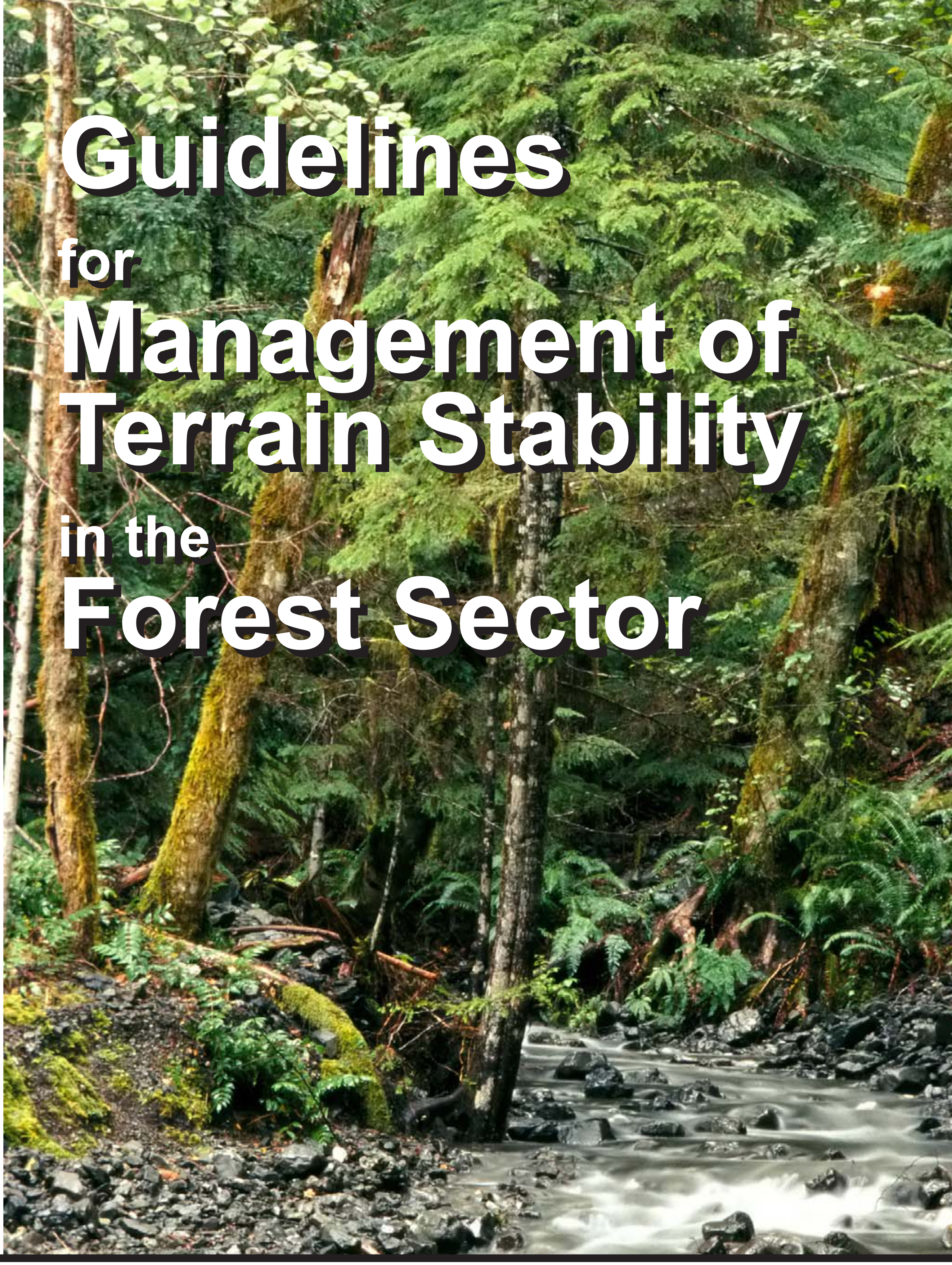
Guidelines for Management of Terrain Stability in the Forest Sector



Professional Engineers and Geoscientists of BC

ASSOCIATION OF BC FOREST PROFESSIONALS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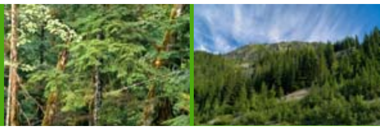


1. INTRODUCTION

Forest Development[1] (*Planning and Operations*) has the potential to cause, or be affected by, landslides. *Members* of the Association of British Columbia Forest Professionals *(ABCFP)* and the Association of Professional Engineers and Geoscientists of British Columbia *(APEGBC)* have professional obligations to protect the interests of the public, worker safety and the environment.

