Guidelines

for

Terrain Stability Assessments

in the

Forest Sector

October 2, 2009

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A goal of the Joint Practices Board (JPB) of the Association of British Columbia Forest Professionals (*ABCFP)*[1] and the Association of Professional Engineers and Geoscientists of British Columbia (*APEGBC)* is to provide guidance to help establish standards of care for managing terrain stability in the forest sector.

Previously, the JPB issued 'Guidelines for Management of Terrain Stability in the Forest Sector' (A*BCFP/APEGBC* 2008). Those Guidelines were directed to Forest Professionals and provide guidance for developing a *Terrain Stability Management Model* that considers a *Terrain Stability Assessment (TSA*).

In 2003, the Division of Engineers and Geoscientists in the Forest Sector of *APEGBC* developed 'Guidelines for Terrain Stability Assessments in the Forest Sector' (*APEGBC* 2003). They provided guidance to *Members* of *APEGBC* for carrying out a *Terrain Stability Assessment (TSA).*

The Guidelines you are presently reading were prepared by the JPB of *ABCFP/APEGBC*. They are directed to *Members* of both *ABCFP* and *APEGBC* who carry out *TSAs,* as well as to others who work on *Forest Development t*eams and/or use the results of *TSAs.* These Guidelines expand on, and update, the information provided in *APEGBC* 2003.

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[1] Terms in italics are defined in Section 1

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DEFINITIONS

The following definitions are specific to these Guidelines.

Agreement
A contract, either formal (written) or informal (verbal or implied), between a *Client* and a *Member* or *Members*, or other legal entity, to conduct a *Terrain Stability Assessment*.

ABCFP
Association of British Columbia Forest Professionals

APEGBC
Association of Professional Engineers and Geoscientists of British Columbia

Client
A party who engages a *Terrain Stability Professional* to conduct a *Terrain Stability Assessment.* This is typically a *Licensee* or a *Coordinating Registered Professional*, but can be another interested party.

Coordinating Registered Professional (CRP)
An individual, typically a *Member* of *ABCFP,* but can be a *Member* of *APEGBC*, who is responsible for coordinating all activities related to *Forest Development*. A CRP can also be a managing professional as defined in the *ABCFP/APEGBC* 'Guidelines for Management of Terrain Stability in the Forest Sector' (2008).

Direct Supervision
Responsibility for the control and conduct of the work of a subordinate.

Field Review
Observations and assessments carried out by a *Terrain Stability Professional* during or following *Operations*.

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

Government
Regulatory authorities governing all aspects of *Forest Development* on Provincial Crown land, and having jurisdiction over aspects of *Forest Development* on private forestry land. Such authorities include federal, provincial, regional and municipal governments

Harvesting Personnel
Individuals, company or Provincial Crown agency that carry out harvesting aspects of *Operations*, including timber harvesting, trail construction and silviculture activities.

Hazard
A harmful or potentially harmful *landslide*. A hazard includes the geomorphic attributes and effects of a *landslide*, such as volume of material involved and spatial extent, as well as the effect of the *landslide* on other geomorphic processes such as fluvial processes.

A qualitative or quantitative estimate of the likelihood or probability of a *landslide* occurring, referred to as a hazard analysis.

Other definitions of hazard exist, and a *TSA* report should clarify the definition of hazard used.

Landslide
A movement of a mass of rock, debris, or earth down a slope (Cruden, 1991).

Licensee
An individual, company or Provincial Crown agency that has the legal right to harvest timber. A *Licensee* engages in, or contracts out, *Planning* and *Operations*.

A Licensee refers to a Land Owner when *Forest Development* is on private land.

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

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

Planning
Aspects of *Forest Development* related to the planning of roads and trails, timber harvesting and silviculture activities. These include locating proposed roads and trails; designing roads, bridges and other engineered structures associated with roads; designing and laying out cutblock boundaries, selecting harvesting systems and selecting silvicultural systems.

Risk
A combination of a *hazard* and the consequences to elements potentially at risk (elements at risk) from the *hazard.*

A qualitative or quantitative estimate of the risk is referred to as a risk analysis

Other definitions of risk exist, and a *TSA* report should clarify the definition of risk used.

Road Personnel
Individuals, company or Provincial Crown agency that carry out road aspects of *Operations*, including construction, maintenance, deactivation and reactivation.

Terrain Stability Assessment (TSA)
A *hazard* analysis or *risk* analysis for an area associated with *Operations*, a comparison of the results of the analysis with established or implied acceptable *hazard* or *risk* criteria and, if required, recommendations/options to achieve those criteria.

The results of a TSA are documented in a TSA report.

Terrain Stability Management Model
A system, process or procedure to manage terrain stability related to *Forest Development*. It can consist of a document, a map, a diagram; or some combination of these, and should provide guidance with respect to:

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

Refer to *ABCFP/APEGBC* 'Guidelines for Management of Terrain Stability in the Forest Sector' (2008).

Terrain Stability Professional (TSP)
A *Member* with appropriate levels of education, training and experience (skill sets) to conduct a *TSA*.

2

INTRODUCTION

Forest Development[2] often takes place within, or adjacent to, areas that may be prone to *landslide hazards* (or simply *hazards*).

A Terrain Stability Assessment *(TSA)* is carried out by a Terrain Stability Professional (*TSP)* to:

- identify and estimate the existing and post *Forest Development* probability of a *hazard* occurring (*hazard* analysis), or
- identify and estimate the existing and post *Forest Development* effects or consequences as a result of these *hazards (risk* analysis*)*;
- compare the results of the *hazard* or *risk* analysis with established or implied acceptable *hazard* or *risk* criteria; and
- depending on the requirements of the *CRP,* provide recommendations/options to manage the *hazards* or *risks* related to *Forest Development*.

