FOREST PRACTICES CODE

of

BRITISH COLUMBIA

Soil Conservation Surveys Guidebook

2nd Edition
May 2001

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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, where required and established under the Code, must be followed.

Forest Practices Code guidebooks have been developed to support the regulations, but are not part of the legislation. The recommendations in the guidebooks are not mandatory requirements, but once a recommended practice is included in a plan, prescription, or contract, it becomes legally enforceable. 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 to help users exercise their professional judgement in developing site-specific management strategies and prescriptions to accommodate resource management objectives. Some guidebook recommendations provide a range of options or outcomes considered 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 the only acceptable options.

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1 Introduction

Soil conservation is a key component in the *Forest Practices Code of British Columbia Act.* This guidebook describes procedures for measuring disturbance to soil caused by forest practices.

The first part of this guidebook provides an overview of post-harvest and post-treatment inspection procedures. The section discusses how soil conservation requirements have changed, and describes generally how disturbance on access structures and in the net area to be reforested (NAR) should be measured.

The second part of the guidebook provides the current requirements and definitions that apply to soil conservation surveys.

The third part of the guidebook describes how soil conservation surveys should be carried out. It details the requirements for visual inspections, road traverse surveys, landing surveys, and transect surveys for small and large areas. Also described are how survey points established during transect surveys are classified.

Appendix 1 provides the requirements and definitions that apply to prescriptions that were approved under the Forest Practices Code (Code) before June 15, 1998. Appendix 2 outlines the sequence used for classifying survey points, Appendix 3 presents a random number table, Appendix 4 shows a table of grid spacings for the transect survey method for large areas, Appendix 5 describes field marking conventions, Appendix 6 contains the forms to be used in conducting soil conservation surveys, and Appendix 7 presents the recommended limits of soil disturbance for coastal and interior sites.

2 Overview of post-harvest and post-treatment soil inspection procedures

Important aspects of soil conservation are the inspections carried out to check that detrimental impacts to forest soils are being minimized. This section of the guidebook outlines survey procedures appropriate for given situations.

Soil conservation surveys examine:

- the proportion of the prescription area occupied by access structures,
- the amount of soil disturbance within the net area to be reforested (NAR), and
- the amount of forest floor displacement within the NAR.[1]

Pre-harvest silviculture prescriptions, silviculture prescriptions and stand management prescriptions set maximum limits for some or all, three of these factors. The limits depend on the standards in effect when the particular prescription was approved. Compliance surveys can be conducted for each factor.

2.1 Different soil conservation requirements over time

A number of significant changes to soil conservation requirements have been introduced over the years. Before any soil conservation survey is undertaken, the first step is to determine what soil conservation requirements were specified and what definitions apply. **Each soil conservation survey must be based on the standards specified in the prescription and must use the definitions in place when the prescription was approved.**

In the time prior to full Forest Practices Code compliance, there are three periods during which different soil conservation requirements and different definitions applied to prescriptions. (Requirements and definitions for these periods can be found in the first edition of the *Soil Conservation Surveys Guidebook* [1997]).

Since the Code was introduced, there have continued to be some changes, including the elimination of requirements to specify limits for forest floor displacement and forest floor reduction, and modification of how limits for temporary access structures are specified. A further description of these changes is provided in Appendix 1.

[1] Although specifying limits for forest floor displacement is no longer required for silviculture prescriptions approved under current legislation. It is a requirement on Code prescriptions approved before June 15, 1998.

In addition, soil conservation requirements for areas under woodlot licences have also undergone some changes and can be different from those of other tenures. These are discussed in a later section in this guidebook entitled "Woodlot licence area requirements."

Unless otherwise specified, the following sections of this guidebook provide the soil conservation requirements and definitions of the regulations and *Act* in effect at the time of this guidebook's publication.

Under the current requirements, silviculture prescriptions must specify:

- the maximum percentage of the total area under the prescription that may be occupied by permanent access structures;
- the maximum percentage of the NAR that may be occupied by soil disturbance; and
- the extent to which the maximum percentage of soil disturbance in the NAR can be temporarily exceeded to construct temporary access structures.

2.2 Requirement for soil conservation surveys

Soil conservation compliance reports are required in all areas where the government must establish a free-growing stand (in keeping with the Silviculture Practices Regulation). The district manager must complete a report that states the extent to which an area under a silviculture prescription is in compliance with the allowable limits prescribed for the area that may be occupied by permanent access structures and the amount of soil disturbance.

An assessment should be in the form of a visual inspection to confirm that the maximum limits in the prescription have not been exceeded. **No formal survey measurements need to be done, unless it is apparent that the limits may have been exceeded.**

For major licensees, soil conservation surveys are not mandatory. However, if visual inspections indicate that their operations may be in non-compliance, the district manager, in accordance with the Silviculture Practices Regulation, can direct the licensees to conduct surveys. The purpose of these surveys is to inspect a) the nature and extent of the total area under the silviculture prescription occupied by permanent access structures, and b) soil disturbance in the NAR, including temporary access structures.

2.3 Measuring the area occupied by permanent access structures

Silviculture prescriptions must specify the maximum percentage of the total area under the plan that can be occupied by permanent access structures (e.g. permanent haul roads, landings, gravel pits, borrow pits, and permanent logging trails). The types and definitions of access structures that count towards the maximum percentage in the prescription have changed over time, but the field measurement procedures are very similar.

Assessment of access structures begins with visual inspection. Where problems appear, a more detailed road and landing survey procedure is used to determine the percentage of the area occupied by permanent access structures.

2.4 Measuring soil disturbance

Maximum soil disturbance limits are specified in a prescription by standards unit. For each standards unit, the prescription should state the assessed hazards for soil compaction, soil displacement, and soil erosion, and indicate the likelihood of landslides (if detailed terrain stability mapping has been done). The assessed hazards should be used to determine:

- the maximum amount of soil disturbance allowed within a standards unit; and
- which types of soil disturbance to count in each standards unit (see the summary table in Appendix 7).

When a person is checking for compliance, it is important to know both of these factors. Separate strata must be used when surveying standards units that have different maximum limits or different categories of soil disturbance that count.

Where the method of timber harvesting is cable or aerial, it is not necessary to specify the soil hazards, only the likelihood of landslides (if warranted). **Where soil hazards have not been assessed, compacted areas and all categories of dispersed disturbance must be counted as soil disturbance** (i.e., those categories normally counted only on more sensitive sites).

Measuring soil disturbance begins with a visual inspection. Where disturbance appears to exceed the limits set out in the silviculture prescription, a transect survey may be required to determine the percentage of the area occupied by soil disturbance.

Transect surveys classify survey points along transect lines. Survey points are classified based on the soil conditions observed at and around each point.

In some cases, surveys may be conducted on strata that are smaller than the standards unit. The procedures and criteria for site stratification are discussed in the section “Survey methods for soil disturbance – Site stratification.”

3 Definitions and requirements

3.1 Access structures

Access structures located within a cutblock are identified as either permanent or temporary in a silviculture prescription.

Permanent access structures include main haul roads, spur roads, landings, gravel pits, borrow pits, quarries, and permanent logging trails that are built within the total area under the prescription. To be classified as permanent in a prescription, they must satisfy one of the following conditions: a) they must be in use for a long enough period such that, even if they were to be rehabilitated, a commercial crop of trees could not be established on the area occupied by these structures by the time a commercial crop is established on an adjacent area of the cutblock; or b) they must be constructed through soil or rock or ballasted with material that would make them unsuitable for rehabilitation. Such structures are not part of the net area to be reforested (NAR) and do not count towards soil disturbance.

