

Guidelines

for
**Terrain
Stability
Assessments**
in the
Forest Sector



Association of Professional Engineers
and Geoscientists of British Columbia

October 2003

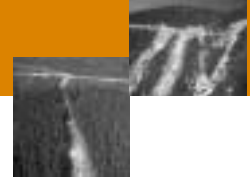
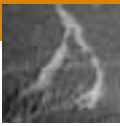


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Cover: 1995 slope failure in the Indian River watershed about 20 km southeast of Squamish, BC. Photo: Frank Baumann PEng.

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DEFINITIONS

The definitions in this section are specific to these Guidelines for Terrain Stability Assessments in the Forest Sector:

Agreement

The contract, whether formal (written) or informal (verbal or implied), between the *Client* and the *Member(s)*, or other legal entity, for conducting the *Terrain Stability Assessment*.

APEGBC

The Association of Professional Engineers and Geoscientists of British Columbia.

Assessment

See *Terrain Stability Assessment*.

Client

The party who engages the *Terrain Stability Professional* to conduct the *Terrain Stability Assessment*. This is typically the *Licensee* or the *Coordinating Registered Professional* but can be the *Earth Works Contractor*, the *Harvesting Contractor* or another interested party.

Coordinating Registered Professional

The individual, typically a member of the Association of British Columbia Professional Foresters (ABCPF) but can be a *Member of APEGBC*, who is responsible for coordinating all activities relating to the *Development*. The *Coordinating Registered Professional's* role includes: determining what studies are required for the *Development*; ensuring that the appropriate professionals with the necessary skill sets are retained to conduct the studies; and incorporating the results and recommendations from the studies in the overall *Development*.

Development

Aspects of forest management, existing and proposed, related to *Planning* and *Operations*.

Direct Supervision

Responsibility for the control and conduct of the engineering or geoscience work of a subordinate.

Earth Works Contractor and Harvesting Contractor

The individual, company or Provincial Crown agency that carries out the *Operations*. The *Earth Works Contractor* is typically responsible for road construc-



tion, maintenance and deactivation. The *Harvesting Contractor* is typically responsible for timber harvesting and trail construction. The two contractors can be one and the same.

Field Review

The observations and assessments carried out by, or under the *Direct Supervision* of, the *Terrain Stability Professional* during or following *Operations* in order to ascertain: 1) whether the terrain conditions are generally consistent with those considered in the *Terrain Stability Assessment*; and/or 2) whether the *Operations* are being carried out, or were carried out, in general conformance with the recommendations provided in the *Terrain Stability Assessment*.

Government

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

Licensee or Land Owner

The individual, company or Provincial Crown agency possessing the legal rights to harvest timber in a *Development*. For the purpose of this document, *Licensee* also refers to *Land Owner* in the case of forest *Development* on private property. The *Licensee* generally engages in, or contracts out, *Planning* and *Operations*.

Member

A Professional Engineer or Professional Geoscientist registered and in good standing with APEGBC.

Operations

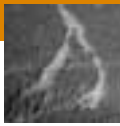
The aspects of forest *Development* relating to roads and trails, and timber harvesting. These typically include construction, maintenance, deactivation or rehabilitation of roads and trails; and cutting, processing and removal of timber.

Planning

The aspects of forest *Development* relating to the planning of roads and trails, and timber harvesting. These include locating proposed roads and trails; designing roads, bridges and other engineered structures associated with roads; designing cutblock boundaries and silvicultural systems; and selecting harvesting systems.

Terrain Stability Assessment (Assessment)

Includes both: 1) the analysis of landslide hazards and risks as a result of *Operations* on the terrain within, adjacent to and connected to the *Development* area; and 2) recommendations to manage landslide hazards and risks based on a comparison to



known or implied criteria for tolerable/acceptable landslide hazard and/or risk as established by the *Government, Licensee* or other stakeholder. *Assessments* include pre-field communications, data collection and analyses; fieldwork; data compilation, analyses and report preparation; and *Field Reviews* (where required).

Terrain Stability Professional

For the purpose of these Guidelines, a *Member* registered with APEGBC and with the appropriate level of education, training and experience to conduct *Terrain Stability Assessments* (see Section 6).



INTRODUCTION

Forest *Development* is often within, adjacent to or connected to areas that are, or can be, prone to landslides. Forest resource managers, therefore, rely on *Terrain Stability Professionals* to provide guidance on terrain stability issues relating to a *Development*. *Terrain Stability Assessments* are conducted by *Terrain Stability Professionals* to evaluate the landslide hazards and risks in an area, and the likely impact of a *Development* on these hazards and risks. Where appropriate, *Terrain Stability Assessment* reports should include recommendations for reducing the potential for *Development*-related landslide hazards and risks.