The goal of carrying out a *TSA* is ultimately to protect the safety, health and welfare of the public, to protect the environment, and to promote health and safety within the workplace.

2.1 Purpose and Scope of Guidelines

These Guidelines provide general standards of professional practice to *TSPs* who carry out *TSAs* related to *Forest Development* in British Columbia. They specify tasks that should be carried out by a *TSP* to meet his/her standard of care in the best interest of the *Client* or employer, the public, the environment and worker safety. These Guidelines can also be used to assist a *TSP* and his/her *Client* or employer establish the scope of work and an *Agreement*.

In addition, these Guidelines describe the skill sets required by a *Member* to be competent to carry out a *TSA*.

A *TSP* often works in conjunction with a *Coordinating Registered Professional* (*CRP*) and other *Forest Development* team members. These Guidelines also discuss the roles and responsibilities of these other team members.

Consistent with *ABCFP/APEGBC* Joint Practice Board's (JPB's) terms of reference, these Guidelines apply solely to *Members* of *ABCFP* and *APEGBC* and to *TSAs* associated with *Forest Development* in British Columbia.

2.2 Professional Obligations

As stated in the respective Codes of Ethics, *Members* of *ABCFP* and *APEGBC* have professional obligations to protect the safety, health and welfare of the public, to protect the environment, and to promote health and safety within the workplace. These Guidelines are intended to establish standards of practice so that *Members* can fulfill their professional

[2] Terms in italics are defined in Section 1

obligations. Failure to meet the intent of these Guidelines could be evidence of unprofessional conduct and lead to disciplinary proceedings by *ABCFP* or *APEGBC*.

Members must exercise professional judgment when providing professional services, and as such, the application of these Guidelines can vary depending on 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 an appropriate standard of practice in the performance of professional services. Such judgments and decisions depend upon an evaluation of the facts and circumstances in a particular situation.

Also, as stated in the respective Codes of Ethics, *Members* of *ABCFP* and *APEGBC* must practice only in areas where they are appropriately trained and experienced.

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

Members of *APEGBC*, who are retained to provide consulting services, must follow 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."

2.3 Acknowledgments

These Guidelines have been prepared by a Task Force of the *ABCFP/APEGBC* JPB. They expand and update the 'Guidelines for Terrain Stability Assessments in the Forest Sector' (*APEGBC* 2003), which was prepared by the Division of Engineers and Geoscientists in the Forest Sector (DEGIFS), a Division of *APEGBC*. A second JPB Task Force prepared Section 6, Skill Sets for Terrain Stability Assessments.

ABCFP and *APEGBC* acknowledge the efforts of DEGIFS and JPB Task Force members and reviewers in preparing this document.

3

PROJECT ORGANIZATION AND RESPONSIBILITIES

3.1 Team Approach

The roles and responsibilities of those involved in completing a *TSA* vary depending on the *Forest Development* and the parties involved. All stages of *Forest Development*, including the *TSA,* are best achieved through a team approach. A team is typically led by a *CRP* who engages a *TSP* to conduct a *TSA*. Other team members can include: Forest Professionals*, Road Personnel* and *Harvesting Personnel* and Specialists. From initial *Planning*, through to post *Operations*, good communication among team members is essential*.*

ABCFP and *APEGBC* support the concept and implementation of professional reliance in a team approach.

3.2 Roles and Responsibilities

3.2.1 Coordinating Registered Professional

Throughout the *Forest Development* process, the *CRP* provides professional services to his/her *Client* or employer, typically a *Licensee*. The *CRP* has the obligation "to inform the client or employer of any action planned or undertaken by the client or employer that the member believes is detrimental to good forest stewardship"[3] and to "present clearly to employers and clients the possible consequences if professional decisions or judgments are overruled or disregarded"[4].

The roles and responsibilities of the *CRP* are as follows:

In the planning stage of the *TSA*:

- ensure a *TSP,* with the necessary and appropriate skill sets (see Section 6), is retained to conduct the *TSA*;
- in consultation with the *TSP*, establish the scope of the *TSA.* (see Sections 4.2 and 4.3);
- establish terms for any additional services that may be required beyond the scope of a typical *TSA* (see Section 4.11);
- recognize that the *TSA* is based on the proposed *Forest Development* and that changes to the *Forest Development* could invalidate the *TSA*;
- provide the *TSP* with all background information (written or otherwise) related to the *Forest Development,* including location of elements at risk (see Section 4.4); and
- provide the *TSP* all established or implied acceptable *hazard* or *risk* criteria. Such criteria may have been established by the *Licensee*, *Government*, or other stakeholders.

[3] ABCFP Code of Ethics Principle 5.5
[4] ABCPF Code of Ethics Principle 8

Upon receipt of the *TSA* report:

- review the results of the TSA *hazard* analysis or *risk* analysis compared to the appropriate acceptable *hazard* or *risk* criteria;
- communicate with the *TSP* to ensure that any questions or uncertainties with regard to any aspect of the *TSA* report are answered;
- where appropriate, communicate the *hazards* or *risks* described in the *TSA* report to *Government* and/or Land Owners of adjacent property who may be responsible for accepting the *hazards* or *risks*;
- if recommended in the *TSA* report, keep the *TSP* informed of the progress of *Operations,* and retain the *TSP* to conduct appropriate *Field Review*s during *Operations*;
- coordinate and review all reports, maps and other documents produced during *Planning* to ensure consistency with the results and recommendations/options in the *TSA* report;
- coordinate communication among the *Licensee*, the *Roads Personnel*, the *Harvesting Personnel* and the various persons involved in *Planning,* including the *TSP,* so that the recommendations/options of the *TSA* report are implemented in a manner that complies with applicable codes and regulations, and meets the needs of the *Licensee*, the public and the environment;
- recognize the limitations of the *TSA* (see Section 4.8), and promptly notify the *TSP* if or when terrain conditions encountered during *Operations* differ from those described in the *TSA* report; and
- ensure a communication process is in place when unexpected terrain conditions are encountered.