Temporary access structures include roads, landings, pits or quarries, excavated or bladed trails, main skid trails, backspar trails, corduroyed trails, and similar structures within the NAR that are identified as being temporary in a silviculture prescription. Such structures count towards soil disturbance unless they have been rehabilitated. (See "Soil disturbance requiring rehabilitation," below.)

3.2 Soil disturbance

Soil disturbance is a general term referring to the following types of disturbance that occur on the NAR:

- unrehabilitated temporary access structures, including excavated or bladed trails of a temporary nature,
- corduroyed trails,
- compacted areas, and
- dispersed disturbance.

Dispersed disturbance is itself a general term referring to dispersed trails, gouges, and scalps. *Dispersed trails* include wheel and track ruts (normally created during the operation of ground-based equipment on wet soils of limited load-bearing strength) and compaction from repeated machine traffic. *Gouges* are subdivided into deep gouges, wide gouges, and long gouges. *Scalps* are divided into wide scalps and very wide scalps.

Some types of disturbance, such as wide scalps and repeated machine traffic, count as soil disturbance only on more sensitive sites.

When soil disturbance is being assessed, it is necessary first to determine which types of soil disturbance will count on the standards unit and which measurement criteria will be appropriate for each disturbance type.

3.3 Soil disturbance requiring rehabilitation

Temporary access structures (including excavated or bladed trails of a temporary nature), compacted areas, and corduroyed trails require rehabilitation, unless exempted by the district manager. If they are not rehabilitated in accordance with the requirements of the regulations, they count as soil disturbance. (Once satisfactorily rehabilitated, they no longer count as soil disturbance.) Survey symbols for bladed trails and similar structures are shown in Table 1.

Soil conservation surveys can be done before these structures are rehabilitated, with the objective of determining the percentage of the NAR occupied by temporary access. Normally, however, soil conservation surveys are conducted after rehabilitation is complete.

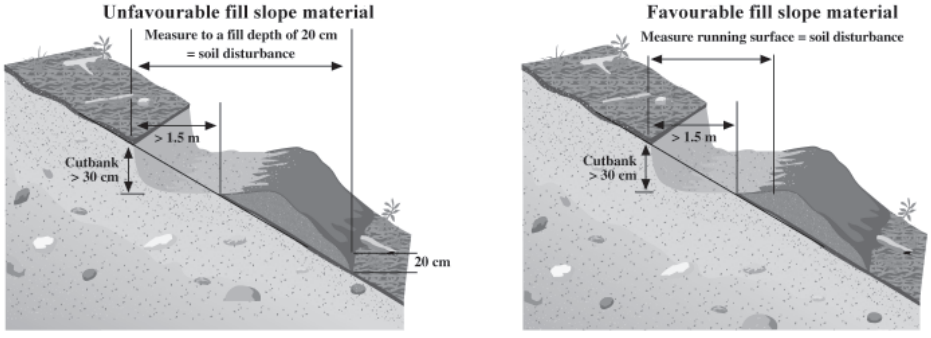
Table 1. Soil disturbance categories requiring rehabilitation[a]

Symbol[b]	Category	Example
R	Excavated/bladed trails	Contour-built skid roads that have not been rehabilitated
Y	Corduroyed trails	Skid trails or backspar trails that have been ballasted with logs
A	Compacted areas	Junctions of skid trails and excessively compacted roadside work areas

[a] These categories require rehabilitation unless exempted by the district manager.

[b] These one-letter symbols are used to record a category of disturbance when conducting a survey.

3.3.1 Excavated or bladed trails (R)



Excavated or bladed trails are constructed trails that have:

- a mineral soil cutbank height greater than 30 cm, and
- an excavated width greater than 1.5 m.

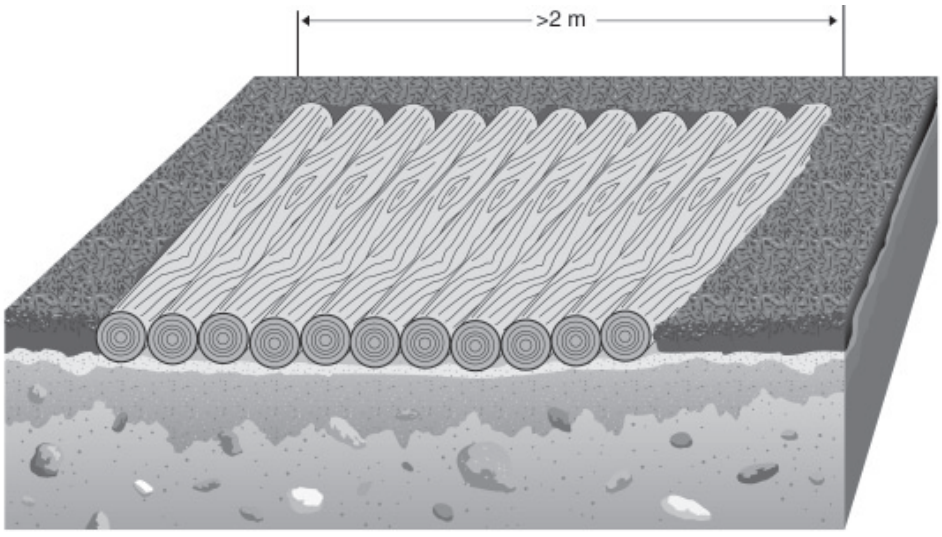
The classification of soil disturbance on excavated and bladed trails depends on whether fill slopes are considered a favourable or unfavourable medium for growing trees. (If this is not stated in the silviculture prescription, the section on fill slope soil material in the *Soil Conservation Guidebook* should be consulted.)

- If fill slopes are unfavourable: Classify survey points as soil disturbance (R) if they fall on the trail between the place where the sidecast is consistently greater than 20 cm deep and the top of the cut. Do not count as part of the sidecast any accumulations of slash that are clean woody debris (i.e., those that contain less than 30% mineral soil).
- If fill slopes are favourable: Classify survey points as soil disturbance (R) if they fall on the trail between the top of the cut to the outside edge of the compacted running surface. If the running surface is not compacted (e.g., on a winter trail), then include only survey points that fall within the excavated width.

If excavated or bladed trails have been satisfactorily rehabilitated, the exposed mineral soil surface associated with the trail does not count as soil disturbance. The exception is if the trail is under a woodlot site plan (as discussed in the section "Woodlot licence area requirements.")

Unrehabilitated excavated or bladed trails that are not identified as permanent logging trails in a silviculture prescription must be counted as soil disturbance on all sites.

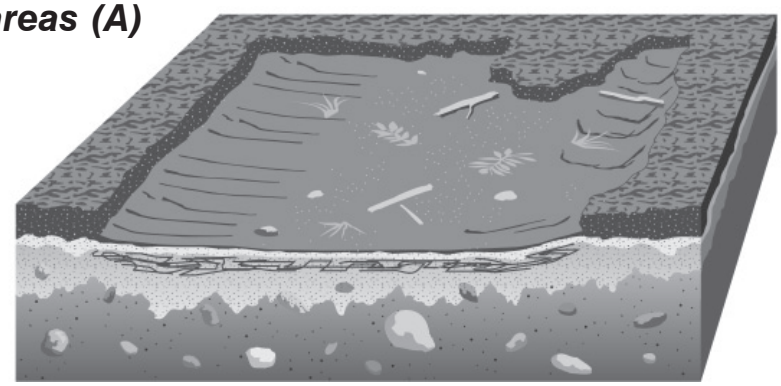
3.3.2 Corduroyed trails (Y)



Corduroyed trails are constructed using logs and woody debris placed side by side to form a surface greater than 2 m in length and capable of supporting equipment traffic. Tree tops and limbs placed in front of harvesting equipment to distribute machine load and reduce soil compaction should not be considered as corduroyed trails, unless the debris prevents the establishment of regeneration at close to the approved target stocking standards. If satisfactorily rehabilitated, a corduroyed trail does not count as soil disturbance.