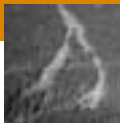
These Guidelines for Terrain Stability Assessments in the Forest Sector (Guidelines) have been prepared by a Task Force of the Division of Engineers and Geoscientists in the Forest Sector (DEGIFS), a Division of the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC), and were adopted by the Council of APEGBC. APEGBC is committed to maintaining the high quality of the services *Members* provide to their Clients and the public. *Members* are professionally accountable for their work under the Engineers and Geoscientists Act, which is enforced by APEGBC.

2.1 Purpose of Guidelines

These Guidelines set out the general standards of professional practice that *Members* should follow in providing professional engineering and geoscience services related to *Terrain Stability Assessments*.

Members must exercise professional judgment when providing professional services; as such, the application of these Guidelines can vary depending on the circumstances. These Guidelines may be used to assist in establishing the scope of work and terms of *Members'* service contracts with their *Clients*.

The Guidelines are intended to establish standards of practice that *Members* should follow to fulfill their professional obligations, especially in regard to their primary duties to protect the safety, health and welfare of the public; to protect the environment; and to promote health and safety within the workplace. Failure to meet the intent of these Guidelines could be evidence of unprofessional conduct and lead to disciplinary proceedings by APEGBC.



APEGBC supports the principle that *Members* should receive fair and adequate compensation for professional services, including the services provided to comply with these Guidelines. Low fees are 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* when receiving instructions for services and reaching agreements regarding compensation.

2.2 Scope of Guidelines

These Guidelines apply to *Terrain Stability Assessments* conducted within the forest sector in British Columbia. They outline the professional services that should generally be provided by *Terrain Stability Professionals* as part of *Terrain Stability Assessments*.

These Guidelines specify tasks that should generally be performed by *Terrain Stability Professionals* to meet a standard of care that is in the best interest of the public, the environment, worker safety and the *Development*, and to ensure that the tasks are properly coordinated with the work of other forest *Development* team members. These Guidelines should assist in maintaining the integrity of the *Terrain Stability Assessment* process. As *Terrain Stability Professionals* often work in conjunction with Registered Professional Foresters and other team members, these Guidelines should also assist in delineating the responsibilities of the various team members involved in forest *Development*.

2.3 Qualification

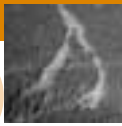
Notwithstanding the purpose and scope of these Guidelines, the decision of *Terrain Stability Professionals* not to follow one or more aspects of these Guidelines does not mean that they have failed to meet the standard of care in the performance of their professional services. Such judgments and decisions depend upon an evaluation of all facts and circumstances to determine if other reasonable and prudent *Terrain Stability Professionals*, in similar circumstances, would have conducted themselves similarly.



2.4 Acknowledgment

These Guidelines have been prepared by a Task Force of DEGIFS, a Division of *APEGBC*. The Guidelines were reviewed by several parties including the DEGIFS Executive, a DEGIFS Review Committee, the Ministry of Forests, the Association of British Columbia Professional Foresters (ABC PF) and the APEGBC/ABC PF Joint Practices Board. *APEG-BC* acknowledges the efforts of all Task Force members and reviewers in preparing this document.

3



PROJECT ORGANIZATION AND RESPONSIBILITIES

3.1 Common Forms of Project Organization

The organization of *Terrain Stability Assessments* varies according to the needs of the *Development* and the parties involved. The *Terrain Stability Professional* is typically engaged by the *Licensee* or the *Coordinating Registered Professional*, but can be engaged by the *Earth Works Contractor* or *Harvesting Contractor*, and sometimes by another interested party.

3.2 Responsibilities of Organization Participants

3.2.1 Licensee

The following responsibilities assume that the *Licensee* is directly or indirectly the *Client* for the *Assessment*.

3.2.1.1 In order for the *Terrain Stability Professional* to carry out an appropriate *Terrain Stability Assessment*, the *Licensee* should:

- a) have on staff, or retain, qualified professionals with responsibility for the *Development*, including a *Coordinating Registered Professional*;
- b) before commencing the *Assessment*, and in consultation with the *Terrain Stability Professional*, establish, or direct the *Coordinating Registered Professional* to establish, the scope of the *Assessment* including any specialty services required (see Section 4.11);
- c) before commencing the *Assessment*, complete an *Agreement* with the *Terrain Stability Professional* confirming the scope, compensation and schedule for the *Assessment*;
- d) establish terms for any additional services that may be required beyond the scope of the *Assessment*;
- e) ensure that all required approvals, licenses and permits from the appropriate *Government* agencies are obtained;
- f) recognize that the *Assessment* is based on the *Development* and that changes to the *Development* could invalidate the *Assessment*;
- g) disclose fully and promptly all information (written or otherwise) related to the *Assessment*. Background information is discussed in Section 4.3;
- h) review the hazard and/or risk analysis in the *Assessment* report and



determine if all appropriate adjacent elements at risk have been considered, and if the risks are tolerable/acceptable;