The *APEGBC Guidelines for Terrain Stability Assessments in the Forest Sector* (October, 2003) provides the current standard of professional practice for *Professional Engineers* and *Professional Geoscientists* conducting a *Terrain Stability Assessment (TSA*). Those guidelines, however, focus on the standard of practice for carrying out a *TSA*. They do not address when and where a *TSA* should be carried out, or how to manage terrain stability issues where no *TSA* has been carried out.

1.1 Purpose and Scope of the Guidelines

These guidelines are intended to assist in the management of terrain stability by providing guidance for establishing, implementing and updating a *Terrain Stability Management Model* (or simply *Model*). A *Model* should provide guidance:

- as to when and where a *TSA* should be carried out;
- for managing terrain stability, whether or not a *TSA* has been carried out;
- for establishing risk criteria for specified values (elements at risk);
- for selecting *Forest Development* strategies that are consistent with the risks; and
- for establishing a consistent and logical decision-making process to analyze and document decisions concerning the management of terrain stability.

A *Model* is intended to help optimize the use of *TSAs* by focusing such assessments on areas where *Forest Development* may pose an unacceptable risk to the interests of the public, worker safety and the environment.

These guidelines set out general standards of professional practice related to establishing, implementing and updating a *Model* for the forest sector. They should not be considered as a guideline for professional practice for other, non-forest related development.

Failure to meet the intent of these guidelines could be evidence of unprofessional conduct and may give rise to disciplinary proceedings by *ABCFP* or *APEGBC*. These guidelines may be used to assist in establishing the scope of work and terms of a *Member's* service contracts with his/her clients or employer. Refer to Section 1.3 regarding application of these guidelines.

1.2 Basic Concepts

These guidelines are based on the following concepts:

- adherence to the *Engineers and Geoscientists Act*, R.S.B.C. 1996 c. 116 as amended;
- adherence to the *Foresters Act*, R.S.B.C. 2003 c. 19;

1 *Terms in italics are defined in Section 2.*

- fulfilling the professional obligations to protect the interests of the public, worker safety and the environment;
- relying on the training, experience and professionalism of *Members*; and
- recognizing and building upon the team concept.

Delivery of professional services relating to the management of terrain stability in the forest sector involves professional forestry, professional engineering and professional geoscience.

The Foresters Act includes, within the definition of the practice of professional forestry, "…assessing the impact of professional forestry activities to advise or direct corrective action as required to conserve, protect, manage, rehabilitate or enhance the forests, forest lands, forest resources or forest ecosystems"; and "planning, locating and approving forest transportation systems including forest roads".

The *Engineers and Geoscientists Act* includes, within the definition of the practice of professional engineering "…reporting on, designing, or directing the construction of any works that require for their design, or the supervision of their construction, or the supervision of their maintenance, such experience and technical knowledge as are required by or under this *Act*…".

The *Engineers and Geoscientists Act* includes, within the definition of the practice of professional geoscience "… reporting, advising, acquiring, processing, evaluating, interpreting, surveying, sampling or examining related to any activity that is directed towards the investigation of surface or sub-surface geological conditions, and requires the professional application of the principles of geology, geophysics or geochemistry".

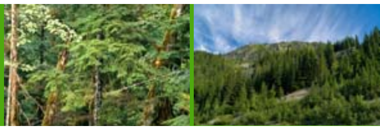
Government has granted *ABCFP* and *APEGBC* legislative authority to regulate *Members* working in the forest sector. This authority includes determining which professional activities *Members* of the respective association can carry out. These guidelines have been prepared by the Joint Practice Board comprising *Members* of *ABCFP* and *APEGBC*. The Joint Practice Board was specifically mandated by the Councils of *ABCFP* and *APEGBC,* in a Memorandum of Understanding originally signed in 1994 and updated in 2006, to make recommendations to their respective Councils on matters related to the practice overlap among the professions.

Government regulates forest management in B.C. on crown and private land separately. The *Foresters Act* does not distinguish the practice of forestry by land ownership. A *t Model* must be consistent with all applicable legislation governing the practice of forestry and forest management on the area to which the *Model* applies.

In the event of any inconsistencies or contradictions between these guidelines and legislation, the latter shall prevail.

1.3 Professional Conduct

Members must exercise professional judgment when providing professional services, and as such, the



application of these guidelines can vary depending on the circumstances. Notwithstanding the purpose and scope of these guidelines, the decision of *Members* not to follow one or more aspects of these guidelines does not necessarily mean that they have failed to meet the appropriate standard of practice in the performance of professional services. Such judgments and decisions depend upon an evaluation of all facts and circumstances in a particular project.

