FOREST PRACTICES CODE

of

BRITISH COLUMBIA

Hazard Assessment Keys for Evaluating Site Sensitivity to Soil Degrading Processes Guidebook

Second edition
Version 2.1

March 1999

FOREST SERVICE BRITISH COLUMBIA

BRITISH COLUMBIA

BC Environment

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Preface

This guidebook has been prepared to help forest resource managers plan, prescribe and implement sound forest practices that comply with the Forest Practices Code.

Guidebooks are one of the four components of the Forest Practices Code. The others are the *Forest Practices Code of British Columbia Act*, the regulations, and the standards. The ***Forest Practices Code of British Columbia Act*** is the legislative umbrella authorizing the Code's other components. It enables the Code, establishes mandatory requirements for planning and forest practices, sets enforcement and penalty provisions, and specifies administrative arrangements. The **regulations** lay out the forest practices that apply province-wide. **Standards** may be established by the chief forester, where required, to expand on a regulation. Both regulations and standards are mandatory requirements under the Code.

Forest Practices Code guidebooks have been developed to support the regulations; however, only those portions of guidebooks cited in regulation are part of the legislation.

The *Hazard Assessment Keys for Evaluating Site Sensitivity on Soil Degrading Processes Guidebook* is referenced in the *Operational Planning Regulation* (OPR) and the *Woodlot License Forest Management Regulation* (WLFMR). These regulations require that the procedures to determine the risk of sediment delivery to streams, the soil compaction hazard, the soil displacement hazard and the soil erosion hazard are carried out in accordance with the procedures in the guidebook. The relevant sections of the guidebook that contain this information are **identified by a bar along the page margin labeled with the specific regulation being referenced, as well as a change in the text typeface.** They are as follows:

- the "Soil compaction and puddling key," the "Soil displacement key," and the "Soil erosion key" (pages 5, 8, 11-14); and
- the procedures listed under the heading "Risk of sediment delivery to streams" (page 15).

The recommendations that are not part of the cited portion of guidebooks are not mandatory requirements, but once a recommended practice is included in a plan, prescription or contract, it becomes legally enforceable. Except where referenced by regulation, guidebooks are not intended to provide a legal interpretation of the *Act* or regulations. In general, they describe procedures, practices and results that are consistent with the legislated requirements of the Code.

The information provided in each guidebook is intended to help users exercise their professional judgment in developing site-specific management strategies and prescriptions designed to accommodate resource management objectives. Some guidebook recommendations provide a range of options or outcomes considered to be acceptable under varying circumstances.

Where ranges are not specified, flexibility in the application of guidebook recommendations may be required, to adequately achieve land use and resource management objectives specified in higher-level plans. A recommended practice may also be modified when an alternative could provide better results for forest resource stewardship. The examples provided in many guidebooks are not intended to be definitive and should not be interpreted as being the only acceptable options.

Contents

*OPR = Operational Planning Regulation **WLFMR = Woodlot License Forest Management Regulation
*** THPR = Timber Harvesting Practices Regulation

Introduction

The three keys provided in this guidebook have been developed to help individuals assess the inherent sensitivity of a site to three major soil-degrading processes:

- **Soil compaction and puddling**
- **Soil displacement** (the exposure of unfavourable subsoil, or changes in slope hydrology)
- **Soil erosion** (the exposure of mineral soil)

Provided for each soil-degrading process are definitions, controlling site factors, management considerations and a hazard assessment key. Procedures for use of all three are the same throughout the province.

Also included are two tables: one providing information on the risk of sediment delivery to streams; and the other describing indicators of potential slope instability.

The *Hazard Assessment Keys for Evaluating Site Sensitivity to Soil Degrading Processes Guidebook* is cited in the Operational Planning Regulation and the Woodlot Licence Forest Management Regulation. These regulations require that soil compaction hazard, soil displacement hazard, soil erosion hazard and the risk of sediment delivery to streams must be determined in accordance with the procedures set out in this guidebook.

