Tenure applications and tenure management' for more information).

Where debris flow control structures are proposed to mitigate hazards affecting private properties a Dike Maintenance Act (DMA) authorization may be required. One of the primary requirements of a DMA authorization is that the local government must agree to be the Diking Authority. The Diking Authority is responsible for ensuring that construction is done to Ministry of Environment standards, inspections are undertaken, maintenance work (for which the Diking Authority is responsible) is done, and reports are submitted to government.

4.1.6 Action and monitoring – Step 6

Monitoring is an important part of the landslide risk management process.. Effective risk management incorporates additional monitoring as needed to validate analyses and, when appropriate, to implement additional risk control.

The land manager will need to determine who is responsible for monitoring. In some circumstances it may be necessary to include monitoring as a Crown land tenure holders obligations (refer to section 5.1 for more information).

4.1.7 Timing

Where a preliminary analysis recommends further assessment, risk analysis should be completed as soon as possible. This is required to facilitate timely communication and implementation of any risk mitigation treatments that may be necessary. The timeliness of risk analyses may be compromised by weather, access constraints, availability of qualified terrain stability professionals, or other reasons. However, every effort should be made to expedite completion of risk analyses for high risk situations.

Where there is an high risk of a landslide, it may be appropriate to carry out risk control planning at the same time as the risk analysis and mitigation options reporting; this will also help ensure enough time is available for treatments to be considered, funded and implemented under favourable weather conditions. The timely production of the risk analysis report can be critical under these and other circumstances.

4.2 Communication

4.2.1 Communication of Risk Analysis Results

Where the initial risk screening, field work, or the results of a risk analysis indicate that there is a significant threat to public safety, buildings or infrastructure, the land manager shall immediately notify EMBC, FLNR executive and any other agency or group they feel should be made aware of the situation (e.g. Ministry of Environment, Ministry of Transportation and Infrastructure, Department of Fisheries and Oceans, local government, and First Nations). The results of a risk analysis should be reviewed and evaluated by all agencies involved. Additional more detailed risk analyses may often be warranted in these cases. The results of any risk analyses including maps, air photos or satellite images should be made available to FLNR staff, and others for planning activities on the land.

4.2.2 Communication with tenure holders, residents and private property owners

For situations where FLNRO has become aware of hazards that pose a risk of significant harm to the public, residents, property owners or Crown land tenure holders, there is a legal requirement for the agency to disclose information on the risks without delay (as per s. 25 of the FOI Act).

Even in situations where the FOI Act does not apply, if hazards have changed and there is a subsequent increase in risk, consideration should still be given to warning potentially affected stakeholders and the public.

When there is high risk, timely communication and the methods of communication may be critical to prevent harm to people. Multiple communication methods and efforts may be appropriate (e.g. posting notices on residents' doors or roadways, public service messages on the radio, telephone calls, etc).

5. CROWN LAND ADMINISTRATIVE TOOLS

5.1 Tenure applications and tenure management

If a land tenure decision maker determines that there may be potential hazards on an application area (e.g. the site is on the coast and located on or immediately downhill of a 60% or greater slope, or reconnaissance terrain stability mapping produced for forestry purposes identifies potentially high hazards), they can request that the applicant have a terrain stability assessment carried out by a qualified terrain stability professional at the applicant's expense. This information will be considered in the application adjudication process. In cases where applicants conduct terrain stability mapping or assessments voluntarily as part of their own due diligence (i.e. to ensure that their proposals can be designed and constructed as proposed), the land tenure decision maker may also request that the information be submitted for consideration.

If a hazard has been identified, and an application proceeds to tenure issuance, or an existing tenure is being replaced, the Crown land tenure decision maker may impose conditions in the tenure document and / or requirements in the management plan for the tenure holder to mitigate risks. This may include the requirement of providing periodic monitoring reports prepared by a qualified terrain stability professional. These reports may be required at set periods or triggered by adverse weather events or other events, such as forest fires, that have the potential for affecting slope stability. It may be

necessary to seek advice on the nature and timing of the monitoring from a qualified terrain stability professional. In addition, if any special improvements or mitigative works are necessary they will need to be identified in the management plan, along with a maintenance schedule for mitigative works. A separate tenure may be necessary if the works are to be the responsibility of the proponent and are to be placed on Crown land outside of the existing or proposed tenure area.

Apart from issuing warnings and / or requiring mitigation works, consideration should also be given to adding special provisions, such as waivers or indemnities, into new or replacement tenure documents. These may be used where clients are well aware of risks and willing to accept liability (i.e. rather than letting the Province carry the liability). Legal services should be contacted for further advice on the appropriateness of such tools for a particular situation.

If risks are determined to be too high and mitigation measures not practical, options may include disallowing an application, seeking to amend an existing tenure or terminating an existing tenure prior to the end of the term. For these latter two situations, legal services advice should be sought in order to avoid any unintended consequences (i.e. this could vary depending on the type of tenure, and terms and conditions in place).

5.2 Restricting dispositions and uses on high risk terrain

The Crown land decision maker may decide that an area of high or very high risks, including active landslide areas, are not suitable for future development and should not be available for tenuring. In such cases, it may be appropriate to proceed with establishing a reserve (s. 15, s. 16), withdrawal (s. 17) or a prohibition (s. 66), as provided for under the *Land Act*. Depending on which instrument is used, future land tenures and activities may either be prohibited or limited to certain purposes (i.e. low impact activities). A notation of interest may be used as a map designation to “flag” that information on high hazards or risks exist for the area.