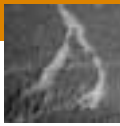
- i) where appropriate, communicate the hazard and/or risks described in the *Assessment* report to the appropriate *Government(s)* and owners of adjacent elements at risk who may be responsible for accepting the hazard and/or risks;
- j) retain the *Terrain Stability Professional* to conduct *Field Reviews* during *Operations* when recommended in the *Assessment* report;
- k) keep the *Terrain Stability Professional* informed, or have the *Coordinating Registered Professional* keep the *Terrain Stability Professional* informed, of the progress of the *Operations* when a *Field Review* is recommended in the *Assessment* report; and
- l) recognize the limitations of *Terrain Stability Assessments*, as described in Section 4.7, and promptly notify the *Terrain Stability Professional* if or when terrain conditions encountered during *Operations* differ from those described in the *Assessment* report.

3.2.1.2 Principle 8 of the Professional Engineers and Geoscientists Code of Ethics states that *Members* shall “present clearly to employers and clients the possible consequences if professional decisions or judgments are overruled or disregarded.” In order for the *Member* to fulfill this principle, the *Licensee* or *Coordinating Registered Professional* must notify the *Terrain Stability Professional* if the recommendations in the *Assessment* report are not followed during *Operations*. The *Licensee* or *Coordinating Registered Professional* should then retain the *Terrain Stability Professional* to review the potential implications of the *Operations* not following the recommendations in the *Assessment*.

3.2.2 Coordinating Registered Professional

3.2.2.1 In order for the *Terrain Stability Professional* to carry out an appropriate *Assessment*, the *Coordinating Registered Professional* should:

- a) interpret and define the needs of the *Licensee*;
- b) ensure that the *Licensee's* responsibilities, described in Sections 3.2.1.1 and 3.2.1.2, are met;
- c) coordinate and review all reports, maps and other documents produced by the various persons involved in *Planning*; and
- d) coordinate communication of information between the *Licensee*, the *Earth Works Contractor*, the *Harvesting Contractor* and the various persons involved in *Planning*, including the *Terrain Stability Professional*, so that the *Assessment* proceeds in a manner that com-



plies with applicable codes and regulations and meets the needs of the *Licensee*, the public and the environment.

3.2.2.2 The *Coordinating Registered Professional* is responsible for ensuring that all recommendations included in the *Terrain Stability Assessment* report are adequately addressed in the *Development*. The *Coordinating Registered Professional* should request that the *Terrain Stability Professional* clarify any questions or uncertainties with regard to the recommendations.

3.2.3 Terrain Stability Professional

3.2.3.1 The *Terrain Stability Professional* is responsible for identifying and analyzing the stability of the terrain along proposed or existing road alignments, within proposed or existing cutblocks, and in adjacent or connected areas that could be affected by the *Operations*. The *Terrain Stability Professional*, where required, is also responsible for recommending methods of mitigating landslide hazards and risks. If included in the *Agreement*, the *Assessment* can also include aspects of forest *Planning* and *Operations* beyond the standard *Terrain Stability Assessment*.

3.2.3.2 The *Terrain Stability Professional* should, in consultation with the *Licensee* and the *Coordinating Registered Professional*, establish the scope and limitations of the *Terrain Stability Assessment* (see Section 3.2.1.1 (b) above).

3.2.3.3 The *Terrain Stability Professional* should make reasonable attempts to obtain all information (written or otherwise) related to the *Assessment* from the *Licensee*, *Coordinating Registered Professional* and others. Possible relevant background information is summarized in Section 4.3.

3.2.3.4 In conducting the *Assessment*, the *Terrain Stability Professional* may rely on information provided by the *Licensee* or the *Coordinating Registered Professional* such as fish stream classifications, topographic information, geometric road designs, deflection lines and specific elements at risk.

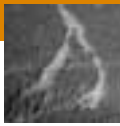
3.2.3.5 In conducting the *Assessment*, the *Terrain Stability Professional* may refer to pre-existing terrain and terrain stability maps, and specific terrain information provided by the *Licensee* or the *Coordinating Registered Professional*, but should consider their reliability.

3.2.3.6 When fieldwork is conducted as part of the *Assessment*, the *Terrain Stability Professional* should conduct sufficient fieldwork, within the limits of the *Development* area, to reasonably determine the terrain condi-



tions. Fieldwork can include areas outside of the *Development* area that can affect or be affected by the *Development* (see Section 4.4).