ABCFP and *APEGBC* support the principle that *Members* should receive fair compensation for professional services; adequate to ensure that the professional services can be carried out appropriately. Inadequate compensation is not a justification for services that do not meet the standards set out in these guidelines. *Members* may wish to discuss these Guidelines with their clients or employer when receiving instructions for an assignment and reaching agreements regarding compensation.

When *Professional Engineers* or *Professional Geoscientists* are involved in a project involving the management of terrain stability, they must provide the following notification in accordance with the *Engineers and Geoscientist Act* and Bylaw 17(a) related to liability insurance:

> *"Before entering into an agreement to provide professional engineering or professional geoscience services to the public, a member, licensee or certificate holder must notify the client, in writing, whether or not professional liability insurance is held and whether that insurance is applicable to the services in questions. The note shall include a provision for an acknowledgement of the advice to be signed by the client."*

Members must only practice in areas where they are appropriately trained and experienced. *Professional Engineers* and *Professional Geoscientists* "shall undertake and accept responsibility for professional assignments only when qualified by training or experience"[2]. *Forest Professionals* have a responsibility "to practice only in those fields where training and ability make the member professionally competent."[3]

2 *APEGBC Bylaw 14(a)(2)*
3 *ABCFP Bylaw 11.3.7*

2. DEFINITIONS

The definitions in this section are specific to these guidelines.

ABCFP
Association of British Columbia Forest Professionals.

APEGBC
Association of Professional Engineers and Geoscientists of British Columbia.

Forest Development
Forestry management, existing and proposed, related to *Planning* and *Operations*.

Forest Professional
Member of *ABCFP.*

Government
The regulatory authority governing all aspects of *Forest Development* on Provincial Crown land. Also, regulatory authority having jurisdiction over aspects of *Forest Development* on private land. Such authorities include federal, provincial and municipal governments and regional districts.

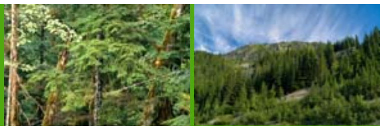
Harvesting and Road Personnel
Personnel who supervise or carry out the operational aspects of *Forest Development*. These individuals typically include harvest and road supervisors, machine operators and on-site workers.

Licensee
An individual, company, or Provincial Crown agency possessing the legal right to harvest timber. For the purpose of these Guidelines, *Licensee* also refers to land owners in the case of *Forest Development* on private property. The *Licensee* generally engages in, or contracts out, *Forest Development*.

Managing Professional
An individual, typically a *Member* of *ABCFP*, but can be a *Member* of *APEGBC*, responsible for establishing and implementing a *Model*, that addresses management of terrain stability and its relationship with *Forest Development*.

Member
A *Registered Professional Forester*, *Registered Forest Technologist*, Special Permit Holder registered and in good standing with *ABCFP*; or a *Professional Engineer*, *Professional Geoscientist*, or Limited Licence holder registered and in good standing with *APEGBC*.

Operations
Aspects of *Forest Development* related to the construction, maintenance, deactivation or rehabilitation of forest roads or trails; timber harvesting and silviculture activities.



Planning
Aspects of *Forest Development* related to the *Planning* of forest roads and trails, and timber harvesting activities.

Professional Engineer
Member of *APEGBC.*

Professional Geoscientist
Member of *APEGBC.*

Specialist
An individual that specializes in a particular occupation, practice or branch of learning. Such individuals that may be involved in the management of terrain stability include, but are not limited to, *Forest Professionals, Professional Engineers* and *Geoscientists* with specialized expertise; Professional Biologists, Professional Agrologists, Archeologists, Hydrologists or others specializing in the management or valuation of forest resources.

Terrain Stability Assessment (TSA)
An assessment that includes both: 1) an analysis of landslide hazards and risks as a result of *Operations* within, adjacent to and connected to a *Forest Development* area; and 2) recommendations or options to manage landslide hazards and risks, based on a comparison to known or implied levels of acceptable landslide hazard and/or risk as established by the *Government*, *Licensee* or other stakeholders. *TSAs* can include pre-field communications, data collection, field work and analyses, report preparation; and field reviews.

Terrain Stability Management Model (or simply Model)
A system, process or procedure for the management of terrain stability related to the *Forest Development*. A *Model* can consist of a document, a map, a chart or diagram; or some combination of these. A *Model* should provide guidance:

- as to when and where a *TSA* should be carried out;
- for managing terrain stability, whether or not a *TSA* has been carried out;
- for establishing risk criteria for specified values (elements at risk);
- for selecting *Forest Development* strategies that are consistent with the risks; and
- for establishing a consistent and logical decision-making process to analyze and document decisions concerning the management of terrain stability.