Legislated requirements

A person preparing a *silviculture prescription* must:

- determine the soil compaction, soil erosion and soil displacement hazards for areas where the proposed harvest method is other than cable or aerial;
- specify any indicators of potential slope instability if a terrain stability field assessment has not been carried out;
- if temporary access structures are being proposed, specify the depth to, and type of, unfavourable subsoil (if any) present; and
- if an excavated or bladed trail is being proposed in a community watershed, determine the risk of sediment delivery to streams.

Exceptions:
If trees will not be harvested on the area under the *silviculture prescription* (e.g., for backlog areas, areas where trees have been damaged by natural causes), the following applies:

- there is no need to specify the indicators of potential slope instability, risk of sediment delivery to streams or information on unfavourable subsoil; and

- if mechanical site preparation will not be used, and this is specified in the prescription, there is no requirement to determine soil hazards for the area.

For woodlot licence areas, a site plan must include, if required by the district manager:
- the results of any soil hazard assessments; and
- if an excavated or bladed trail is being proposed within a community watershed, the soil erosion hazard and risk of sediment delivery to streams.

A person preparing a *stand management prescription*, other than for a woodlot licence area, must:
- specify the soil compaction hazard for each treatment area where mechanical stand-tending treatments are proposed; and
- determine the hazards for soil erosion and soil displacement if trail building is associated with the mechanical stand-tending treatment.

For woodlot licence areas, a stand management prescription must include the hazard for soil compaction, if stand tending will be conducted using heavy equipment and soil disturbance will occupy more than 5% of the area to be treated.

Excavated and bladed trails cannot be constructed in an area *within a community watershed* unless assessments for the soil erosion hazard and risk of sediment delivery to streams have been carried out and the results of the assessments indicate that the area does not have:
- a high or very high soil erosion hazard; and
- a moderate, high or very high risk of sediment delivery to streams.

Pre-harvest data collection needs

Before standard units for silviculture prescriptions are delineated, site and soil data must be collected to characterize variability in site sensitivity to soil disturbance. The data required for conducting a hazard assessment are summarized below. If additional information is required on methods for collecting and interpreting data refer to the Silviculture Prescriptions Field Method Book - Interim Draft (Ministry of Forests, May 1997[1]), or consult with the Ministry of Forest's district earth scientist or regional soil scientist.

Data required for conducting a soil disturbance hazard assessment

Climatic information	• biogeoclimatic subzone/variant
Slope and terrain information	• slope gradient • slope length/uniformity • presence of slope instability indicators • presence of hummocky terrain
Site hydrology information	• gully spacing • soil moisture regime • occurrence/depth of seepage
Soil information	• forest floor depth and dominant horizon • soil texture and changes with depth • coarse fragment content (%) and changes with depth • depth to carbonates • depth to bedrock • depth to unfavourable subsoil • type of unfavourable subsoil • depth to water-restricting layer

The subsequent evaluation of mineral soil sensitivity to disturbance involves working through the three hazard assessment keys described in the following sections, one each for soil compaction and puddling, soil displacement and soil erosion.

Note on organic soils:
Organic soils, composed of >40 cm of wet organic material, or of peaty forest floors >40 cm thick, are particularly susceptible to rutting and puddling. The very low load-bearing strength of these materials means that they have a high soil displacement hazard and a very high soil compaction and puddling hazard. A soil erosion hazard rating, however, has not yet been developed for organic soils.

1 A final version of the Silviculture Prescriptions Field Method Book should be available by summer 1999.

Soil compaction and puddling hazard

Definitions

Soil compaction is the increase in soil bulk density that results from the rearrangement of soil particles in response to applied external forces.

Soil puddling is the destruction of soil structure and the associated loss of macroporosity that results from working the soil when wet.