- 3.2.3.7** If the area of the *Assessment* is limited to a specific portion of the *Development* area, the *Terrain Stability Professional* should specifically state in the *Assessment* report which areas were assessed and why. If the *Terrain Stability Professional* believes that the limits of the *Assessment* are inappropriate, he/she should notify and discuss with the *Coordinating Registered Professional* the potential implications the limits may have on the study and the *Development*.
- 3.2.3.8** *Field Reviews* are required under APEGBC's Quality Management Bylaw 14(b)(4) (see Section 4.8). Therefore, a *Terrain Stability Professional's* responsibilities can include *Field Reviews* during *Operations* to confirm or further assess terrain conditions and to ascertain whether the *Operations* are being carried out or were carried out in general conformance with the recommendations provided in the *Assessment* report. The *Terrain Stability Professional* must notify the *Coordinating Registered Professional* where a *Field Review* is recommended, or under what conditions *Field Reviews* are recommended.
- 3.2.3.9** The *Terrain Stability Professional* should promptly notify the *Coordinating Registered Professional* in writing as to the results of the *Field Reviews*, including any changes to the original recommendations and any areas where the *Operations* do not generally conform to the recommendations in the *Assessment* report.
- 3.2.3.10** Field observations during the *Assessment* and during *Field Reviews* may be delegated to others but only under the *Direct Supervision* of a *Terrain Stability Professional*.
- 3.2.3.11** The *Terrain Stability Professional* should notify the *Coordinating Registered Professional* when specialty services are required (as described in Section 4.11) and whether another *Terrain Stability Professional* may need to be retained to carry out these specialized services.
- 3.2.3.12** To fulfill Principles 1 and 9 of the Code of Ethics, if the *Licensee* or *Coordinating Registered Professional* fail or refuse to carry out the obligations in Section 3.2.1 and 3.2.2, and this failure could compromise the *Terrain Stability Professional's* professional obligations, the *Terrain Stability Professional* should:
- a) advise the *Licensee* in writing of the potential consequences of its actions;



- b) consider whether the *Terrain Stability Professional* should continue with the *Assessment*; and
- c) consider whether the situation warrants notifying the appropriate *Government* authority, *APEGBC* or other relevant agencies or regulatory bodies.

3.2.4 Earth Works Contractor and Harvesting Contractor

The *Earth Works Contractor* and *Harvesting Contractor* generally have contracts with the *Licensee* and do not usually have a direct contractual relationship with the *Terrain Stability Professional*.

3.2.4.1 The *Earth Works Contractor* and *Harvesting Contractor* are responsible for:

- a) following all details of the proposed *Development* including road designs, construction techniques, deactivation plans and harvesting plans;
- b) ensuring all safety precautions are taken to protect workers, the public and the environment; and
- c) all temporary works not included in the proposed *Development* details.

3.2.4.2 The *Earth Works Contractor* should notify the *Licensee* or the *Coordinating Registered Professional* when terrain conditions encountered during *Operations* are significantly different than those described in the *Assessment* report, or when signs of potential or incipient slope instability are observed.

3.2.4.3 The *Harvesting Contractor* should notify the *Coordinating Registered Professional* or the *Licensee* when excess ground disturbance occurs during harvesting, or when signs of potential or incipient slope instability are observed.

GUIDELINES FOR PROFESSIONAL PRACTICE



The services that the *Terrain Stability Professional* should consider as part of appropriate practice in carrying out *Assessments* are outlined below. This outline can assist in explaining the scope of *Assessments* to *Clients*; however, this outline is not intended to be exhaustive and professional judgment is required when adding or subtracting specific items in the provision of services.

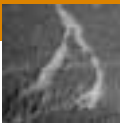
4.1 General

In general, *Terrain Stability Assessments* fall into one of two broad categories:

- a) *Assessments* of new *Developments* (i.e. proposed roads or cutblocks);
or
- b) *Assessments* of existing *Developments*.

Some aspects of the two *Assessments* are similar; however, there are distinct differences between the two. Some examples of these differences include:

- a) the response of the terrain to *Operations* is more apparent in developed areas;
- b) subsurface conditions are better exposed in developed areas (notably road and trail cutslopes);
- c) road construction techniques and the condition of the terrain downslope of the road can be obscured by road fill and spoil in developed areas;
- d) natural surface drainage patterns are often more easily identified in undeveloped areas;
- e) past road construction, maintenance and deactivation activities can mask evidence of factors contributing to landslides within, adjacent to and connected to developed areas;
- f) alternatives for mitigating landslide hazards and risks are often more limited in developed areas (i.e. relocation or deletion of roads or sections of cutblocks are not options in developed areas); and



- g) existing roads/trails can cause drainage problems for new roads or cutblocks downslope. Likewise, new roads or trails can affect old roads and trails downslope.