3. ROLES AND RESPONSIBILITIES

3.1 Team Approach

All stages of a *Model:* establishing, implementing, and updating are best achieved through a team approach. A team is typically led by a *Managing Professional*. Other team members can include: *Forest Professionals, Harvesting and Road Personnel,* and *Specialists*. From initial *Planning*, through to post-*Forest Development*, good communication among team members is essential for effectively managing terrain stability.

3.2 Managing Professional

The *Managing Professional* is responsible for:

- establishing and implementing the *Model;*
- updating the *Model* as new information is acquired or processes are modified*;* and
- communicating with team members, and ensuring communication among all team members, during all stages of managing terrain stability.

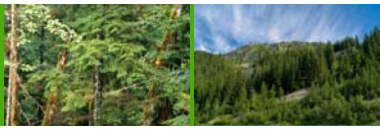
The role of *Managing Professional* can be assigned to different individuals at different phases. For example, depending on the *Licensee's* organizational structure, the *Managing Professional* that establishes the *Model* might be different from the individual that implements or updates the *Model.*

3.3 Forest Professionals

The involvement of *Forest Professionals* is essential in all phases of *a Model. Forest Professionals* have a lead role in most aspects of *Forest Development,* and are the key personnel that apply the *Model* during ongoing *Operations.* For example, during *Planning*, *Forest Professionals* often make valuable field observations of terrain conditions and site characteristics. These observations are important for *Forest Professionals* to decide if and when *Specialists* are required. *Forest Professionals* are responsible for choosing *Forest Development* strategies; and for evaluating the effectiveness of these strategies in achieving terrain management objectives. Their feedback to the *Managing Professional* is critical to ensure that the *Model* is updated and improved.

3.4 Harvesting and Road Personnel

Harvesting and Road Personnel typically have a wealth of experience in local terrain conditions and *Operations* and therefore can provide valuable input into establishing a *Model*. As implementers, *Harvesting and Road Personnel* need to fully understand the objectives and strategies for the management of terrain stability. They are typically the first to observe and encounter terrain conditions exposed during *Operations.* Accordingly, effective and timely communication to the *Forest Professionals* responsible for *Forest Development* is essential if terrain conditions are different or changed from those anticipated. In addition, *Harvesting and Road Personnel* often can provide valuable feedback as to the effectiveness of the *Model* and opportunities for its improvement and updating.



3.5 Specialists

In many cases *Specialists*, particularly terrain *Specialists* can provide important input into the development of a *Model*. Input from other *Specialists* can assist in identifying elements at risk from landslides, evaluating the potential vulnerability of such elements; and help assess other natural processes, such as snow avalanches and windthrow, that might affect terrain stability.

For example, during development of a *Model,* a terrain *Specialist* could provide guidance on regional landslide occurrence; identify key stability issues in the area to which the *Model* applies; and assist with definitions for stability hazard, geomorphic effects and risk. Windthrow *Specialists* could provide input on approaches to windthrow assessment and management where windthrow has the potential to affect terrain stability. Professional biologists could provide input on fisheries values and habitat sensitivity in order to define consequences in the *Model*.

These and other specialists may be called upon by *Forest Professionals* during implementation of the *Model* to assess hazards or consequences from *Forest Development*.

The input of these *Specialists* is also important for updating and improving the *Model*; for example, by updating information on terrain stability or windthrow behaviour in response to *Forest Development* strategies selected; by reporting on the consequences to resources such as fish following experience with the *Model*; and by providing input to the *Managing Professional* on advances in science in the *Specialists*' fields that are relevant to forest management.

4. ESTABLISHING A TERRAIN STABILITY MANAGEMENT MODEL

4.1 Scope of a Terrain Stability Management Model

A *Model* can consist of a document, a map, a chart or diagram; or some combination of these. The scope of a *Model* will primarily be a function of:

- the size of the operating area;
- the complexity of terrain conditions affecting stability; and
- the *Licensee's* management objectives.

The area to which a *Model* applies can vary depending on the particular circumstances of a *Licensee*. A *Model* can apply to a *Licensee's* holdings throughout the province, or to a specific region, watershed, woodlot or harvest area. If a single *Model* is to apply to a large area, it may need to accommodate a wide variety of terrain and terrain stability conditions, and management objectives.