Unrehabilitated corduroyed trails must be counted as soil disturbance on all sites.

3.3.3 Compacted areas (A)



Compacted areas are areas on which there is evidence of compaction at the survey point and on 100% of a portion that is both greater than 100 m^2 in area and greater than 5 m wide.

Assessing compaction

Any of these conditions is considered to be compacted soil: compacted mineral soil, puddled mineral soil, and compacted deposits of slash and organic debris.

Mineral soil compaction is assessed relative to the conditions of adjacent undisturbed soil. Any one of the following defines a compacted condition:

- Coarse platy structure.

  The soil breaks apart in consolidated plates that are typically 1 cm or greater in thickness. This structure is not evident in the adjacent undisturbed soil.

- Loss of the normal structure evident in the undisturbed soil.
- A noticeable change in density. If the disturbed and undisturbed soils have the same moisture content, their difference in density may be recognized by:
  - a difference in resistance when a shovel is used to penetrate the soils, or
  - a difference in resistance when blocks of soil 2.5 cm thick are crushed between the thumb and index finger.

- Compacted deposits of forest floor, fine slash, and woody debris, overlaying and partially imbedded in, or crushed into, the mineral soil that cannot be readily excavated with a shovel (e.g., deposits of compacted and cribbed-in slash on winter skid trails that are deeper than 20 cm). Compaction of mineral soil occurs when accumulations of slash and woody debris are compacted and pressed into the mineral soil by repeated heavy machine traffic. Often the overlying accumulations are difficult to dig through or separate with a shovel; however, it may be necessary to sample the underlying mineral soil for evidence of compaction (in accordance with the three previous points), if there is any doubt about impacts to the soil.

Unrehabilitated compacted areas are counted as soil disturbance on all sites except those with low compaction hazard. Where the compaction hazard has not been assessed, compacted areas are always counted as soil disturbance.

3.4 Dispersed disturbance

The dispersed disturbance categories and symbols are shown in Table 2.

Note that while all the descriptions provided in this section are contained in the Operational Planning Regulation, the regulation does not identify the specific categories by the reference names used here (e.g., the term "repeated machine traffic" is not specified in the regulation, but the description of this category does fall under the definition of a dispersed trail).

Table 2. Dispersed disturbance categories

Symbol[a]	Category	Example
T	Wheel or track ruts	Machine traffic on wet soils
E	Repeated machine traffic	Skid trails
G	Deep gouges	Mound excavations
L	Long gouges	Excessive ripper-plow trenches, poor mounding
W	Wide gouges	Poor screefing, mounding, or stumping; intermittent trail blading
V	Very wide scalps	Scalping during piling, scalping on skid trails, areas where the forest floor has been completely burned off
S	Wide scalps	Aggressive patch scarification scalping during piling, or on skid trails
–	Not counted (undisturbed, etc.)	Survey points not meeting the criteria of categories above, or that fall on large logs, boulders, or slash piles where the ground surface cannot be seen and reliable assessment cannot be made
X	Not surveyed	Points that fall outside the NAR (e.g., on a permanent landing)

[a] These one-letter symbols should be used in field surveys to record soil disturbance.

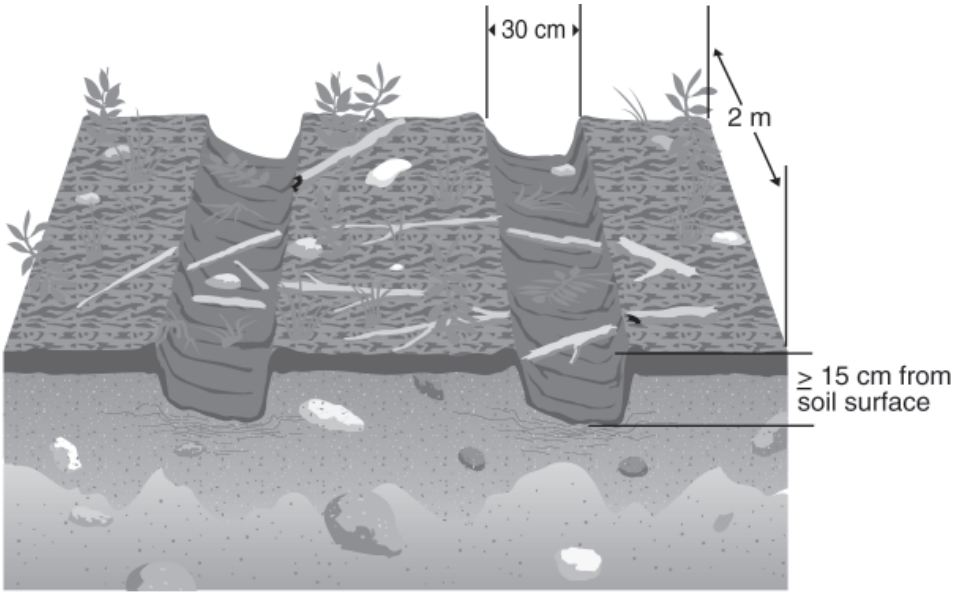
3.4.1 Dispersed trail: wheel or track ruts (T)

Wheel or track ruts are impressions or ruts in the soil caused by heavy equipment traffic. They are at least 30 cm wide and 2 m long. Two different depth criteria (5 cm and 15 cm) apply, depending on the compaction hazard of the standards unit being assessed. On sites with a high or very high compaction hazard, or where the compaction hazard has not been assessed, both depth criteria apply. On sites with a moderate or low compaction hazard, only the 15 cm depth criterion applies. This category does not require the survey point to be assessed for evidence of compaction.

Ruts 15 cm deep

Ruts must have a minimum depth of 15 cm at the deepest point in the perpendicular cross-section, over the entire length of 2 m. Depth is measured from the surface of the undisturbed forest floor to either the forest floor surface in the bottom of the rut or the mineral soil surface in the bottom of the rut if a forest floor is not present.

- For areas of organic soil within cutblocks, measure 15 cm from the undisturbed organic soil surface to the surface in the bottom of the rut (Figure 1).

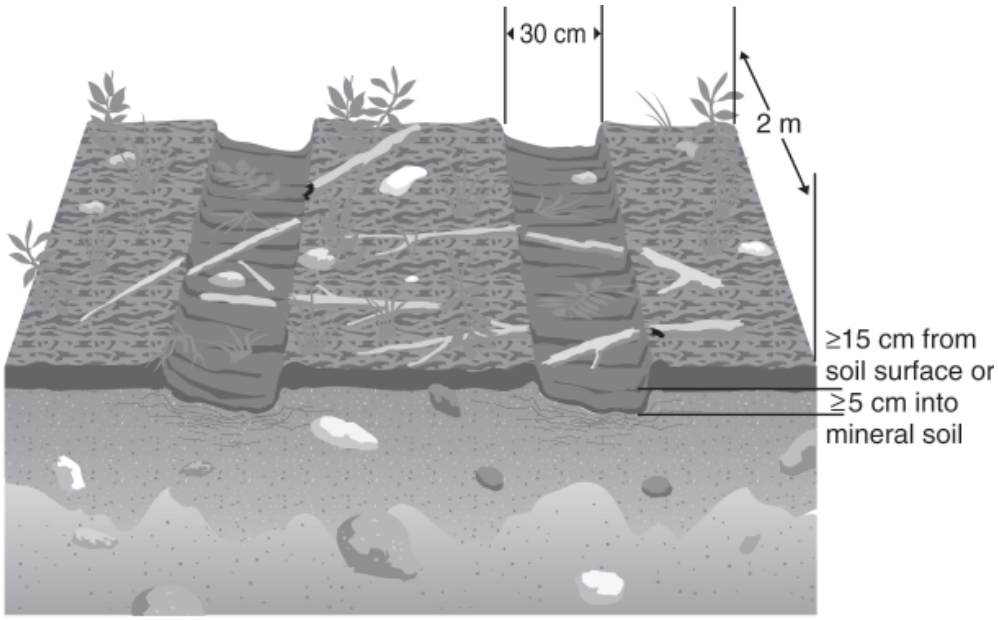


Wheel or track ruts 15 cm deep are counted as soil disturbance on all sites.