The *CRP* needs to exercise judgment if considering not following recommendations/options presented in the *TSA* report, or when deciding unexpected terrain conditions are not significantly different from those described in the *TSA* report. In such instances, further communication with the *TSP* is usually warranted. Failure to follow the *TSP's* recommendations/options, or not notifying the *TSP* when encountering unexpected terrain conditions during *Operations*, could result in the *CRP* and or *Licensee* accepting liability for negative results.

3.2.2 Terrain Stability Professional

The roles and responsibilities of the *TSP* are as follows :

In the planning stage of the *TSA*:

- if a *Licensee* does not have a *CRP*, the *TSP* should recommend that a *CRP* be retained;
- in consultation with the *CRP*, establish the scope of the *TSA* (see Sections 3.2.1, 4.2 and 4.3); and
- make reasonable attempts to obtain all background information (written or otherwise) related to the *TSA,* from the *CRP* and others, but consider the reliability and accuracy of such information (see Section 4.4).

During the *TSA*:

- conduct sufficient fieldwork to reasonably evaluate the terrain conditions and *hazards* or *risks* (fieldwork can include areas outside of the *Forest Development* area that could affect or be affected by *Operations* -- see Section 4.5);
- if the area of the *TSA* is limited to a specific portion of the *Forest Development* area, discuss with the *CRP* the implications the limits could have on the *TSA*, and in the *TSA* report discuss which areas were assessed and why;
- identify and analyze *hazards* or *risks* along existing and proposed road alignments, within existing and proposed cutblocks, and in adjacent areas that could be affected by the *Operations*, or could affect the *Operations*;

- compare the results of the *hazard* or *risk* analysis associated with the *Forest Development* with established or implied acceptable *hazard* or *risk* criteria;
- if required, provide recommendations/options to manage the *hazards* and *risks*;
- notify the *CRP* when specialty services are required (see Section 4.11) and whether a Specialist should be retained to carry out the specialty services;
- document the results of the *TSA* in an appropriately written report with supporting rationale and a statement of limitations, that can easily be understood by all team members (see Sections 4.6, 4.7 and 4.8); and
- describe in the *TSA* report when and where *Field Reviews* are recommended (see Section 4.9).

After the *TSA*:

- during *Operations,* carry out *Field Review*s as required 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/options provided in the *TSA* report[5] (see Section 4.9); and
- promptly provide the *CRP* with written results of the *Field Review*, including any changes to the original recommendations/options and any areas where the *Operations* do not generally conform to the recommendations/options in the *TSA* report;

Many aspects of the *TSA* and *Field Reviews* can be delegated to others, but only under the *Direct Supervision* of a *TSP*.

At any time during the *TSA*, if the *CRP* (and/or *Licensee*) fail or refuse to carry out the roles and responsibilities described in Section 3.2.1, and if this failure or refusal could compromise the *TSP's* professional obligations, the *TSP* should:

- advise the *CRP* (and/or *Licensee*) in writing of the potential consequences of his/her inactions;
- consider whether he/she should continue as the *TSP* for the *TSA;* and
- consider whether the situation warrants notifying the appropriate *Government*, *ABCFP*, *APEGBC* or other relevant agencies or regulatory bodies.

3.2.3 Road Personnel and Harvesting Personnel

Road Personnel and *Harvesting Personnel* typically have a wealth of experience in local terrain conditions and *Operations* and, therefore, can provide valuable input into identifying *hazards* or *risks* and recommendations/options. In addition, *Road Personnel* and *Harvesting Personnel* often can provide valuable feedback as to the effectiveness of the *TSA* recommendation/options and opportunities for future recommendations/options.

As those who implement *Operations*, *Road Personnel* and *Harvesting Personnel* need to fully understand the objectives and follow and recommendations/options in the *TSA* report as incorporated into the proposed *Operations*. Alternatively, in consultation with the *TSP* and the *CRP, Road Personnel* and *Harvesting Personnel* can suggest viable alternatives.

Road Personnel and *Harvesting Personnel* are typically the first to observe and encounter terrain conditions exposed during *Operations.* Therefore, effective and timely communication to the *CRP* is helpful and potentially beneficial in situations, such as when:

- terrain conditions or excavated materials are different or changed from those described in the *TSA* report;

[5] APEGBC Bylaw 14(b)(4); *ABCFP* Standard 12.5.1

- excess ground disturbance occurs during harvesting; and
- signs of potential or incipient slope movement are observed.

The CRP should provide *Road Personnel* and *Harvesting Personnel* with a communication protocol for such situations.

Established rainfall shutdown guidelines should be followed by all *Operations* personnel.

3.2.4 Specialists

Specialists are required when specialty services, beyond the scope of a typical *TSA* are required. Bridge foundation stability, bedrock stability and fisheries management are a few examples of professional services outside the scope of most *TSAs* (see Section 4.11).

The need for a Specialist can arise from many different circumstances. Any team member can recommend the need for specialty services to ensure the objectives of the *TSA* are met.