For a small area, or where terrain conditions are reasonably homogeneous and consistent across the operating area, a *Model* can be quite simple. Where terrain conditions are complex and/or variable, a higher level of effort in the decision making process and in guiding *Forest Development* should be reflected in the *Model.*

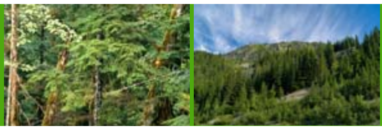
For example, a woodlot may have a specific area or single feature such as an escarpment that is of concern for terrain stability. In this instance, a *Model* may consist of a simple annotated map describing how the area or feature is to be treated for road construction or harvesting. Management objectives for terrain stability management might be to avoid impacts to a specific element at risk such as adjacent property or a single stream.

For a large operating area, a *Model* may need to describe a wide variety of terrain conditions. There may be many elements at risk to consider. Management objectives might set thresholds of acceptable risk or landslide occurrence for the different elements; and might for example, incorporate terrain stability management with other management strategies such as windthrow control. Management objectives on crown land may differ from those on private land with respect to elements at risk. For example, risk to biodiversity and habitat features may be managed differently on crown land than on private land.

4.2 Key Aspects of a Terrain Stability Management Model

A *Model* should provide guidance:

- as to when and where a *TSA* should be carried out;
- for managing terrain stability, whether or not a *TSA* has been carried out;
- for establishing risk criteria for specified values (elements at risk);
- for selecting *Forest Development* strategies that are consistent with the risks; and
- for establishing a consistent and logical decision-making process to analyze and document decisions concerning the management of terrain stability.



To determine when and where a *TSA* should be carried out, a *Model* would typically consider the following components:

- definitions of terms used to describe hazard, consequence and risk;
- characterization of terrain stability conditions;
- a discussion of how *Operations* affect, or are affected by terrain stability;
- triggers for when to conduct a *TSA*; and
- guidance for when and what type of *Specialists* are required.

As indicated in the previous examples, the level of effort in addressing these components should be appropriate to the size of the operating area, the complexity of terrain conditions; and the *Licensee's* management objectives.

For managing terrain stability where a *TSA* is done, the *Model* may require that a *TSA* address certain topics that are of specific concern in the operating area.

Where a *TSA* is not done, the *Model* should set out what measures are employed to manage terrain stability, such as standard operating procedures.

Where there are multiple elements at risk, a *Model* would typically characterize the elements and their potential vulnerability. Consideration of elements at risk may be part of the triggers for when a *TSA* is done; and would be part of selecting appropriate *Forest Development* strategies whether or not a *TSA* is done.

A key aspect of the *Model* is documentation. The rationale on which the *Model* is based must be documented. Most important, the *Model* should set out the documentation required for applying the *Model* and making decisions that are guided by it.

4.3 Steps for Establishing a Terrain Stability Management Model

Steps in establishing a *Model* would typically be to:

1. Select a team and define the responsibilities of each team member in creating the *Model*.
2. Define the scope of the *Model.*
3. Establish definitions for terms used to describe hazard, consequence and risk.
4. Characterize general terrain stability conditions in the operating area, describe in general how terrain stability is affected by *Forest Development*, and how *Operations* may be affected by terrain stability.
5. Create a decision process for triggering a *TSA.*
6. Develop guidance on the use of *Specialists*.
7. Set out requirements for specific content of *TSAs* that may be of special interest for the operating area.
8. Develop guidance on managing terrain stability when a *TSA* is not done.
9. Decide how consideration of elements at risk should be a component of the *Model.*
10. Characterize elements at risk and their vulnerability.
11. Establish guidance regarding acceptable risk.
12. Establish general guidance for appropriate *Forest Development* strategies.

13. Prepare plans for implementation and updating, including roles and responsibilities; and documentation requirements.
14. Document the basis for the *Model*.

All steps may not be relevant in all cases.

4.3.1 Descriptors for Hazard, Consequence and Risk

Subjective relative terms used to describe hazard and consequence such as “high”, “moderate”, or “low” should be defined, preferably using criteria that can be quantified or visually verified (for example, frequency, probability, physical size or extent). Definitions should reflect specific terrain issues in the operating area. An example is given in *Horel and Higman* (2006).

4.3.2 Characterizing Terrain Stability

Understanding general terrain stability of the operating area provides a basis for estimating the relative likelihood of landslides that might affect or be caused by *Forest Development*.

Terrain stability is typically governed by the following:

- slope gradient (natural or man-made);
- surface water, groundwater, rainfall and snowmelt;
- strength of materials (including surficial materials, bedrock and fill material); and

by changes to these factors over time due to natural geomorphic processes, *Forest Development* or other human activities.