Assessments of new Developments can be carried out before road alignments and cutblock boundaries have been laid out (pre-layout *Assessment*) or afterwards (post-layout *Assessment*). A pre-layout *Assessment* is typically conducted to provide guidance to the layout personnel, particularly in areas where the terrain stability conditions are critical and could affect the viability of the *Development*, or where alternative road alignments are being considered. A post-layout *Assessment* may still be required depending on the terrain conditions, the level of survey control, and subsequent changes to the road alignments and cutblock boundaries. Post-layout *Assessments* are used to confirm that road alignments and cutblock boundaries are appropriate. Post-layout *Assessments* typically have better field control as field stations for road alignments and cutblock boundaries exist.


Assessments can address the entire *Development* area, most of the area, or only a selected section of the area. Depending on terrain conditions, *Assessments* can range from reconnaissance in nature (consisting of a review of background information with little or no fieldwork) or detailed in nature (including a substantial amount of fieldwork). The scope of the *Assessment* can also be affected by the *Client's* objectives and budget; however, *Members* must still meet the standards set by these Guidelines.

4.2 Objectives

Objectives of *Assessments* are to:

- a) characterize the existing landslide hazards (terrain and terrain stability conditions) in areas within, adjacent to or connected to the *Development* area;
- b) evaluate potential or existing effects of the *Development* on terrain stability;
- c) determine the landslide hazards and potential or existing effects of the *Development* on identified elements at risk; and
- d) recommend site-specific actions to reduce and/or manage the landslide hazards and risks resulting from the *Development*.

The types of recommendations for proposed new *Developments* will differ from existing *Developments*. Recommendations for new

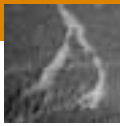


Developments can involve modifications to the road or trail location; construction techniques; drainage layout and installation; inspection frequency; deactivation/rehabilitation measures; proposed harvesting area; harvesting technique; or silvicultural system. Recommendations for existing *Developments* can involve modifications to existing roads and trails; upgrading/modification of the drainage installation; changes to inspection procedures and/or frequency; or deactivation or rehabilitation measures.

4.3 Background Work

Prior to fieldwork, the *Terrain Stability Professional* should collect and review existing information regarding the *Development* area. The required background information will depend on the nature of the *Assessment*. The *Terrain Stability Professional* should consider the applicability of the following information:

- a) plans or maps showing the *Development* area and future *Development* opportunities in the vicinity;
- b) airphotos, recent as well as historic (historic aerial photographs are particularly important when assessing older *Developments*);
- c) large and small scale topographic maps;
- d) bedrock and surficial geology maps;
- e) terrain classification and terrain stability maps;
- f) silvicultural and logging plans;
- g) design or as-built plans, profiles and cross-sections of roads and trails;
- h) road, trail and cutblock traverse information including deflection line traverses;
- i) stream or gully traverse notes;
- j) hydrological or watershed assessments;
- k) forest cover maps;
- l) other resource inventory maps such as stream classification and fish inventory;
- m) information from reports, letters, memos or other sources regarding existing known landslides;
- n) prior geotechnical, geological or *Terrain Stability Assessment* reports in the general *Development* area;
- o) overview reports that address terrain stability and/or constraints related to terrain stability (such as terrain attribute studies or reports accompanying terrain, terrain stability or surficial geology maps); and
- p) other information deemed pertinent to the *Assessment*.



Where possible, this information should be reviewed prior to undertaking fieldwork to assist in planning fieldwork, the *Development* and future *Development* potential; and to provide background on the terrain conditions. The *Terrain Stability Professional* should consider the reliability of the background information and the potential effects inaccurate information could have on the *Assessment*.

If pertinent information is not provided until after the fieldwork, the *Terrain Stability Professional* may require additional fieldwork.

4.4 Fieldwork

The level (intensity, amount and timing) of fieldwork is dependent on terrain conditions, adjacent elements at risk and non-terrain factors such as weather conditions, accessibility, and local knowledge and experience of the *Terrain Stability Professional*. The level of fieldwork for *Assessments* in existing *Development* areas is also governed by the extent and age of the *Operations* and the extent of any landslides that may have resulted. Older, ground-based *Operations* may require more extensive fieldwork due to overgrowth or the potential for a high density of roads and trails.