In many cases the Specialist provides important input into a specific element of the *TSA.* Where the *TSP* possesses a specialist skill set, the he/she may conduct both the *TSA* and the specialty service.

4

GUIDELINES FOR PROFESSIONAL PRACTICE

4.1 Background

4.1.1 Brief History of *TSAs*

The following brief history of *TSAs* is summarized from Fannin et al (2007).

The practice of carrying out *TSAs* began in the Coastal areas of BC in the 1980s. The practice was prompted by several logging-related *landslides* and the resulting effects to fish habitat and forest sites on the Queen Charlotte Islands and Vancouver Island. *TSAs* in the southern Interior of BC began in the early 1990s due to several logging-related landslides that affected populated areas, and due to a growing awareness of soil disturbance from ground-based harvesting on steep slopes.

With the introduction of the Forest Practices Code in 1995, *TSAs* were required by regulation under certain circumstances when roads or harvesting were proposed in areas identified as having: a moderate to high likelihood of l*andslides*; unstable or potentially unstable terrain; sites with indicators of slope instability and, in absence of mapping, slopes steeper than 60%. The need for a *TSA* was based solely on perceived probability of a *hazard* at the site, not on the potential consequences and/or *risk* associated with the *hazard*. “Qualified registered professionals” were required to conduct a *TSA*.

A review by the Forest Practices Board in 2005 found that the occurrence of *landslides* related to *Forest Development* decreased after the Forest Practices Code was introduced. This was probably due, in part, to *TSAs* conducted by professionals, to improved practices recommended by the *TSA* reports, and to the avoidance of *risk* associated with road construction and harvesting on potentially unstable terrain.

Under the Forest and Range Practices Act (FRPA), introduced in 2003, the requirement by regulation to undertake *TSAs* was removed. An increased level of accountability was placed on industry for results of their practices. The FRPA requirement that forest practices do not cause a “material adverse effect” on specified forest values has shifted the emphasis from probability of *hazard*-based to *risk*-based management of *landslide*-prone terrain. While not all forestry in BC is governed by FRPA, this shift highlighted the need for guidelines to assist forest professionals to develop management strategies for *landslide*-prone terrain; and for updating the previous Guidelines for Terrain Stability Assessments in the Forest Sector (*APEGBC* 2003).

4.1.2 Summary of Regional Issues

Climatic and geologic conditions vary widely across BC. As well, different forest management objectives and different harvesting methods are used in different regions and under different

circumstances. Consequently, terrain stability concerns vary widely by geographic or physiographic region through out the province.

In coastal regions of BC, shallow rapid *landslides* (debris slides, debris avalanches and debris flows) are common after road construction and harvesting; they are typically triggered by heavy rain. Root decay, windthrow, road drainage and slope overloading are often contributing factors. Similar *landslides* are also frequent in parts of the Columbia Mountains and Skeena-Hazelton Mountains, although they usually occur during the spring snowmelt season, with drainage diversion by roads being the most common contributing factor.

In the northeast and west central BC, deep-seated slumps in fine-textured glacial deposits or weak bedrock are common. In parts of the Interior plateaux, “gentle-over-steep” *landslides*, caused by *Forest Development* on gently-sloped uplands above incised, steep valley sides are a common problem.

Different skill sets may be required to address regional variation. A *TSP* is expected to know the specific *landslide* concerns associated with *Forest Development* for the region in which he/she works, and to keep abreast of new and pertinent information and research related to forest management and *landslides* in the region.

Other terrain-related issues besides *landslides* exist in some regions. For example, in the Columbia Mountains and Coast Mountains, snow avalanches following harvesting are a concern. In much of the dry southern Interior plateau, the likelihood of *landslides* caused by *Forest Development* is low, and sediment delivery to streams derived from road surface erosion and small-scale mass wasting along roads and skid trails is often a greater concern.

Although the primary focus of a *TSA* is *landslides*, if during a *TSA* other terrain-related issues are identified, if the TSP is qualified, the other issues should either be addressed in the *TSA* report or be addressed in a separate report, or a recommendation should be made to retain a Specialist. A team approach is one method to address multiple terrain-related issues.

4.2 General

The services that a *TSP* should consider as appropriate when carrying out a *TSA* are outlined below. This outline can assist in explaining the scope of a *TSA* to *Clients* or employers; however, it is not intended to be exhaustive and professional judgment is required when adding or removing specific items.

A *TSA* is typically conducted to assess *hazards* or *risks* from *landslides*:

- within and upslope of proposed cutblocks;
- associated with proposed road locations; and
- associated with road construction, maintenance, deactivation or reactivation.

The *hazards* or *risks* include those resulting from both natural *landslides* that could affect the cutblock or road, and *landslides* resulting from timber harvesting or road construction, maintenance, deactivation and reactivation.

The *TSA* report can also provide recommendations/options to manage identified *hazards* or *risks* if they exceed established or implied acceptable *hazard* or *risk* criteria.

In carrying out the *TSA*, the *TSP* should keep in mind his/her professional obligations to protect the safety, health and welfare of the public, to protect the environment, and to promote health

and safety within the workplace, and remember to practice only in areas where he/she are appropriately trained and experienced.