Forest Development or other human activities can:

- change the slope of the ground surface (e.g., road cuts, road fills, quarries, spoil piles);
- change surface and groundwater flow regimes;
- create loose, low strength, fill material;
- surcharge slopes by the addition of fill or equipment;
- reduce strength in the rooting zone due to loss of root reinforcement.

These changes can increase the likelihood for instability. The effects on stability of non-forest developments such as mining, utilities, agriculture, etc. should also be considered if they could be relevant to *Forest Development* in the operating area.

Regional stability trends are often closely associated with climate, topography and regional geology. In characterizing terrain stability conditions in the operating area, a *Model* should take into consideration:

- variation of biogeoclimatic zones and geomorphology across the area;
- the known terrain stability history (both natural and development-related);
- the amount and reliability of information available; and
- the effectiveness of existing terrain stability management strategies.

The potential for terrain stability to change over time in response to historical or ongoing *Forest*

Development should be considered. In some regions, the effects of past and new *Forest Development*, such as changes to slope drainage, can have profound effects on terrain stability. A *Model* for a particular area should reflect the specific stability implications that *Forest Development* might have in that area; for example, existing road drainage networks, gentle-over-steep landforms, etc.

Sources of terrain information available to assist in the development of a *Model* for a specific region may include:

- topographic maps or slope mapping from digital elevation models
- bedrock or surficial geology maps
- terrain stability maps
- natural or development-related landslide hazard maps
- consequence or risk inventory maps
- watershed assessment reports
- landslide inventories
- published scientific literature
- existing terrain stability assessments
- landslide assessment reports
- local knowledge on the occurrence of landslides and the effects of development.

Not all of these sources are available in all areas, and other types of terrain information may be available in some areas.

Terrain stability mapping is a commonly used source of stability information for *Forest Development*. The Resource Inventory Standards Committee (RISC) 1996 provides a summary of several types of terrain stability maps.

The accuracy, reliability, applicability and limitations of terrain stability maps and other information sources must be considered in the way that the *Model* makes use of these sources.

4.3.3 Triggering a Terrain Stability Assessment (TSA)

A primary purpose of a *Model* is to provide guidance for requiring a *TSA*, and to provide guidance for using the results of a *TSA* for assessing and managing risk.

The particular guidance depends, to a large extent, on the type and reliability of terrain and terrain stability information available, and the size and complexity of the operation.

Possible approaches that a *Model* can take for determining the need for a *TSA* include:

1. A simple hazard-based approach whereby a *TSA* is triggered based on a certain level of hazard, regardless of consequences. For example, maps of the proposed *Forest Development* (cutblock or road locations) are overlain by terrain stability maps, and a *TSA* is triggered if the *Forest Development* falls within a mapped area indicated as having potentially unstable terrain as determined by criteria set out in the *Model*. This approach gives minimal consideration to downslope values for triggering a *TSA*.
2. A simple spatial relationship to elements at risk, whereby if the proposed *Forest Development* is located within, upslope, or upstream of a specified element at risk, a *TSA* is triggered regardless

of the terrain hazard potential.

Note that criteria based on topographic (slope) maps or terrain stability mapping alone may result in inappropriate consideration of the risk that the *Forest Development* may pose to workers, public safety, and environmental and socio-economic values.

3. A risk-based approach whereby the potential stability hazard is considered in conjunction with the potential for a landslide to impact an element at risk.

The basic components of a risk-based approach are as follows:

- defining the relative likelihood of landslides occurring;
- identifying the elements at risk; and
- estimating in general terms the likelihood of a landslide impacting an element at risk.

Defining the relative hazard of landslides occurring can be done by means of terrain stability or similar mapping; by landslide inventory data; by applying site-level criteria (such as indicators of instability); by a two-step procedure that uses both inventory-level information and site-level criteria; or by some other process that takes into account the factors described in Section 4.3.2.

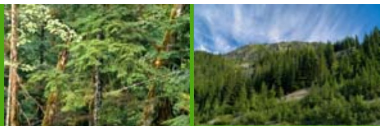
Estimating the likelihood of a landslide impacting an element at risk can make use of specialized map products (e.g., hazard and consequence maps, runout zone analysis maps, etc); or criteria based generally on the scientific literature; or locally based landslide runout studies; or by some other means that employs defensible criteria. Where consequences are high it is prudent to take a precautionary approach when making a preliminary estimate of possible impacts.