The *Terrain Stability Professional* must exercise professional judgment when determining what specific areas to assess in the field. Fieldwork should consider critical areas within, adjacent to and connected to the *Development* area that can be affected by the *Operations*, such as:

- a) areas that may be considered unstable, or potentially unstable, based on received information such as mapping, airphotos, observations made by others, or observations made during the background phase of the *Assessment*;
- b) sections of roads and trails crossing terrain that is moderately steep to steep, or considered unstable or potentially unstable, based on received information such as mapping, airphotos, past landslides, observations made by others, or observations made during the background phase of the *Assessment*;
- c) gully systems and other areas of concentrated surface or near-surface water flow;
- d) existing or proposed road drainage structures including culverts, cross-ditches and water bars, ditches, swales and drainage divides in the road surface; and
- e) specific areas upslope of high value elements at risk as determined by the *Licensee* or *Coordinating Registered Professional*.



If there are past landslides (natural or *Operations*-related) within, adjacent to or connected to the *Development* area, the level of fieldwork should be adjusted to review such areas and should include determining the possible cause or causes of the landslides as part of the supporting rationale described in Section 4.5.

Assessments should consider areas downslope of, adjacent to or connected to the proposed *Development* area that could be affected by the *Operations*. Examples include:

- a) gullies bordering the *Development*, particularly where prone to windthrow; and
- b) unstable, potentially unstable, and moderately steep to steeply sloping terrain downslope of the *Development* that could be affected by hydrological changes caused by the *Development*.

Areas with significant elements at risk warrant greater attention during the fieldwork.

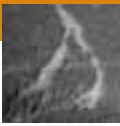
Assessments should consider areas upslope of the *Development* area that could affect the *Development*, such as:

- a) areas of existing *Operations* where roads, trails or cutblocks could be concentrating or diverting surface or near-surface water flows; and
- b) areas of natural instability that could affect the *Development* area, *Operations* or workers and equipment.

The *Terrain Stability Professional* should collect and analyze the information available from past *Operations* in nearby areas of similar terrain as part of the supporting rationale for the *Assessment* (see Section 4.5).

4.5 Supporting Rationale

The *Terrain Stability Professional* must have a rationale to support his/her conclusions and recommendations. Supporting rationale in the forestry context typically relates the geomorphic history of a particular terrain type to particular past forest practices. This approach relies on past performance to extrapolate the likely terrain response to the *Development*. Past performance can be based on terrain attribute studies, observations made by the *Terrain Stability Professional* in the general *Development* area, the general experience of the *Terrain Stability Professional* in dealing with similar terrain, or a combination of these.



The presence or absence of landslides on similar terrain near the *Development* area can provide a strong indication of the landslide potential within the *Development* area. Where there are landslides, developing a supporting rationale requires assessing the terrain prone to landslides in context with the type of *Development*, the natural geomorphic conditions, and climatic conditions that resulted in the landslide(s). Where practicable, factors contributing to past landslides must be investigated and analyzed in order to predict the future landslide potential and provide options to mitigate the landslide hazard or risk.


Traditional methods of slope stability analysis may be useful in some circumstances, but they typically require more detailed information than is obtained in an *Assessment*. Such slope stability analyses require investigation, testing and engineering evaluation of the subsurface soil and groundwater conditions. The accuracy of the analysis is dependent on the accuracy of the data obtained and used. If particular circumstances arise during a *Terrain Stability Assessment* where a more detailed method of analysis is warranted, such an investigation and analysis should be considered a specialty service, as described in Section 4.11.

4.6 Reports

Written reports are the means by which *Terrain Stability Professionals* communicate the results of their *Assessments* to their *Clients*. When authorized, the reports are often also used by other parties such as *Earth Works Contractors*, *Harvesting Contractors* and the *Government*. To suit the needs of the *Client*, report formats will vary depending on the target readers and the scope of the *Assessment*. The *Terrain Stability Professional* should review the format and contents of the *Assessment* report with the *Client* to meet the needs of the *Client*.

The *Assessment* report should include the following:

- a) objectives of the *Assessment*;
- b) scope and limitations of work;
- c) background information available, what information was used and its relevance;
- d) methodology, including the extent of fieldwork;
- e) observations made;
- f) supporting rationale for the conclusions, including the method of analysis;

- 
- g) conclusions;
 - h) recommendations to mitigate the landslide hazards and risks;
 - i) definitions of qualitative ratings used in the *Assessment*; and
 - j) any other information as specified in the *Agreement*.

The report should be clearly written with sufficient detail to allow the *Coordinating Registered Professional* and other members of the *Planning* team to implement the recommendations, and to allow other *Terrain Stability Professionals* to understand the supporting rationale for the conclusions and recommendations. The report should contain sufficient information to enable the *Coordinating Registered Professional, Licensee* and *Government* agencies to understand the hazards and evaluate whether the risks are acceptable.