Ruts 5 cm deep

On sites with high or very high compaction hazard, both 15-cm-deep ruts and ruts at least 5 cm deep into mineral soil should be counted. Depth is measured from the surface of the undisturbed mineral soil to the mineral soil surface in the bottom of the rut, ignoring any forest floor that may be in the rut.

⇒ Measure at the deepest point in the perpendicular cross-section over the entire length of 2 m (Figure 1).



Wheel or track ruts 5 cm deep are counted as soil disturbance on sites with high or very high soil compaction hazard or where compaction hazard has not been assessed.

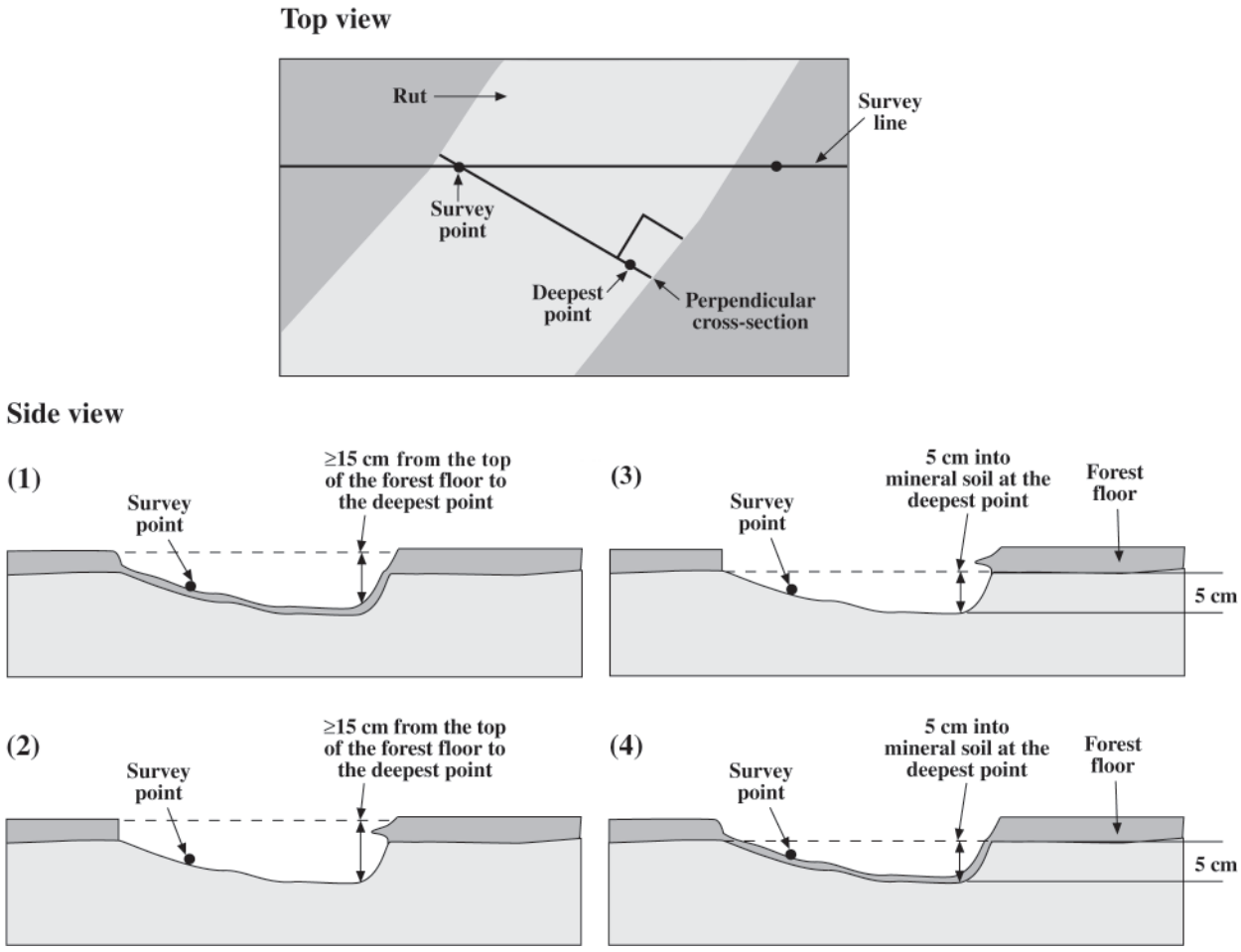


Figure 1. Depth assessment of wheel or track ruts.

Top view: The depth assessment for wheel or track ruts uses the deepest point in the perpendicular cross-section of the rut, not the depth exactly at the survey point, as is the case for most other disturbances.

Side view:

(1) On all sites, ruts can be assessed using the depth of 15 cm from the surface of the undisturbed forest floor to the top of the forest floor in the rut.

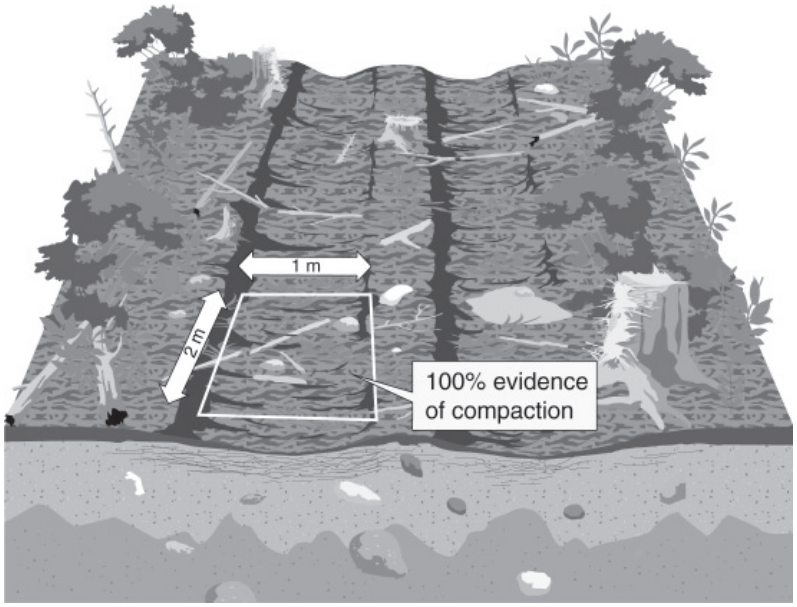
(2) Where forest floor is not present in the rut, measure at least 15 cm from the top of the undisturbed forest floor to the mineral soil surface in the rut.

(3) For sites with very high or high soil compaction hazard or where the compaction hazard has not been assessed, measure at least 5 cm from the surface of the undisturbed mineral soil to the mineral soil surface in the bottom of the rut. The mineral soil itself must be depressed 5 cm.

(4) When assessing 5-cm-deep ruts into mineral soil, gently brush aside any forest floor if it is present in the bottom of the rut, and measure to the mineral soil surface in the bottom of the rut.