<u>Field confirmation</u>

Because of the limitations of terrain stability mapping and other planning-level information sources, a *Model* should incorporate field information as well as an office review in order to determine whether a *TSA* is required. Actual site conditions may suggest a higher degree of stability than predicted in the office phase, and thus negate the need for a *TSA*. Conversely, a *TSA* may be warranted where field indicators of instability are identified in areas not predicted by the office phase. The *Model* should provide guidance on the use of both office and field information to make a determination on the need for a *TSA*. The *Managing Professional* should seek advice from a *Specialist* with expertise in terrain stability to assist with this aspect of the *Model.*

Accurate field observations of terrain stability conditions require field personnel to have a level of knowledge, training and experience in terrain stability consistent with the type or complexity of terrain conditions present within a given region or local area. In making a decision on the requirement for a *TSA*, the level of reliance on field observations must be consistent with the knowledge and experience of the field personnel. The *Model* should include a process for confirming the knowledge and experience of field personnel and, where necessary, provide for appropriate training.

4.3.4 Use of Specialists



A *Model* should provide guidance on what sorts of situations *Specialist* expertise is advisable, and what types of *Specialists* are appropriate for those situations. *Specialists* commonly used to assist with terrain stability, risk management and *Development* strategies include terrain *Specialists*; snow avalanche *Specialists*; windthrow *Specialists*; engineering *Specialists*; and fisheries biologists. Examples of *Specialists* with specific expertise applicable to slope stability include rock slope engineers, geotechnical engineers or structural engineers for design of large retaining structures.

4.3.5 Terrain Stability Assessments

The *Model* may require that *TSAs* cover specific topics that are applicable to the operating area. For example, the primary terrain stability concern in a particular area might be the potential for debris flows in gullies; in another area it might be the influence of road drainage on slopes below roads. In an area susceptible to windthrow, a *Model* might require a *TSA* to address the potential implications on stability if windthrow were to occur.

4.3.6 Managing Terrain Stability When a TSA is Not Done

The *Model* should provide guidance for cases where a *TSA* is not done, with respect to documenting the rationale, method of estimating hazard and risk, addressing worker safety, and choosing *Forest Development* strategies.

A *Licensee's* standard procedures for harvesting, road construction, road maintenance and deactivation can have a significant effect on terrain stability. *TSAs* often make assumptions that certain construction or maintenance methods will be used. Where *TSAs* are not done, *Forest Professionals* often rely on specific operating procedures to achieve an expected standard of performance. It is the *Forest Professional'*s responsibility to ensure that plans are implemented and perform as intended.

Operating procedures need to be suitable for the particular terrain conditions in which they are used, to avoid increasing the potential for instability, and to address worker safety concerns related to terrain conditions. A common example is the need to manage road drainage effectively. In some areas, this is the most important aspect of terrain stability management. Typical examples of terrain conditions affecting worker safety would be upslope terrain hazards (rock falls, avalanches, debris torrents); cutslope instability; and ground conditions underneath equipment during road construction or deactivation.

A *Model* should provide guidance as to suitable operating procedures for the specific terrain stability conditions of the area, and what the critical concerns are. It should also provide for evaluation of standard procedures with respect to stability and worker safety implications; and for modification of the procedures as needed.

4.3.7 Elements at Risk

Elements at risk:

- may be part of the determination for when a *TSA* is done;
- are considered when applying the findings of a *TSA*; and
- are considered when choosing *Forest Development* strategies when a *TSA* is not done.

A *Model* must consider public safety, worker safety, public infrastructure, the property of others; and other values required to be considered by legislation.

For consideration of risk to other values, or elements, the *Model* either should identify the types of elements to be considered; or should describe a procedure by which these elements are identified. The *Model* can make use of mapped inventories of specific resources, or site-level criteria, or both. The *Model* should include guidance for evaluating the relative importance and vulnerability of elements at risk, and relative consequences that is consistent with accepted methods and good practice (ref. *Wise et al.* [ed.], 2004).

4.3.8 Acceptable Risk

A *Model* should provide guidance regarding levels of acceptable risk for the elements identified as described in Section 4.3.7.

A *TSA* typically estimates the hazard (probability or likelihood of a landslide occurring) and the geomorphic effect (probable landslide size and runout distance). *Forest Professionals* use this information to estimate the risk to specific elements.

Guidance for acceptable risk should take into consideration the relative severity of the consequences, the ability to influence the consequences with risk control measures; and the possibility and practicability of remediating consequences should they occur. A *Model* may set out categories of consequences and indicate acceptable risk levels for each category.

The levels of acceptable risk should be established to be consistent with any standards that may be set by government, including precedents set in case law. In establishing levels of acceptable risk, the accuracy and uncertainty of terrain stability hazard ratings and landslide runout estimates should be taken into consideration.