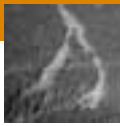
A peer review of the *Assessment* report is strongly encouraged as part of the quality assurance/quality control program (see Section 5), particularly where high value elements are at risk due to *Development*.

4.7 Limitations of the Assessment

Although fieldwork associated with *Assessments* can provide a reasonable coverage of road alignments and cutblock boundaries, it cannot practically cover the entire *Development* area or the entire area potentially affected by the *Development*. Accordingly, surface and subsurface conditions are typically inferred from observed surface expression and limited natural or excavated soil exposures. Existing *Developments* often provide better exposure of the near-surface conditions due to road or trail excavations, but can obscure the natural ground conditions by fill placement and can also have altered the natural drainage patterns.

Assessments are largely qualitative, based on observed and inferred conditions, and may not reliably identify conditions that are not visible. *Assessments* generally do not include subsurface investigations, measurements of soil strength properties or groundwater conditions. Conclusions and recommendations contained in *Assessment* reports are based on the assumption that standard forest *Operations* practices will be used. Substandard practices may render the conclusions and recommendations void.

Assessment reports do not typically include bridge foundation assessments or investigations, nor should they be relied on for such purposes unless specifically stated in the *Agreement* for services and the



Assessment report. Bridge foundation assessments often require subsurface investigation and geotechnical testing.

Assessments do not consider the landslide hazard under earthquake conditions. Such work is considered a speciality service under Section 4.11.

4.8 Field Reviews

The objectives of *Field Reviews* are to:

- a) ascertain or further assess general terrain conditions during *Operations*;
- b) observe if *Operations* are being carried out or were carried out in general conformance with the recommendations provided in the *Assessment* report; and
- c) recommend changes to the *Assessment* and/or *Operations* when warranted by field conditions.

The *Terrain Stability Professional* must comply with the requirements of APEGBC's Quality Management Bylaw 14(b)(4). The degree to which the *Terrain Stability Professional* is involved in carrying out *Field Reviews* relating to *Terrain Stability Assessments* is based on the judgment of the *Terrain Stability Professional* and depends on several factors including:

- a) landslide hazards;
- b) value of elements at risk;
- c) complexity or sensitivity of the terrain;
- d) complexity of the recommendation(s); and
- e) potential effect that variations in the subsurface conditions could have on the analysis and recommendations.

Field Reviews are particularly important where the *Development* represents a significant hazard to adjacent elements at risk; where non-typical forest *Operations* are recommended; and where variations in the subsurface conditions could significantly affect slope stability within and/or adjacent or connected to the *Development*.

Field Reviews are required for all designs resulting from specialty services (see Section 4.11).



Field Reviews should be conducted by the *Terrain Stability Professional* who conducted the *Assessment*, or by others under the *Direct Supervision* of that *Terrain Stability Professional*.

Field Reviews do not replace the need for appropriate *Development* inspections or supervision on the part of the *Coordinating Registered Professional* or the *Licensee*. Nor do they relieve the *Earth Works Contractor* or *Harvesting Contractor* of their responsibilities to supervise the work, follow the *Development* plans, conduct the work in accordance with good practice and provide safe working conditions.

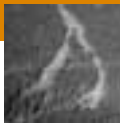
4.9 Supplanting the Terrain Stability Professional

If a second *Terrain Stability Professional* is retained to advise on terrain stability issues or to conduct *Field Reviews*, that *Terrain Stability Professional* should carry out *Assessments* and *Field Reviews* as required to accept full responsibility for the terrain stability aspects of the *Development*.

4.10 Landslide Investigations

Landslide investigations are often conducted following a landslide to determine the factors contributing to the landslide, the mechanism of failure and the effects; and to provide recommendations for mitigating residual or future hazards and risks. These investigations are different from landslide assessments conducted as part of *Terrain Stability Assessments*. Landslide investigations, in this context, are considered specialty services (see Section 4.11) and are not typically included in *Terrain Stability Assessments*.

The scope of work required for landslide investigations depends on the magnitude of the landslide, the damage caused by the landslide and the elements at risk. Landslide investigations in remote areas could simply involve a review of background information and field reconnaissance. Where elements at risk values are greater, more thorough investigations are warranted and could include drilling, sampling, instrumentation, laboratory testing and detailed slope stability analyses. Landslide investigations can be conducted in phases beginning with a review of background information and field reconnaissance followed by drilling, sampling, instrumentation, laboratory testing and detailed slope stability analyses, if required.