3.4.2 Dispersed trail: repeated machine traffic (E)

The category *repeated machine traffic* describes disturbance resulting from repeated heavy machine traffic. Such disturbance is typically found on repeatedly used skid trails, which are obvious linear features. It may also occur on heavy traffic areas associated with roadside work areas and around piles constructed by windrowing or piling slash. This disturbance rarely occurs on moderate compaction hazard soils logged under dry conditions, where random skidding operations have limited the use of trails to one or two passes.

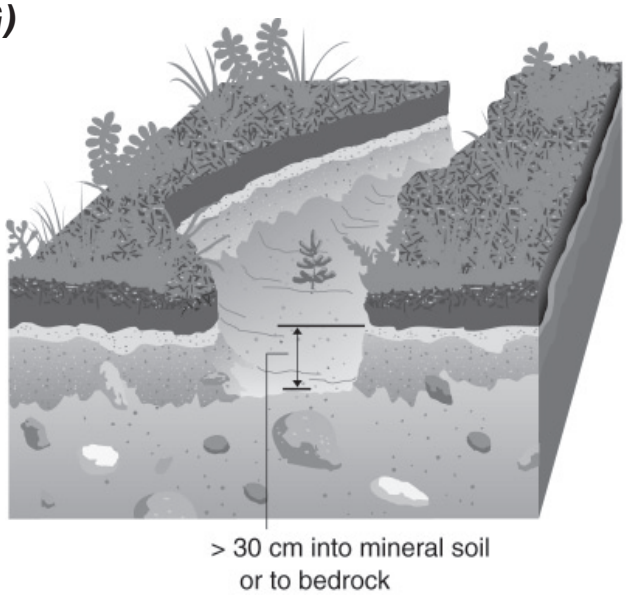


The following criteria define repeated machine traffic:

- The survey point shows evidence of compaction (see "Assessing compaction," above), indicated by:
  - altered soil structure or increased density relative to the surrounding soil,
  - puddling, and
  - compacted deposits of forest floor, fine slash, and woody debris overlaying and partially imbedded in, or crushed into, the mineral soil (compacted such that they cannot be readily excavated with a shovel).
- There is evidence of compaction across 100% of a 1 x 2 m rectangle. (If digging in the 1 x 2 m rectangle shows less than 100% compaction, the disturbance should not be called repeated machine traffic.)

Repeated machine traffic must be counted as soil disturbance on all sites except those with low compaction hazard. Where the compaction hazard has not been assessed, repeated machine traffic must be counted as soil disturbance.

3.4.3 Deep gouges (G)

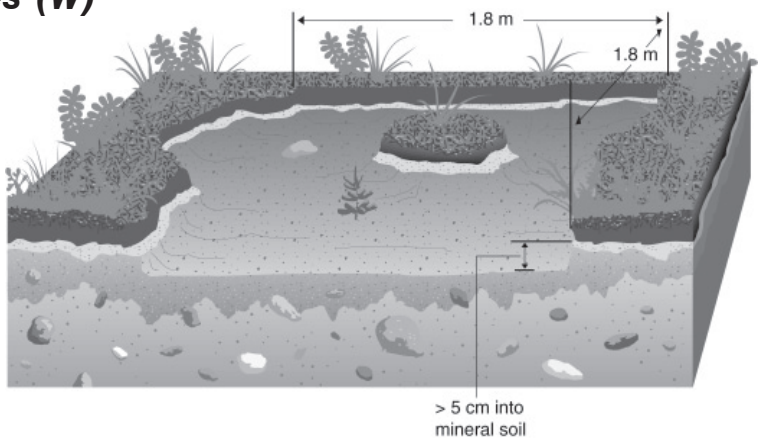


Deep gouges are excavations into mineral soil that are deeper than 30 cm or to bedrock at the survey point.

⇒ Measure from the undisturbed mineral soil surface to the mineral soil surface in the gouge.

Deep gouges must be counted as soil disturbance on all sites.

3.4.4 Wide gouges (W)

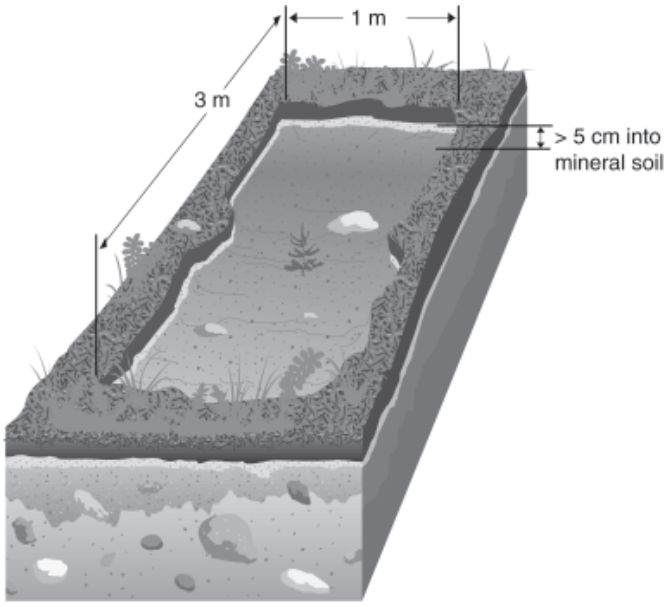


Wide gouges are excavations into mineral soil that are a) deeper than 5 cm at the survey point and b) deeper than 5 cm or to bedrock, on at least 80% of an area 1.8 x 1.8 m.

⇒ Measure the depth of the gouge from the undisturbed mineral soil surface to the mineral soil surface in the gouge.

Wide gouges must be counted as soil disturbance on all sites.

3.4.5 Long gouges (L)

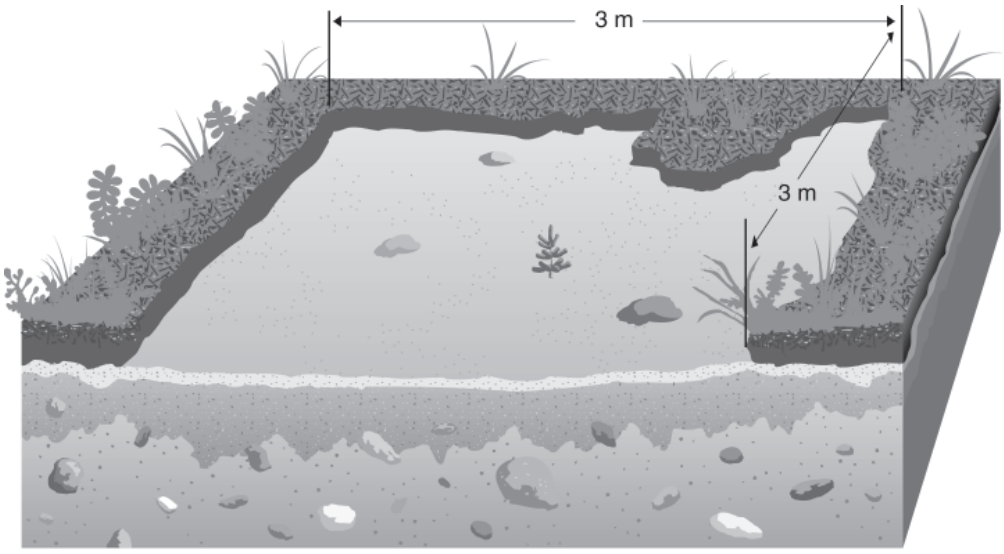


Long gouges are excavations into mineral soil that are a) deeper than 5 cm at the survey point and b) deeper than 5 cm or to bedrock on 100% of an area 1 x 3 m.