In general, the *TSA* is carried out for either proposed *Forest Development* (proposed roads or cutblocks); or for existing *Forest Development*. Some aspects of the two *TSAs* are similar; however, there are also distinct differences. Some examples of these differences include:

- the response of the terrain to *Operations* is more apparent in developed areas;
- subsurface conditions are often better exposed in developed areas (notably road and trail cut slopes);
- road construction, maintenance, deactivation and reactivation activities can mask contributing factors to *landslides* within, or adjacent to, developed areas;
- road construction techniques and the condition of the terrain downslope of the road can be obscured by road fill and spoil in developed areas;
- natural surface drainage patterns are often more easily identified in undeveloped areas;
- existing roads/trails can cause downslope drainage issues for new roads or cutblocks; similarly, new roads/trails can affect existing downslope roads/trails; and
- alternatives for managing *hazards* or *risks* are often more limited in developed areas, for example relocation or deletion of roads or sections of cutblocks may not be options in developed areas.

A *TSA* of proposed *Forest Developments* can be carried out before road alignments and cutblock boundaries have been laid out (pre-layout *TSA*) or afterwards (post-layout *TSA*).

A pre-layout *TSA* is typically conducted to provide guidance to the layout personnel during *Planning*, particularly in areas where *hazards* or *risks* could affect the viability of the *Forest Development*, or where alternative road alignments are being considered. A post-layout *TSA* may still be required depending on the terrain conditions, the level of survey control, and subsequent changes to the road alignments and cutblock boundaries.

A post-layout *TSAs* is used to confirm that road alignments and cutblock boundaries are appropriate. A post-layout *TSA* typically has better field control because field stations for road alignments and cutblock boundaries exist.

A *TSA* can address the entire *Forest Development* area, most of the area, or only a selected section of the area, as determined by the *CRP* and *TSP*. Depending on terrain conditions, a *TSA* can range from reconnaissance in nature (consisting of a review of background information with little or no fieldwork) to detailed in nature (including a considerable fieldwork). The scope of a *TSA* can also be affected by the *Client's* objectives and budget; however, as discussed in Section 2 a *TSP* must still meet the standards described by these Guidelines.

4.3 Objectives

The objectives of a *TSA* includes, but is not limited to:

- evaluate existing and potential effects of *Forest Development* on terrain stability;
- characterize the terrain and existing *hazards* in areas within, or adjacent to, the *Forest Development* area;
- determine the *hazards* or *risks* of *Forest Development* on identified elements at risk, including worker and public safety;
- compare the *hazards* or *risks* with established or implied acceptable *hazard* or *risk* criteria, including those determined by *Government* and those contained within a *Licensee's Terrain Stability Management Model*; and

- if required, provide site-specific recommendations/options to manage the *hazards* and *risks* resulting from the *Forest Development*.

Descriptions and ratings of *hazard* or *risk* should focus on specific areas (for example, homogenous terrain units, specific road sections) within a *Forest Development* area, rather than providing a single *hazard* rating for the entire area.

Where downslope consequences are high, such as public safety, infrastructure, or private property, a more rigorous *TSA* is warranted, unless proposed *Operations* will result in no increase in *risk*. Where residences, public roads, public spaces or public infrastructure are downslope of the *Forest Development*, the *TSA* should address public safety. In the case of *Forest Development* above residences, the *TSA* should be conducted similarly to that specified in the 'Guidelines for Legislated Landslide Assessments for Proposed Residential Development in British Columbia' (*APEGBC* 2008).

Types of recommendations/options for proposed *Forest Developments* will differ from existing *Forest Developments*.

4.4 Preliminary Work

Prior to fieldwork, the *TSP* should collect and review existing background information regarding the *Forest Development* and *Forest Development* area. The background information will depend on the nature of the *TSA*. The *TSP* must consider the applicability of the following:

- plans or maps showing the *Forest Development* area and future *Forest Development* opportunities in the vicinity;
- air photos at various scales and dates;
- large and small scale topographic maps;
- bedrock and surficial geology maps;
- terrain classification and terrain stability maps;
- silviculture and logging plans;
- design or as-built plans, profiles and cross-sections of roads and trails;
- road, trail and cutblock traverse information including deflection line traverses;
- stream or gully traverse notes;
- hydrological or watershed assessments;
- forest cover maps;
- other resource inventory maps such as stream classification and fish inventory;
- terrain attribute studies or less formal information regarding existing or potential landslides;
- prior geotechnical, geological or *TSA* reports in the general *Forest Development* area;
- overview reports that address terrain stability and/or constraints related to terrain stability; and
- any other information deemed relevant .for example, local knowledge and experience.

Where possible, the *TSP* should acquire this information to assist in planning fieldwork, to provide background on the terrain conditions, and to understand the *Forest Development* and future *Forest Development* potential. The *TSP* should consider the reliability and accuracy of the background information and the potential effects that unreliable or inaccurate information could have on the *TSA.* If pertinent information is not provided until after the fieldwork, the *TSP* may have to return to the field.

4.5 Fieldwork

The intensity (amount and timing) of fieldwork is dependent on the complexity of the terrain, terrain conditions, adjacent elements at risk and non-terrain factors such as weather, accessibility, and local knowledge and experience of the *TSP*. The intensity of fieldwork for a *TSA* in an existing *Forest Development* area is also governed by the extent and age of previous *Operations* and by the presence of *landslides* that may have occurred as a result of those *Operations*. Older, ground-based *Operations* may require more intensive fieldwork due to forest regeneration or because of a high density of roads and trails.

Based on a review of the background information, the *TSP* should exercise professional judgment when determining what specific areas to assess in the field. Fieldwork should consider critical areas within, or adjacent to, the *Forest Development* area that can be affected by *Operations*, such as:

- moderately steep to steep and unstable or potentially unstable terrain*;*
- gully systems and other areas of concentrated surface or near-surface water flow;
- existing or proposed road drainage structures including culverts, cross-ditches and water bars, ditches, swales and drainage divides in the road surface; and
- landslide transport and deposition zones that have high value elements at risk.