Site factors determining hazards

- texture
- coarse fragments
- moisture regime
- forest floor H horizon $\geq$20 cm
- organic soil

Management considerations

- applied forces
  - equipment (ground pressure)
  - number of passes
- scheduling of operations
- scalping
- slope (adverse, favourable)
- frozen soil >15 cm deep
- compressible snow >1 m
- seasonal soil moisture content

The soil compaction and puddling hazard key derives a hazard rating from an assessment of how the load-bearing capacity of the soil is affected by the combined influences of soil texture, coarse fragment content, moisture regime, thickness of the forest floor H horizon, and soil type (mineral or organic).

Soil compaction and puddling hazard key

Operational Planning Regulation 1(1), 37(3)(a)(ii), 50(3)(g)(i) and Woodlot License Forest Management Regulation 1(1), 19(2)(c)

Use dominant soil texture and coarse fragment content of the upper 30 cm of mineral soil to assess compaction hazard. If a pronounced textural change occurs within the upper 30 cm (e.g., silty over sandy soil), then use the more limiting soil texture, providing it amounts to 5 cm of the top 30 cm.

Soil compaction and puddling hazard key

Soil texture[a] (0-30 cm)		**Hazard rating[b]** moisture regime	
		Xeric-subhygric[c] [c](H horizons <20 cm)	**Subhygric[d]-subhydric** [d](H horizons ≥20 cm)
Fragmental (coarse fragments >70%)		**L**	**M**
Coarse fragments (<70%)	Sandy S, LS	**L**	**VH[e]**
	Sandy loam SL, fSL	**M**	
	Silty/loamy SiL, Si, L	**H**	
	Clayey SCL, CL, SiCL, SC, SiC, C	**VH**	

a Soil texture abbreviations: S - sand; LS - loamy sand; CL -clay loam; SL - sandy loam; fSL - fine sandy loam*; C - clay; L - loam; Si - silt; SiC - silty clay; SiL - silt loam; SC - sandy clay; SCL - sandy clay loam; SiCL - silty clay loam
*For the purposes of this key, fSL, “fine sandy loam,” means the soil contains 30% or more fine or very fine sand, or more than 40% fine and very fine sand combined. Fine sand is 0.25-0.10 mm in diameter, very fine sand is 0.10-0.05 mm in diameter. These generally represent the limits of visible particles.

b L - Low; M - Moderate; H - High; VH - Very high.

c Use this column for subhygric sites with forest floor H horizons <20 cm thick.

d Use this column for subhygric sites with forest floor H horizons ≥20 cm thick.

e **Organic soils** composed of > 40 cm of wet organic material, or forest floors >40 cm (including Folisols <40 cm), are susceptible to rutting because their very low load-bearing strength materials make them easy to displace.

Soil displacement hazard

Definitions

Soil displacement is the mechanical movement of soil materials by equipment and logs. It involves excavation, scalping, exposure of underlying material and burial of surface soils. Soil displacement can result in soil degradation by:

- exposing unfavourable subsoils,
- redistributing and causing the loss of nutrients, and
- altering slope hydrology.

Close gully spacing occurs when there are two or more >2 m deep, sharp-edged gullies per 100 m along the contour. Gentler, rounder gullies are not a concern, since extra excavation would not be required to allow a bladed structure to cross such gullies. Note that the use of the term *gully* in this key should not be confused with the definition in the *Operational Planning Regulation* which is used when identifying gullies that may require special management measures and, if located on the coast, a gully assessment.

Hummocky terrain is broken terrain with small, but steep-sided knolls or ridges (e.g., eskers, rocky knobs and drumlins).

Unfavourable subsoils are those that produce unfavourable growing conditions when exposed by displacement. Unfavourable subsoils include:

- dense parent materials: compact glacial till, silt or clay-textured glaciolacustrine, or other soil parent materials that cannot be readily dug with a shovel (i.e., a pick or pulaski is required to loosen the materials before digging).
- dense, clayey Bt horizons: clay-enriched subsoils of Luvisols >5 cm thick and with clayey textures that cannot be readily dug with a shovel.
- sandy materials with sand or loamy sand texture: granular materials with a low content of silt and clay, and low water-holding and nutrient-storing capacity.
- fragmental materials: subsoils composed of >70% coarse fragments (i.e., fragments >2 mm diameter).
- soil layer containing appreciable calcium carbonate (lime), such that the soil particles <2 mm in diameter effervesce (fizz) when in contact with 10% HCl (muriatic acid). Coarse fragments in these calcareous soils may have white coatings, or there may be powdery white deposits in the soil.