⇒ Measure the depth of the gouge from the undisturbed mineral soil surface to the mineral soil surface in the gouge.

Long gouges must be counted as soil disturbance on all sites.

3.4.6 Very wide scalps (V)



Very wide scalps are areas where the forest floor has been removed at the survey point and from over 80% of an area 3 x 3 m.

Forest floor is considered removed when the underlying mineral soil is exposed as a result of scalping, gouging, or burning, and the exposed mineral soil is covered by:

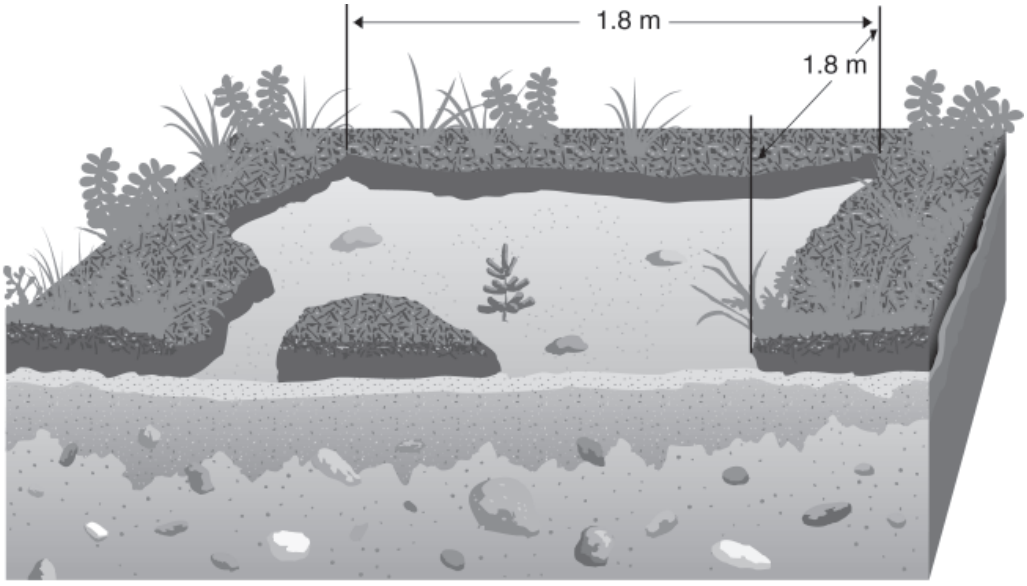
- fine woody slash, undecomposed needles, or dislodged rotten wood, or
- dislodged forest floor that is less than half the depth of the adjacent undisturbed forest floor.

Forest floor is not considered to be removed when it is:

- intact forest floor of any depth, typically showing roots growing into the mineral soil;
- mixed forest floor and mineral soil resulting from prescribed site preparation mixing treatments (mixed forest floor is a non-compact layer at least 5 cm thick at the surface, at least half composed of forest floor material); or
- exposed mineral soil covered by dislodged forest floor that is at least half the depth of the adjacent undisturbed forest floor (dislodged forest floor must be similar to the adjacent undisturbed forest floor to be acceptable).

Very wide scalps must be counted as soil disturbance on all sites.

3.4.7 Wide scalps (S)



Wide scalps are areas where the forest floor has been removed at the survey point and from over 80% of an area 1.8 x 1.8 m.

The same definition of forest floor removal applies here as is described above for very wide scalps.

Wide scalps must be counted as soil disturbance on sites with:

- very high soil displacement hazard,
- very high compaction hazard,
- very high soil erosion hazard,
- moderate or high likelihood of landslides, or
- where the hazards for soil compaction, soil displacement, or soil erosion have not been assessed.

3.4.8 Rehabilitation disturbance

Rehabilitation disturbance occurs when a temporary access structure or other type of soil disturbance is satisfactorily rehabilitated.

⇒ Record points that land on rehabilitation disturbance as not counted or undisturbed ("–").

The acceptability of rehabilitation should not be assessed using the soil conservation surveys described in this manual, but should be evaluated based on completion of the treatments as required in the Timber Harvesting Practices Regulation or described in a soil rehabilitation plan. (Note that rehabilitation disturbance can be dealt with differently under woodlot licence areas, as described in the section on "Woodlot licence area requirements.")

3.4.9 Prescribed fire impacts

Large areas where *prescribed fire* has completely consumed the forest floor should be treated like scalps. Prescribed fire impacts must be counted as soil disturbance if they meet the specifications described for very wide scalps or wide scalps.

3.4.10 Woodlot licence area requirements

Requirements and definitions related to soil conservation on areas under woodlot licences are provided in the Woodlot Licence Forest Management Regulation, which came into effect on November 30, 1998. Before this date, the requirements for woodlot licensees were the same as for major tenure holders. The following discusses some of the requirements of the new regulation.

The district manager can direct the woodlot licensee to conduct a survey to determine both the total area of the cutblock occupied by permanent access structures and the nature and extent of soil disturbance in the NAR.

For *woodlot licence areas,* a permanent access structure is any in-block road, landing, pit, or quarry not identified as requiring rehabilitation in an operational plan. Excavated or bladed trails, other logging trails, or similar structures may also be permanent access structures if identified as such in an operational plan. The maximum proportion of the total area within a cutblock that may be occupied by permanent access structures is the amount specified in an operational plan, or 7% if there is no amount specified.

Those structures not identified as permanent access structures and not rehabilitated contribute to the total area occupied by soil disturbance. The maximum proportion of any standards unit within the NAR that may be occupied by soil disturbance is the amount specified in the forest development plan or site plan, if an assessment of soil hazards has been carried out. If an operational plan for the area does not specify the maximum proportion of the NAR that may be occupied by soil disturbance, then the limit is 5%.

For areas covered by site plans, the maximum limit for soil disturbance must accommodate the area that will be occupied by all non-permanent access structures. (Note that the term “temporary access structure” is not used, nor defined in the Woodlot Licence Forest Management Regulation.) Even after these structures are rehabilitated, they may still be counted as soil disturbance if they meet any of the criteria for dispersed disturbance. For example, the surface of a rehabilitated temporary road that does not have any forest floor remaining could be categorized as a scalp and therefore count as soil disturbance. (This would not count on an area covered by a prescription held by a major licensee or a timber sale licensee.)

For areas covered by silviculture prescriptions approved before the Woodlot Licence Forest Management Regulation came into effect, access structures identified as requiring rehabilitation do not count as soil disturbance if they are satisfactorily rehabilitated.

For an area under a stand management prescription that calls for mechanized ground-based stand tending treatments using heavy machinery, the maximum proportion of the area to be treated that may be occupied by soil disturbance is the amount specified in the prescription—or 5% if no amount is specified.

4 Survey methods

4.1 Information needed from the approved plan

⇒ The purpose of a soil conservation survey is to determine whether the standards in the approved plan (silviculture prescription, stand management prescription, or site plan) have been adhered to. Check the approved plan to determine the following[2]:

- the date the plan was approved and, in some cases, when it was submitted for approval.
  - Note that if the prescription was submitted before June 15, 1998 but approved after this date, it must adhere to the rules in place prior to the June 15, 1998 legislation and regulation amendments;
- which access structures are permanent, and the approved maximum allowable limits for these structures;
  - Although not a requirement, worksheets used for calculating road occupancy from road layout and design standards may sometimes accompany the prescription. These worksheets can be useful for comparing proposed and constructed dimensions;
- which access structures are temporary, by how much maximum soil disturbance limits can be temporarily exceeded to construct temporary access structures, and, if required, *the maximum allowable limits for temporary access structures*;
- which excavated or bladed trails and other temporary access structures have to be rehabilitated, the maximum time to complete rehabilitation following the completion of harvesting, and, if required, *the methods for rehabilitation*;
- whether fill slopes are considered favourable or unfavourable growing media (this information is optional for prescriptions, but is useful to know when measuring haul roads and unrehabilitated excavated or bladed trails);
- whether fill slopes adjacent to permanent roads will not be reforested to improve visibility or to facilitate snow removal;
- what maximum allowable level of soil disturbance has been approved for each standards unit;
- *what maximum allowable level of forest floor displacement has been approved for each standards unit* (if required);

[2] Note that the information in italics is no longer a requirement for prescriptions submitted and approved on or after June 15, 1998.