With the exception of section 66 prohibitions, the *Land Act* instruments noted only affect issuance of other *Land Act* dispositions, they do not have a legal standing on activities that are authorized under other sector legislation (e.g. forestry, mining). However, such reserves or designations, and the reason for their establishment, should be considered by other authorization decision makers.

6. EMERGENCY MANAGEMENT BC - ROLES AND RESPONSIBILITIES

EMBC is the coordinating agency for the provincial government’s emergency management activities, and supports response activities by local authorities as per the Emergency Program Act. The Emergency Program Management Regulation and All Hazards Plan identify the Ministry of Justice - EMBC as the provincial government coordinating agency for landslides other than those affecting highways. EMBC response actions include activation and operation of the Provincial Emergency Coordination Centre (PECC) and activation of regional Provincial Regional Emergency Operations Centres (PREOCs). EMBC will coordinate integrated provincial emergency management through the PREOCs and PECC. A coordinated provincial response may include:

- advice from qualified terrain stability professionals (and other subject matter experts);
- access to geographical information systems and mapping;
- aviation resources for reconnaissance, surveying and planning; and,

- provincial trained staff for deployment to assist local authorities.

For further details about EMBC's response role, refer to the All Hazard Plan:

<http://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/provincial-emergency-planning/embc-all-hazard-plan.pdf>

During a recovery phase, EMBC administers the Disaster Financial Assistance (DFA) Program which provides financial support to help local government bodies and the private sector recover from disasters. The DFA program operates under the Emergency Program Act and the ensuing Compensation and Disaster Financial Assistance Regulation (the "Regulation"). The DFA program is obliged to provide compensation in compliance with this legislation. The Regulation can be found at:

http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/124_95

When the province's costs to deal with a natural disaster place a significant burden on its economy and exceed what it might reasonably be expected to fully bear on its own, the federal government may help through the Disaster Financial Assistance Arrangements (DFAA). If DFAA is approved, the Province can recover a portion of its disaster response and recovery costs including costs incurred by other ministries.

APPENDIX A - FURTHER READING

Association of Professional Engineers and Geoscientists of British Columbia. 2010. Guidelines for Legislated Landslide Assessments for Proposed Residential Development in British Columbia.

<http://www.apeg.bc.ca/ppractice/documents/ppguidelines/guidelineslegislatedlandslide1.pdf>

Association of Professional Engineers and Geoscientists of British Columbia and the Association of British Columbia Forest Professionals. 2010. Guidelines for Professional Services in the Forest Sector – Terrain Stability Assessments.

http://www.apeg.bc.ca/ppractice/documents/ppguidelines/TSA_Guidelines.pdf

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 edition. BC Ministry of Forests, Land Management Handbook 18.

Cruden, D.M. and Varnes, D.J. 1996. Landslide types and processes. In: Landslides, investigation and mitigation. A.K. Turner and Schuster, R.L. (editors). National Research Council, Transportation Research Board, Washington, D.C., Special Report No. 247, pp. 36–75.

Geertsema, M., Schwab, J.W., Jordan, P., Millard, T.H. and Rollerson, T.P. 2010. Hillslope Processes. Chapter 8 in: Pike, R.G., Redding, T.E., Moore, R.D., Winker R.D. and Bladon, K.D. (editors). Compendium of Forest Hydrology and Geomorphology in British Columbia. B.C. Ministry of Forests and Range, Victoria, B.C. and FORREX Forum for Research and Extension in Natural Resources, Kamloops, B.C., Land Management Handbook 66.

Porter, M. & Morgenstern, N. 2013. Landslide Risk Evaluation – Chapter K of the Canadian Technical Guidelines and Best Practices Related to Landslides: A National Initiative for Loss Reduction. Geological Survey of Canada, Open File 7312.

VanDine, D.F., 2012. Risk Management – Chapter G of the Canadian Technical Guidelines and Best Practices Related to Landslides: A National Initiative for Loss Reduction. Geological Survey of Canada, Open File 6996.

Wang, B., Ruel, M., Couture, R., Bobrowsky, P.T. & Blais-Stevens, A. 2012. Review of Existing Landslide Guidelines – Chapter E of the Canadian Technical Guidelines and Best Practices Related to Landslides: A National Initiative for Loss Reduction. Geological Survey of Canada, Open File 7058.

Wise, M.P., Moore, G.D., and VanDine, D.F. (eds.) 2004. Landslide Risk Case Studies in Forest Development Planning and Operations. BC Ministry of Forests, Land Management Handbook 56.

The following flood hazard references provide information and guidance related to debris flows, a common landslide occurrence:

Association of Professional Engineers and Geoscientists of BC; Professional Practice Guidelines for Legislated Flood Assessments in a Changing Climate in BC.

Flood Hazard Mapping Program, 2004 MFLNR0

http://www.env.gov.bc.ca/wsd/public_safety/flood/fhm-2012/landuse_documents.html

Flood Hazard Area Land Use Management Guidelines

http://www.env.gov.bc.ca/wsd/public_safety/flood/pdfs_word/guidelines-2011.pdf

APPENDIX 1.

Six Steps in the Decision-Making Framework for Risk Management

(Source: Wise et al. 2004, after Canadian Standards Association (CSA) 1991. Risk management: guideline for decision-makers. Etobicoke, Ont. CAN/CSA-Q850-97)