4.3.9 Choosing Appropriate Development Strategies

A *Model* should provide guidance for *Forest Development* strategies for different levels of acceptable risk.

For example, in an area that experiences post-harvesting open-slope landslides, if downslope consequences are high, guidance for harvest strategies in potentially unstable terrain might be to limit the influence of forest canopy change on slope stability, by restricting harvesting to some level of dispersed extraction.

In another case, if the element at risk is a forest plantation, some extent of clearcut harvesting might be acceptable in potentially unstable terrain if the expected size of landslide would not significantly affect long-term forest productivity.

Other examples can be found in *Horel and Higman* (2006).

4.3.10 Model Development Documentation

The Model should include documentation to describe the basis for various aspects of the *Model*. This might include:

- providing a list of information sources used to characterize terrain stability conditions and trigger *Terrain Stability Assessments*;
- describing the basis for values to be considered;
- providing background on how risk to these values is considered and managed.


5. IMPLEMENTING A TERRAIN STABILITY MANAGEMENT MODEL

Plans for the implementation phase should include:

- roles and responsibilities for applying the *Model;*
- training or communications in use of the *Model* by *Forest Professionals, Harvesting and Road Personnel*, and key *Specialists*;
- a peer review process consistent with good professional practice.

The *Model* should describe documentation required for professional due diligence by the *Forest Professional* working under the *Model.*

5.1 Professional Due Diligence

Professional due diligence refers to the standard of care required of a *Member* acting reasonably and prudently in any given situation. Professional due diligence can be described as exercising the care a reasonable professional under the same or similar circumstances would use. Professional due diligence includes taking all necessary steps to enable the professional to demonstrate to those who may question their work that appropriate consideration was given to all relevant factors. A crucial aspect of professional due diligence, therefore, includes keeping and maintaining appropriate documents, files and/or filing systems.

5.2 Documentation

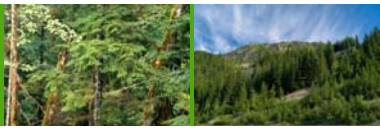
The *Model* must include a documentation process that:

- records the results of the process that determines whether or not a *TSA* will be undertaken;
- initiates an appropriate *Forest Development* strategy where it is decided that a *TSA* is not to be conducted.

A documentation process might include the use of checklists, reference to standard operating procedures or other mechanisms through which it can be demonstrated that all appropriate procedures were followed to ensure no relevant steps or considerations were omitted. It can also include the retention of background information and base data on which the professional relied to formulate the rationale for their decision.

The following list provides some general considerations when developing a professional due diligence documentation system:

- relevant legal requirements have been met;
- the *Forest Professional* has a clear understanding of management objectives and how they related to socio-economic and environmental values;
- the *Forest Professional* is familiar with the relevant characteristics of the area affected by the development;
- the appropriate background information has been gathered and incorporated:
- the *Forest Professional* has consulted the appropriate experts or *Specialists* for those areas for which the professional is not qualified to practice or express an opinion, or for which a second opinion would be prudent;



- when external advice is sought from a *Specialist*, that person is qualified and competent to give that advice and the advice given makes sense based on the *Forest Professional's* own personal knowledge;
- when data is collected by another person, that person is qualified and competent to collect that data and the data collected makes sense based on the *Forest Professional's* own personal knowledge;
- sufficient data were collected according to the required standards;
- the *Forest Professional* has evaluated the risks; and
- the *Forest Professional* has signed and sealed work for which he or she is responsible.


6. UPDATING A TERRAIN STABILITY MANAGMENT MODEL

Provision should be made to update the *Model* as new information becomes available. Possible components of a continual improvement approach could be:

- a planned time interval for periodic reviews of the *Model;*
- maintaining a landslide inventory, undertaking landslide investigations of post *Forest Development* events, and reviewing new research published in scientific literature;
- incorporating new information on values at risk;
- reviewing the guidance on risk tolerance set out in the *Model* in response to new requirements set by government or precedents set in case law;
- reviewing the success of *Forest Development* strategies and standard operating procedures in achieving the desired result with respect to terrain response;
- modifying the *Model* as needed.

Literature Cited

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- Horel, G. and S. Higman. 2006. Terrain Management Code of Practice. Streamline Watershed Management Bulletin 9(2):7-10.
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- Wise, M.P., G.D. Moore, and D.F. VanDine (editors). 2004. Landslide Risk Case Studies in Forest Development, Planning and Operation. BC Ministry of Forests, Research Branch, Victoria, BC. Land Management Handbook Number 56.

References

- The following guidebooks are useful references. In addition, there is extensive published literature on slope stability, terrain management and risk assessment.

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