Seepage needs to be considered only for subhygric, hygric and subhydric sites, as indicated by vegetation (site series). For these sites, typical depth of seepage should be estimated by observing it or the water table directly (and making allowances for recent weather and spring break-up), or by drawing inferences from such signs as soil colour (i.e., mottling and gleying).

Site factors determining hazards

- slope gradient
- slope complexity
- soil depth to:
  - bedrock
  - unfavourable subsoil
  - seepage
- soil chemistry
- carbonates (free lime)

Management considerations

- logging system
- ground versus cable
- equipment size
- use of snow
- skid road spacing, pattern and gradient
- site preparation
- depth of scalping

Soil displacement hazard key

Operational Planning Regulation 1(1), 37(3)(a)(ii), 50(3)(g)(iii)(A) and Woodlot License Forest Management Regulation 1(1), 19(2)(c)

To apply the soil displacement hazard key, add the points accumulated for slope gradient, slope complexity (gullied and/or hummocky terrain), and subsoil conditions (as shown in the three tables on next page). The total determines the rating.

Operational Planning Regulation 1(1), 37(3)(a)(ii), 50(3)(g)(iii)(A) and Woodlot License Forest Management Regulation 1(1), 19(2)(c) continued

Soil displacement hazard key

*Slope gradient**

Slope gradient (%)	Points	Slope gradient (%)	Points
0	**0**	40	**6**
5	**1**	45	**8**
10	**1**	50	**10**
15	**2**	55	**12**
20	**3**	60	**16**
25	**3**	65	**20**
30	**4**	70	**26**
35	**5**	75	**32**

Slope complexity

Terrain feature	Slope gradient (%)	Points
Close gully spacing: (two or more >2 m deep, sharp-edged gullies occur per 100 m along the contour)	<30%	**2**
	30-45%	**4**
	>45%	**6**
Hummocky terrain: (broken terrain with small, but steep-sided knolls or ridges, [e.g., eskers, rocky knobs and drumlins])		**2**

Subsoil conditions

Depth should be measured from the bottom of the LFH to the unfavourable subsoil, bedrock, seepage, or carbonates (**points**)	<30 cm **12**	30-60 cm **8**	61-90 cm **4**	>90 cm **0**

Soil displacement hazard rating: (point total)			
Low <7	**Moderate** 7-14	**High** 15-24	**Very high** >24

Organic soil

Organic soils composed of ≥40 cm of wet, organic materials:	**High**
Forest floors over bedrock or skeletal materials (e.g., Folisols):	**Very high**

* Use average slope to determine rating, but also consider the upper end of the slope range in formulating prescriptions.

Soil erosion hazard (exposed mineral soil)

Definitions

Soil erosion is the wearing away of the earth's surface by water and wind. It includes splash, rill and gully erosion. "Accelerated" erosion is that which is caused by human activities, and that results in more than just geological erosion. It causes both on-site impacts (soil loss, nutrient loss, lower productivity) and off-site impacts (reduced water quality, increased sedimentation, loss of habitat).

Precipitation factors are integrated measures of precipitation type, frequency, and intensity and duration, determined for each biogeoclimatic subzone/variant in the province. (Select the appropriate class from the regional precipitation factors tables that follow the key.)

Short slopes are those with <150 m of unbroken slope length between level or adverse slopes that will impede the continued flow of water.

Long slopes are those with >150 m of unbroken slope length between level or adverse slopes that will impede the continued flow of water.

Broken slopes are variable, complex or benched slopes.