The scope of work required should be determined by the *Terrain Stability Professional* in consultation with the *Licensee* or the *Coordinating Registered Professional* or the *Government* agencies, and the owners of the adjacent elements at risk.

4.11 Specialty Services

The professional qualifications of *Terrain Stability Professionals* vary (see Section 6) and often include other areas of expertise. Depending on their expertise, *Terrain Stability Professionals* may offer specialty services such as:

- a) retaining wall investigation and design;
- b) design of reinforced or mechanically stabilized slopes;
- c) investigation and design of bridge foundations and/or abutments;
- d) design of road base or subgrade stabilization works;
- e) snow avalanche hazard assessments and design of mitigation measures;
- f) landslide investigations and design of mitigation measures;
- g) investigation and design of debris flow control structures;
- h) subsurface drainage design;
- i) investigation and design of slope stabilization works;
- j) landslide rehabilitation and stream channel restoration;
- k) soil erosion assessment and design of mitigation measures;
- l) seismic slope hazard assessments; and
- m) identification of potential areas of acid-generating rock formations, and design of mitigation measures to prevent harmful effects of any drainage generated from the acid-generating rock.

The *Terrain Stability Professional* must adhere to Principle 2 of APEGBC's Code of Ethics and provide specialty services only when qualified by education, training or experience (see Section 6).

Specialty services are beyond the scope of standard *Terrain Stability Assessments*. The *Licensee* or *Coordinating Registered Professional* should not expect such services to be included in standard *Terrain Stability Assessments* and should clearly identify when such services are required. If, through the course of a *Terrain Stability Assessment*, the *Terrain Stability Professional* identifies the need for specialty services, he/she should advise the *Licensee* or the *Coordinating Registered Professional* whether or not he/she is qualified to conduct the required specialty service and, if so, agree upon a revised scope of work.

QUALITY ASSURANCE/ QUALITY CONTROL

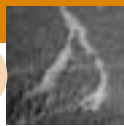
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The *Terrain Stability Professional* should carry out quality assurance/quality control (QA/QC) for all aspects of the *Terrain Stability Assessment*. This quality assurance must satisfy the requirements of APEGBC's Quality Management Bylaw 14(b) (1), (2) and (4) with respect to: retention of files for a minimum of 10 years; formalized in-house checking procedures; and formalized *Field Review* procedures, where required, to confirm that the constructed works are in general conformance with the recommendations of the *Terrain Stability Professional*. The *Terrain Stability Professional* should also remain current with the state of the art in *Terrain Stability Assessments* and any specialized services offered. The QA/QC program should address the background work, fieldwork, analyses, recommendations and report preparation, and should include internal and/or external peer reviews.

The QA/QC program should depend on the level of training and experience of the *Terrain Stability Professional* and the apparent risk due to landslides. Principle 2 of APEGBC's Code of Ethics states that *Members* must "undertake and accept responsibility for professional assignments only when qualified by training or experience." All *Terrain Stability Professionals* must evaluate their qualifications with respect to the terrain stability conditions encountered during the *Assessment*, and the apparent hazards and/or risks. The QA/QC program should require a higher level of training and experience on the part of the *Terrain Stability Professional* and a greater level of service in areas of high risk due to landslides.

The QA/QC program should also consider whether field observations during the *Assessment* or *Field Reviews* are collected directly by the *Terrain Stability Professional* or by others. The *Terrain Stability Professional* should exercise judgment when relying on observations made by others by conducting a sufficient level of review to be satisfied with the quality and accuracy of the observations.

6



EDUCATION, TRAINING AND EXPERIENCE

The *Terrain Stability Professional* must adhere to Principle 2 of APEGBC's Code of Ethics and must have appropriate education, training and experience consistent with the services provided. These can vary depending on the *Terrain Stability Professional's* background and whether specialty services are provided.

Regardless, common qualifications for all *Terrain Stability Professionals* should include formal education, training and experience in the geological sciences including geomorphology, hydrology, airphoto interpretation and soil mechanics. These base qualifications should be supplemented by training and experience in resource road construction and deactivation; soil erosion analysis and control; geologic hazard and risk identification and analysis; landslide avoidance, mitigation and remediation; slope stability analysis; and harvesting and silviculture methods.

The *Terrain Stability Professional* must also have the appropriate education, training and experience when offering specialty services or specialized designs. The most common specialty services provided by *Terrain Stability Professionals* require additional education, training and experience in soil and rock mechanics, groundwater hydrology, Quaternary geology, foundation engineering, retaining wall design, windthrow, or snow avalanche hazard assessment and mitigation. The *Terrain Stability Professional* providing specialized designs, such as geotechnical structures or retaining walls, requires registration with APEGBC as a Professional Engineer.

**Association of
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