The *TSP* should collect and evaluate relevant information available from past *Operations* in nearby areas of similar terrain as part of the supporting rationale for the *TSA* (see Section 4.6). If past *landslides* (natural or *Operations*-related) have occurred in areas within, or adjacent to, the *Forest Development* area, fieldwork should include such areas to determine, where possible, the contributing factors of the landslides as part of the supporting rationale.

A *TSA* should include areas downslope of the *Forest Development* area that could be affected by *Operation*. Examples include:

- gullies or other potentially unstable areas bordering the *Forest Development* area, particularly where prone to windthrow; and
- moderately steep to steep and unstable or potentially unstable terrain that could be affected by hydrological changes caused by *Operations.*

A *TSA* should include areas upslope of the *Forest Development* area that could affect *Operations* or worker safety. Examples include:

- existing roads, trails or cutblocks that could affect slope stability or hydrology; and
- areas of natural *landslides* or other terrain-related processes.

4.6 Supporting Rationale

The *TSP* must consider, and provide in the *TSA* report, supporting rationale to support his/her observations, conclusions and recommendations/options. Such rationale typically relates the geomorphic history of a particular terrain type to past *Forest Development* and relies on past performance to extrapolate the likely terrain response to proposed *Operations*. Past performance can be based on terrain attribute studies, observations made near the *Forest Development* area, the general experience of the *TSP* in dealing with similar terrain, or a combination of these.

The presence or absence of *landslides* on similar terrain near the *Forest Development* area can provide a strong indication of the *landslide* potential within the *Forest Development* area. Where there are nearby *landslides*, developing a supporting rationale requires evaluating the terrain

conditions and proposed *Operations* in comparison to the terrain conditions and previous *Operations* in the area with *landslides*. Where practicable, the factors contributing to past *landslide* activity in nearby areas should be investigated and evaluated to help predict the likelihood of future *landslides* and to provide recommendations/options to manage *hazards* or *risks*.

A limit equilibrium, or similar, slope stability analysis may be useful in some circumstances, but such analyses require more detailed information than is collected in a typical *TSA*[[Tom, good point]]. Such analyses require investigation, testing and evaluation of the subsurface soil and groundwater conditions. The accuracy of the analysis is dependent on the accuracy of the data obtained and analyzed, and is limited by the variability that typically exists at the spatial scale of *Forest Development*. If particular circumstances justify slope stability analysis, a specialty service should be considered (see Section 4.12).

4.7 Reports

Written reports are the means by which the *TSP* communicates the results of his/her *TSA* to the *Client*. *TSA* reports are often used by other parties such as *Road Personnel* and *Harvesting Personnel* and the *Government*. Report formats, by necessity, vary to suit the needs of the *Client*, the target readers and the scope of the *TSA*. The *TSP* should review the format and contents of the report with his/her *Client* to ensure the report will provide sufficient and appropriate information, as well as meets the professional standards of both the *TSP* and the *CRP*.

A *TSA* report typically includes the following:

- objectives;
- scope and limitations of work;
- available background information, what information was used and its relevance;
- methodology, including the extent of fieldwork;
- observations;
- method of analysis;
- supporting rationale;
- established or implied acceptable *hazard* or *risk* criteria;
- conclusions;
- recommendations/options to manage *hazards* or *risks*;
- definitions of qualitative *hazard* or *risk* ratings used; and
- other information as specified in the *Agreement.*

The report should be clearly written with sufficient detail to allow the *CRP* and other *Forest Development* team members to implement the recommendations/options. There should be sufficient detail to allow other *TSPs* to understand the supporting rationale, conclusions and recommendations/options without going in the field. The report should contain sufficient information to enable the *CRP*, *Licensee* and *Government* to understand the *hazards* or *risks*, and to be able to evaluate whether they are acceptable.

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

If *Forest Development* could result in *hazards* and *risks* in a jurisdiction that has local or provincial government landslide acceptable *hazard* or *risk* criteria, the *TSA* report should compare the *hazards* or *risks* to those criteria.

4.8 Limitations of the *TSA* and *TSA* report

The *TSA* report should specify the limitations of the *TSA,* and the *TSA* report. Items that can be addressed under limitations include, but are not limited to:

- the standard of care followed while carrying out the *TSA;*
- interpretation of subsurface conditions from surface observations;
- terrain and weather conditions that could affect the observations; and
- the report should only be used by the Client for its intended use.

As an example, subsurface conditions are inferred from observations of surface characteristics. The *Client* must fully understand and appreciate the limitations, and understand when unexpected subsurface conditions warrant further assessment by the *TSP.*

As another example, *TSAs* do not typically include bridge foundation investigations and assessments, nor do they typically consider the effects of earthquakes. Such work considered speciality services (see Section 4.11).

4.9 Field Reviews

Field Reviews are a component of quality assurance and due diligence. *APEGBC's* Quality Management Bylaw 14(b)(4) requires *Field Reviews* of projects under construction. *Field Reviews* must be carried out by, or under the *Direct Supervision* of, a *TSP* -- usually the *TSP* responsible for the *TSA*.
The objectives of *Field Reviews* are to:

- further assess terrain conditions during *Operations*;
- observe if *Operations* are being carried out, or were carried out, in conformance with the recommendations/options provided in the *TSA* report; and
- recommend changes to the *TSA* and/or *Operations* when warranted.