Water-restricting layer refers to any impermeable, dense layer that restricts the downward flow of water, but does not necessarily impede root growth. It can be compact or cemented layers, bedrock or the permanent water table.

Site factors determining hazards

- climate (precipitation factor)
  - rain intensity/duration
  - snowmelt
- topography
  - slope gradient
  - slope length
  - slope uniformity
- soil properties
  - texture
  - structure
  - coarse fragments
  - water-restricting layers

Management considerations

- logging system
  - ground based, cable or helicopter
  - degree of log suspension, resulting disturbance
- extent of forest floor removal
- road system
- site preparation
- drainage control, erosion control measures
- soil moisture during operations

Soil erosion hazard key

The soil erosion hazard key rates the susceptibility of exposed soil to water erosion (i.e., when protective vegetation, forest floor and slash are removed). Erosion of forest soils remains low when surface organic layers are intact. After mineral soil is exposed, rates of erosion are initially high and then decline after the first year. Therefore, to be effective, erosion control measures must be applied promptly.

Operational Planning Regulation 1(1), 37(3)(a)(ii), 50(3)(g)(iii)(A) and Woodlot License Forest Management Regulation 1(1), 19(2)(h)(iv), 60(6) and Timber Harvesting Practices Regulation 7(4)

To apply the soil erosion hazard key, add the points accumulated for the seven site factors. The total determines the rating.

Note:

- **The soil erosion hazard key is designed for determining the erosion hazard of surface soils exposed in cutblocks by harvesting activities, especially skidding. It is not designed for predicting erosion from roads and ditches, where the subsoil is exposed.**

- The soil erosion rating has not been developed for organic soils.

Operational Planning Regulation 1(1), 37(3)(a)(ii), 50(3)(g)(iii)(A) and Woodlot License Forest Management Regulation 1(1), 19(2)(h)(iv), 60(6) and Timber Harvesting Practices Regulation 7(4) continued

Soil erosion hazard key

Site factors	Degree of contribution of factors			
	Low	**Moderate**	**High**	**Very high**
Climate precipitation factor **(points)**	low **2**	moderate **4**	high **6**	very high **8**
Topography slope gradient (%) **(points)** length/uniformity **(points)**	0-10 **1** short broken **1**	11-20 **3** short uniform **2**	21-50 **6** long broken **3**	>50 **9** long uniform **4**
Depth to water-restricting layer (cm) **(points)**	>90 **1**	61-90 **2**	30-60 **3**	<30 **4**
Surface soil detachability (0-15 cm)[a] **(points)**	SC,C,SiC **1**	SiCL,CL,SCL **2**	SL,L **4**	Si,SiL,fSL,LS,S **8**
Surface coarse fragments (0-15 cm)[a] **(points)**	>60 **1**	31-60 **2**	16-30 **3**	<16 **4**
Subsoil permeability (16-60 cm)[a] texture **(points)**	S,LS,SL,fSL **1**	L,SiL,Si **2**	CL,SCL,SiCL **3**	C,SC,SiC **4**

Soil erosion hazard rating[b]	**Low**	**Moderate**	**High**	**Very high**
(point total)	**<16**	**16-22**	**23-31**	**>31**

a If two contrasting textures or coarse fragment contents occur in the depth, use the one with the highest point rating.

b Gently sloping areas with long, uniform slopes may rate as high soil erosion hazard. The reason is that substantial erosion can occur on these sites given the right conditions.

Precipitation factors for biogeoclimatic subzones by forest region.

Operational Planning
Regulation 1(1),
37(3)(a)(ii),
50(3)(g)(iii)(A)
and
Woodlot License Forest
Management Regulation
1(1), 19(2)(h)(iv), 60(6)
and
Timber Harvesting
Practices Regulation 7(4)

Cariboo forest region: Precipitation factors

Low	Moderate	High	Very high
all BG PPxh			
IDFxm IDFxw IDFdk	IDFmw		
MSxk	MSxc		
SBSdw SBSmc*	SBSmh SBSmc* SBSmw SBSwk		
SBPSxc SBPSdc	SBPSmc SBPSmk		
ESSFxv	ESSFwk*	ESSFwc ESSFwk*	
ICHdk	ICHmk ICHwk*	ICHwk*	

* These subzones/variants encompass two precipitation factor ranges. Use local experience in deciding the appropriate precipitation factor to apply in the keys.