- whether roadside work areas may be surveyed separately from adjacent portions of a cutblock;
- the minimum area to which maximum soil disturbance limits should be applied (see section on "Survey methods for soil disturbance—Site stratification"); and
- the hazards assessed for soil compaction, soil erosion, soil displacement, and, if required, *forest floor displacement and mass wasting (Interior sites),* as well as the likelihood of landslides if a terrain assessment has been carried out (this information is used to determine which soil disturbance categories to count in each standards unit).

Information from the silviculture prescription, stand management prescription, or site plan can be recorded on a Soil Disturbance Summary form (FS 889 in Appendix 6) for reference when assessing soil impacts.

4.2 Visual inspection

A visual inspection is the first level of assessment and can be as simple as a walk-through of the area. It is recommended that the method of inspection and any findings are documented. The back of the Soil Disturbance Summary form (FS 889 in Appendix 6) can be used to make notes and map any areas requiring a further ground check (e.g., such areas as unauthorized temporary access structures or heavily disturbed roadside work areas).

During the visual inspection:

- Verify the location of permanent and temporary access structures, and check whether road widths and landing sizes appear to be excessive or not.
- Look at temporary access structures to determine whether the required rehabilitation has been completed.
- Classify several points within each of the disturbance types present in the NAR (this may involve digging with a shovel to assess compaction and measuring the dimensions of the disturbance).
- Compare the observed disturbance types with the soil disturbance categories that will count on that block.
- Determine whether the disturbance types (see Appendix 7) and levels observed are allowed under the approved plan.
- Identify areas that appear to have excessive disturbance.
- Decide whether a transect survey is warranted.
  - If after an initial visual assessment it appears that disturbance levels may be high, a quick informal survey using a "pacing" method can be useful in

getting a rough estimate of disturbance levels. This "ballpark" estimate may help when deciding whether or not a formal survey is warranted.

- Determine whether a survey should be done for an entire standards unit or a stratified portion of a standards unit (see section on "Survey methods for soil disturbance—Site stratification").

5 Survey methods for access structures

A road traverse survey or landing survey should be conducted if road widths or landing sizes appear larger than normally required for similar operations and if they are not consistent with road layout and design standards. If structures not identified in an approved plan already exist, they should be treated as an operational plan violation.

5.1 Road traverse survey

Application

⇒ Use the following method for measuring the length and width of haul roads and permanent skid trails (i.e., excavated, bladed, or unbladed structures that will be kept free of trees to facilitate repeated stand entries).

Layout

Figure 2 shows layout details of the road traverse survey.

⇒ Hip-chain the length and measure the width at fixed intervals (see "Width measurement interval," below).

⇒ Make the first width measurement at one half of the width measurement interval distance from the point of commencement (POC).

⇒ Measure the length and width in horizontal distance.

⇒ Do not measure the road width on landings.

⇒ At junctions or switchbacks, move the width measurement location in 5-m increments in the direction of travel, until you are back on the regular portion of the road. The distance to the next width measurement will be your normal width measurement interval, less the distance you offset.

⇒ Conduct a separate survey for each different type of structure (such as permanent skid trails or haul roads) that differ in width by more than 3 m (e.g., a narrow spur road and a wide haul road). See Figure 3.

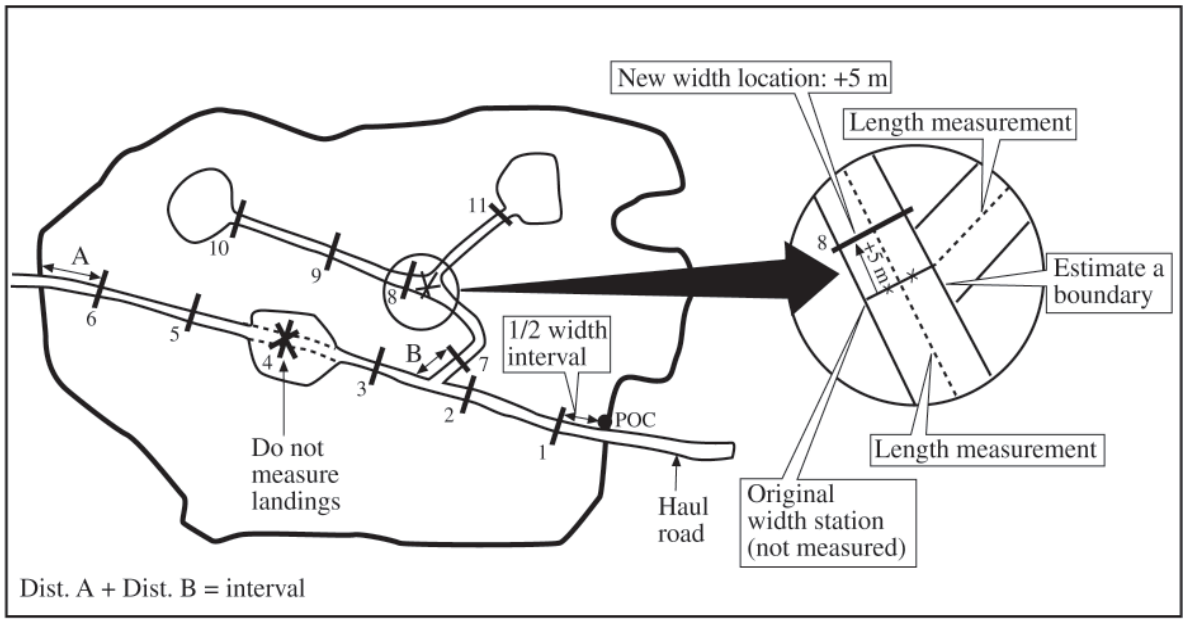


Figure 2. Layout for road traverse survey. Measure the width at approximately 10 locations.

5.1.1 Width measurement interval

The target number of width measurements is 10. Figure 3 shows a typical cutblock, with 10 width measurements for a main haul road and 10 for a spur road.

⇒ Determine the width measurement interval by estimating the total length of road, excluding landings, and dividing by 10.

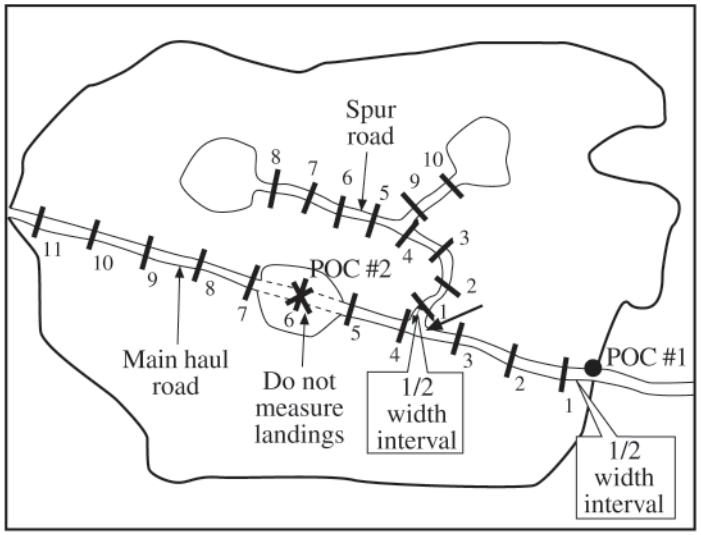


Figure 3. Separate surveys for roads with different widths. Do separate surveys, with approximately 10 width measurements, for roads that differ by more than 3 m in average width.