Field Reviews are particularly warranted:

- in areas that have higher *hazards* or *risks*, or in adjacent areas;
- in areas where there are higher value elements at risk;
- where workers or public safety can be put in jeopardy;
- in areas of complex terrain;
- in situations of non-typical construction methods or engineered designs; and
- where variations in subsurface conditions could significantly affect the recommendations/options.

The number of *Field Reviews* should be based on the judgment of the *TSP,* and also depend on the above factors.

Field Reviews do not replace the need for appropriate *Operations* inspections or supervision on the part of the *CRP* or the *Licensee*. Nor do they relieve *Road Personnel* or *Harvesting Personnel* of their responsibilities to supervise the work, follow the proposed *Operations*, conduct the work in accordance with good practice and provide safe working conditions.

4.10 Supplanting the Terrain Stability Professional

If a second *TSP* is retained to advise on terrain stability issues, or to conduct *Field Reviews*, it should be expected that that *TSP* may carry out additional *TSA* work and additional *Field Reviews,* as required, to accept full responsibility for the terrain stability aspects of the *Forest Development*.

4.11 Specialty Services

Professional skill sets of *TSPs* can vary (see Section 6) and often includes other areas of expertise. Depending on his/her expertise, a *TSP* may be able to offer specialty services such as:

- full rather than partial risk analysis (see Wise et al 2004)
- retaining wall investigation and design;
- design of reinforced or mechanically stabilized slopes;
- investigation and design of bridge foundations and/or abutments;
- design of road base or subgrade stabilization works;
- snow avalanche hazard assessments and design of mitigation measures;
- *landslide* investigations (see below) and design of mitigation measures;
- investigation and design of debris flow control structures;
- subsurface drainage design;
- investigation and design of slope stabilization works;
- safe entry instructions, where required by WorkSafeBC;
- landslide rehabilitation and stream channel restoration;
- soil erosion assessment and design of mitigation measures;
- seismic slope hazard assessments; and
- detailed *hazard* analysis to better estimate probability or occurrence, potential magnitude and run-out.

Landslide investigations are an example of a specialty service. Such investigations are often conducted following a *landslide* to determine the factors that contributed to the *landslide*, the mechanism of failure and the effects; and to provide recommendations/options for managing residual or future *hazards* and *risks*. The scope of work required for a *landslide* investigation depends on the magnitude of the *landslide*, the damage caused by the *landslide* and the elements at risk. *Landslide* investigations where elements at risk values are relatively low may simply involve a review of background information and field reconnaissance. Where elements at risk values are greater, more thorough investigations are warranted and can include drilling, sampling, instrumentation, laboratory testing and detailed slope stability analyses.

The scope of work or specialty services required should be determined by the *TSP* and the Specialist in consultation with the *CRP, Licensee, Government*, and, if applicable, Land Owners of adjacent land.

Specialty services are beyond the scope of a typical *TSA*. The *CRP* or *Licensee* should not expect such services to be included in a *TSA* and should clearly identify in the *Agreement* if such services are required. If, through the course of a *TSA*, the *TSP* identifies the need for specialty services, he/she should advise the *CRP* or *Licensee* whether or not he/she is qualified to carry out the required specialty service and, if so, agree upon a revised scope of work.

The *TSP* must only provide specialty services only when he/she has the required skill sets.

5

QUALITY ASSURANCE/ QUALITY CONTROL

The *TSP* should carry out quality assurance/quality control (QA/QC) for all aspects of the *TSA* (preliminary work, fieldwork, analyses, recommendations/options and report preparation). *APEGBC Members* must satisfy the requirements of Quality Management Bylaws 14(b) (1), (2) and (4) with respect to: retention of files for a minimum of 10 years; in-house checking procedures; and *Field Reviews*, where required (see Section 4.9). The QA/QC program can include internal and external peer reviews.

The *TSP* should remain current with the state of the art of *TSAs* and any specialized services he/she offers.

The level of QA/QC depends on

- the complexity of the terrain;
- the *hazards* and *risks;*
- the training and experience of the *TSP* in relation to the to the terrain, and the *hazards* or *risks*, and
- whether field observations for the *TSA* or *Field Review* are made directly by the *TSP* or under his/her *Direct Supervision*.

In the situation of *Direct Supervision*, the *TSP* should conduct sufficient review to be satisfied with the quality and accuracy of observations made by others.

6

Skill Sets for Terrain Stability Assessments

The *TSP* must adhere to his/her respective *ABCFP*' or APEGBC Code of Ethics and have appropriate education, training and experience (collectively referred to as 'skill sets') consistent with the services provided. *Members* that conduct *TSAs* without sufficient skill sets may be subject to disciplinary action.

Skill sets in a subject area are typically gained from:

- formal study such as university courses; or equivalent knowledge gained from short courses, workshops and self study;
- work experience, usually with mentoring by a senior professional with relevant expertise; and
- continuing professional development – keeping abreast of emerging literature, research and studies.

A single individual can have the required skill sets to carry out a *TSA*, or the required skill sets can be obtained through a team approach. A *TSA* team approach has the advantage of potentially having the knowledge and understanding of a wide range of options for various aspects of *Forest Development*. In addition, working in a team helps to broaden the knowledge base of the individual team members.

Table 1 and Sections 6.1 – 6.4 summarize the common skill sets required to carry out all *TSAs*, as well as the minimum skill sets required to carry out specific types of *TSAs*. These specific types of *TSAs* are, in increasing order of complexity:

- *TSAs* for cutblocks and upslope hazards;
- *TSAs* for proposed road locations; and
- *TSAs* for road construction, maintenance, deactivation or reactivation.

Where downslope elements at risk include public safety, infrastructure or private property, skill sets beyond those required for typical *TSAs* are expected. Such skill sets could involve specialty services (see Section 4.11).