Kamloops forest region: Precipitation factors

Low	Moderate	High	Very high
all BG PPxh			
IDFxh IDFxw IDFdk IDFdm	IDFmw IDFww		
MSxk	MSdc MSdm MSmm		
SBSdh SBSdw	SBSmm		
SBPSmk			
ESSFxc	ESSFdc ESSFdv	ESSFwc ESSFmw	ESSFvc ESSFvv
	ICHmk ICHmw	ICHwk	ICHvk
		CWHds CWHms	

Operational Planning Regulation 1(1), 37(3)(a)(ii), 50(3)(g)(iii)(A) and Woodlot License Forest Management Regulation 1(1), 19(2)(h)(iv), 60(6) and Timber Harvesting Practices Regulation 7(4) continued

Nelson forest region: Precipitation factors

Low	Moderate	High	Very high
PPdh1 PPdh2			
IDFdm1 IDFdm2 IDFun IDFxh1			
	MSdk MSdm1		
	ESSFdc1 ESSFdk	ESSFwc1 ESSFwc2 ESSFwc4 ESSFwm	ESSFvc
	ICHdw ICHmk1 ICHmw1 ICHmw2 ICHmw3 ICHxw	ICHwk1	ICHvk1

Prince George forest region: Precipitation factors

Low	Moderate	High	Very high
SBSdh SBSdk SBSdw SBSmk1 SBSmc*	SBSmh SBSwk SBSmw SBSmk2 SBSmc*	SBSvk	
BWBSdk BWBSmw2 BWBSwc3	 BWBSmw1 BWBSwc1&2		
	ESSFmm ESSFmv ESSFwk*	ESSFwc ESSFwk*	ESSFvc
	all SWB		
	ICHmc ICHmm ICHwk*	ICHvk ICHwk*	

* These subzones/variants encompass two precipitation factor ranges. Use local experience in deciding the appropriate precipitation factor to apply in the keys.

Operational Planning Regulation 1(1), 37(3)(a)(ii), 50(3)(g)(iii)(A) and Woodlot License Forest Management Regulation 1(1), 19(2)(h)(iv), 60(6) and Timber Harvesting Practices Regulation 7(4) continued

Prince Rupert forest region: Precipitation factors

Low	Moderate	High	Very high
SBSdk SBSmc*	SBSmc*		
SBPSmc			
BWBSdk2 BWBSmw2			
	ESSFmc ESSFmk	ESSFwv	
	all SWB		
	ICHmc	ICHvc	
			CWHws1&2
			MHm

* These subzones/variants encompass two precipitation factor ranges. Use local experience in deciding the appropriate precipitation factor to apply in the keys.

Vancouver forest region: Precipitation factors

Low	Moderate	High	Very high
	all CDF		
	IDFww		
		CWHxm CWHds1 CWHms1 CWHwh1	
		ESSFmw	
			CWHdm CWHds2
			MHmm1,2
			CWHvh1, vh2 CWHvm1,vm2 CWHmm1 CWHmm2 CWHms2 CWHwh2 CWHws2
			MHwh

Risk of sediment delivery to streams

Operational Planning Regulation 1(1), 37(3)(a)(v) and Woodlot License Forest Management Regulation 1(1), 19(2)(h)(iv), 60(6) and Timber Harvesting Practices Regulation 7(4)

This rating system should be used where there is a requirement to evaluate the risk of sediment delivery to streams. For example, both the soil erosion hazard and the risk of sediment delivery must be evaluated when one is assessing whether it is acceptable or not to construct an excavated trail within a community watershed.

This table is a sample classification and is intended to illustrate, by example only, how slope and proximity to a stream can interact to affect the likelihood of sediment delivery. Other factors such as slope shape and soil permeability should also be considered. The rating for a specific site will not strictly follow these guidelines. Modifications may be necessary to suit local conditions.

Risk of sediment delivery to streams	Proximity of stream channel to cutblock or standards unit (SU)		
	No stream channel in or adjacent to cutblock or SU	Minor stream* channel in or adjacent to cutblock or SU	Major stream** channel in or adjacent to cutblock or SU
Very Low	Gentle to Steep slope		
Low		Gentle slope	
Moderate		Moderate slope	Gentle slope
High		Steep slope	Moderate slope
Very High			Steep slope
	Slope steepness downslope from cutblock or SU to stream channel		

* Minor streams are those perennial streams with channel widths that are less than or equal to 1.5m, or any ephemeral stream.

** Major streams are perennial streams with channel widths that are greater than 1.5m.

Note: Perennial streams are defined in this guidebook as any stream where it is reasonably likely that the stream flows after July 15 (during the summer period) in most years.

Indicators of potential slope instability[2]

The following list of slope instability indicators must be used during data collection for silviculture prescriptions if a terrain stability field assessment has not been carried out for the area. These indicators must be recorded because, depending on the scale of the initial terrain stability mapping, certain features may have been missed. In heavily forested terrain, some active slope instability features may be obscured on airphotos and not identified during limited field checking. In addition, because of the initial mapping scale, smaller unstable sections of land cannot be mapped.

If indicators of potential slope instability are identified in a cutblock during data collection, a terrain stability field assessment must be carried out.

[2] Modified from: Land Management Handbook 18 (1994). Chatwin, S.C., D.E. Howes, J.W. Schwab, and D.N. Swantson. Crown Publications Inc. 546 Yates Street, Victoria, B.C. V8N 1K8.

Field indicators	Potential landslide type
• recent landslide scars • revegetated landslide scars	• high likelihood of land slides of the same type and size
• partially revegetated strips (may also be snow avalanche tracks) • jack-strawed trees (trees tilted in various directions) • linear strips of even-aged timber • landslide debris piled on lower slopes • soil and rocks piled on the upslope side of trees • pistol butt (recurved) trees (may also indicate snow creep) • mixed or buried soil profiles • poorly developed soils relative to other comparable slopes • tension fractures • poorly drained or gullied*, fine-textured materials <3 m deep on slopes >50% • poorly drained or gullied* coarse-textured materials on slopes >50% • wet site vegetation on slopes >50% • shallow, linear depressions • shallow, wet, organic soils on slopes >40%	• debris avalanches • debris flows (debris torrents) • debris slides
• recently scoured gullies* • exposed soil on gully sides* • debris piles at the mouths of gullies* • vegetation in gully much younger than the adjacent forest • poorly developed soils on gully sides relative to adjacent slopes (because repeated shallow failures continually remove the developed soil profile)	• debris flows (debris torrents) • debris slides

* Apply the *Gully Assessment Procedure Guidebook* to any gullied areas on the Coast.

Field indicators	Potential landslide type
• tension fractures • curved depressions • numerous springs at toe of slope, sag ponds • step-like benches or small scarps • bulges in road • displaced stream channels • jack-strawed trees (trees tilted in various directions), split trees • poorly drained medium- to fine-textured materials (e.g., till, lacustrine, marine and some glaciofluvial deposits) >3 m deep • mixed or buried soil profiles • ridged marine deposits	• slumps • earthflows
• talus or scattered boulders at base of slope • rock faces with freshly exposed rock • steeply dipping, bedrock discontinuities (bedding planes, joints or fracture surfaces, faults) that parallel the slope • bedrock joint or fracture surface intersections that dip steeply out of the slope	• rock slides or rock fall (can be induced by excavation and blasting for roads)

* Apply the *Gully Assessment Procedure Guidebook* to any gullied areas on the Coast.