6.1 Skill Sets Common to All *TSAs*

The basic requirement for all *TSAs* is a Bachelor of Science or Bachelor of Applied Science, or the equivalent.

Besides the basic requirement, Column 1 of Table 1 indicates the other common skill sets required to carry out all *TSAs*.

Because *TSAs* are typically based on air photo interpretation and field observations of terrain features and soil exposures, terrain identification and field observation skills are very important. A *TSP* should be familiar with local resource materials and regulatory requirements relevant to terrain stability and natural hazards in the forest sector. For example: Ministry of Forests'

Technical Reports and Land Management Handbooks; Occupational Health and Safety regulations pertaining to landslides.

6.2 Type 1 – Skill Sets Specific to TSAs for Cutblocks and Upslope Hazards

In addition to the common skill sets addressed in Section 6.1, a *TSP* who carries out *TSAs* for cutblocks and upslope hazards should have the skill sets indicated in Column 2 of Table 1.

In addition, a *TSP* should be familiar with regional terrain conditions in the area, with the type of landslides that occur naturally or as a result of *Forest Development* in the region, and with the factors associated with *Forest Development*-related landslides. He/she should also be familiar with harvest and silvicultural systems and methods most commonly used in the region.

6.3 Type 2 – Skill Sets Specific to TSAs for Proposed Road Locations

In addition to the common skill sets addressed in Section 6.1, a *TSP* who carries out *TSAs* for proposed road locations should have the skill sets indicated in Column 4 of Table 1.

In addition, a *TSP* should understand typical access requirements for various silvicultural systems, and should be able to identify landform characteristics important for road performance and terrain response to road construction.

6.4 Type 3 – Skill Sets Specific to TSAs for Road Construction, Maintenance, Deactivation or Reactivation

In addition to the common skill sets addressed in Section 6.1, a *TSP* who carries out *TSAs* for road construction, maintenance, deactivation or reactivation should have the skill sets indicated in Column 4 of Table 1.

In addition, a *TSP* should understand forest road design; historic forest road stability issues and the factors that caused them; forest road construction methods; soil characteristics that affect the performance, stability and safety of the road, and limitations and relative costs of commonly used equipment. He/she should also be familiar with applicable regulatory requirements as well as standard operating procedures normally used in the *Licensee's* operation for road construction, maintenance, deactivation and reactivation.

Table 1 -- Skills Sets for TSAs

TSA Type				Skill Sets
All	**1**	**2**	**3**	
x	x	x	x	**1. Basic requirement: Bachelor of Science or Applied Science, or equivalent**
				2. Subject areas and equivalent level of knowledge
				2.1 Introductory university-level courses or technology program equivalents*
x	x	x	x	Terrain analysis/airphoto interpretation
x	x	x	x	Terrain stability assessments/geotechnics/risk analysis
x	x	x	x	Field geology/field surveying/field techniques
x	x	x	x	Soil science/soil physics
		x	x	Structural geology/rock mechanics
		x	x	Soil mechanics/slope stability analysis
				2.2 Introductory and Advanced university-level courses*
x	x	x	x	Geomorphology/landforms/surficial geology/Quaternary geology
x	x	x	x	Hydrogeology/groundwater geology
x	x	x	x	Hydrology/surface water/fluvial geomorphology***
x	x	x	x	Natural hazards/landslides/remedial measures
				2.3 General familiarity and understanding of subject matter
x	x	x	x	BC Terrain Classification System/terrain stability mapping classification for forestry
x	x	x	x	Biogeoclimatic Ecosystem Classification system (BEC)
x	x	x	x	Forest access planning/forest harvesting systems/silvicultural systems
x	x	x	x	GIS/CADD/cartography/digital information sources
				2.4 Familiarity and understanding of subject matter, specific to region
x	x	x	x	Vegetative indicators of soil/water relationships
x	x	x	x	Relationships among terrain, hydrology and meteorology.
x	x	x	x	Types and causes of landslides associated with forest development
x	x	x	x	Common road construction, harvesting and silvicultural systems
	x			Windthrow occurrence and influence on stability.
		x	x	Access requirements for silvicultural systems
		x	x	Landform characteristics and terrain response to road construction and performance
			x	Forest road design principles/water management/crossing structures.
			x	Methods of forest road construction/equipment types/licensee's SOP's
			x	Factors affecting workability/stability/performance of road fills and cutslopes.
			x	Relevant regulatory requirements for forest road assessment, design or construction.
				3. Field Experience
x	x	x	x	Typically a member with suitable experience would have three to five years experience relevant to terrain stability, with a strong field component, under the supervision or mentorship of a senior professional. At least one year related to field identification of terrain in the forest sector (or a similar resource sector) under the mentorship of a senior terrain stability or forest professional.
x	x	x	x	Field experience in the region to gain an understanding of regional terrain characteristics, forest development approaches and harvest systems used.
		x	x	Field experience with forest professionals who do forest road layout and prepare forest road designs
			x	Time spent on road construction or deactivation with grade foremen and operators both during and following construction.

TSA Type: **All**: Common to all TSAs **1**: TSAs for cutblocks and upslope terrain hazards **2**: TSAs for proposed road locations **3**: TSAs for road construction, maintenance, deactivation or reactivation

**Introductory*: Understanding of subject, typically gained in university-level introductory or technology program courses.
***Advanced*: Thorough knowledge of subject, typically gained in advanced university courses.
***Fluvial Geomorphology required when a *TSA* evaluates effects to stream channels.

7

REFERENCES

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