5.1.2 Width measurement

On sloping ground, the width measured depends on whether the fill slopes are considered favourable or unfavourable for growing trees (see Figure 4) and whether the fill slope will be kept free of trees. Surveyors should review the prescription to determine whether this information has been provided. In most cases information on fill slope material is not specified, and it it will be up to surveyors to assess whether material is favourable or unfavourable, in the field. Surveyors should consult with silviculture staff before making this assessment, especially if they are not familiar with local conditions. Detailed descriptions of unfavourable growing media are provided in the *Soil Conservation Guidebook,* and further information may be contained in local or regional guidelines.

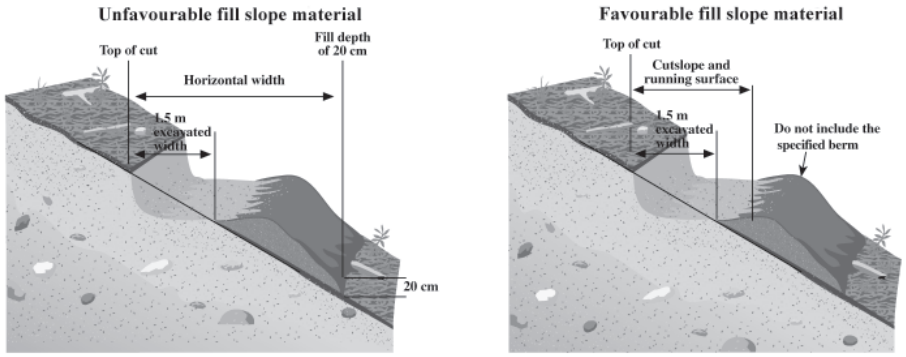


Figure 4. Measuring road widths on sloping ground. Include unfavourable fills greater than 20 cm deep as part of the access structure. For favourable fills, measure only the excavated portion and the compacted running surface.

⇒ If fill slopes are unfavourable for tree growth, measure the width to the top of the cut from a point where the sidecast is consistently greater than 20 cm deep. Do not count as sidecast any accumulations of slash that are clean woody debris (i.e., containing less than 30% mineral soil). Ignore isolated patches of sidecast deeper than 20 cm that are not a contiguous part of the road fill. Road fill with buried stumps or slash is always considered unfavourable.

⇒ If fill slopes are favourable for tree growth, measure the width of the road or trail from the top of the cut to the outside edge of the running surface. Do not include the uncompacted berm and fill slope.

Road edges that will be kept free of trees (to provide adequate visibility, ensure safety standards or facilitate snow removal) should be included as part of the road area.

⇒ On level ground, measure the width in horizontal distance (see Figure 5), including:

- the running surface plus any ditches to the outside edge of each ditch line;
- berms that are made of unfavourable soil material that are greater than 20 cm deep; and
- the area to be kept free of trees for visibility, snow removal, etc.

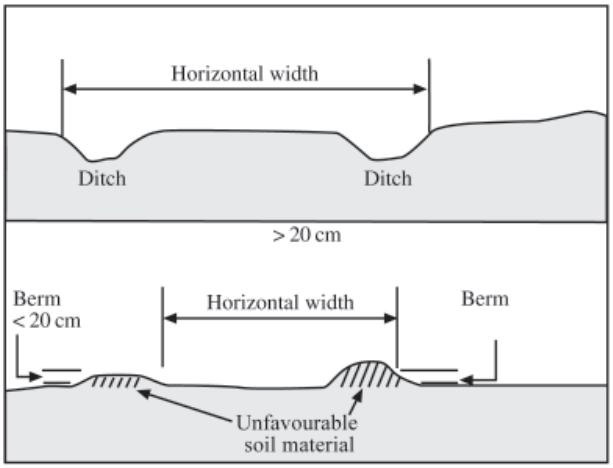


Figure 5. Measuring road widths on level ground. Measure to the outside of the ditches (if present). Otherwise, include berms of unfavourable fill if they are greater than 20 cm deep.

Calculations

⇒ Record the measurements on the Traverse Survey Field Card (FS 880; see Appendix 6), and then use the Traverse Survey Calculation Card (FS 881; see Appendix 6) to do the calculations:

1. Complete separate calculations for each type of structure, such as spur roads, main roads, and permanent skid trails. Record the measurements for each type of structure on the front or back of the FS 880 card.
2. For each type of structure, calculate the total length in horizontal distance.
3. For each type of haul road, measure the length of road that passes through landings and record this under comments on the FS 880 card.
4. For each type of structure, calculate the mean and standard deviation for width from the data on the FS 880 card.
5. For each type of structure, enter on the FS 881 card the number of width measurements, its length[3] and mean width, and the standard

[3] Use the total length if, when you are calculating the landing area, you exclude the area of the roads that cross through it. Otherwise, subtract the length of road on landings from the total length, but include the areas of road that pass through landings in the landing area measurement.

deviation of width. If you need an estimate of landing area minus its road area, enter the road length on landings in a separate column so that the area of roads on landings can be calculated.

6. Follow the calculation procedure on the bottom of the FS 881 card to determine the area disturbed and its lower confidence limit. When calculating the percentage of area occupied by roads and other permanent access structures, use the total (gross) cutblock area after harvesting has been completed, taking into account any deletions or additions.

7. Use the percentage area error calculated on the FS 881 card (and on the Landing Area Calculation Card FS 886, described below) to calculate the lower confidence limit for the proportion of the cutblock occupied by permanent access structures. Follow the calculation procedures on the bottom of the Soil Disturbance Summary Card (FS 889, see Appendix 6).

5.2 Landing survey

Application

⇒ Use the following procedures and methods for determining the area of landings, pits, quarries, and turnouts.

Layout

⇒ Avoid surveying landings before disposal of the debris pile. If a survey must be conducted before routine debris disposal, and the edge of the constructed landing cannot be readily determined, measure to the outer edge of the debris pile.

⇒ Piles that have been burned, with ash remaining, must be assessed according to the soil conditions under the ash pile. If the pile was burned on the landing running surface or unfavourable sidecast, count it as part of the landing. Otherwise, count the burned portion as part of the NAR.

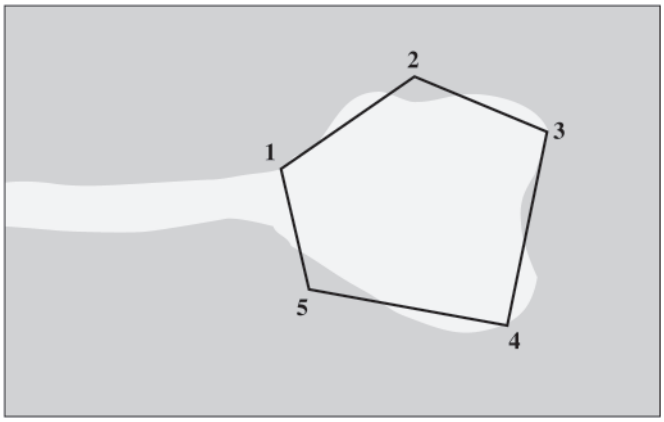
⇒ Measure landing areas depending on whether fill slopes are considered favourable or unfavourable for tree growth (the same as for haul roads):

- If fill slopes are unfavourable, measure to the top of the cut from the point where the sidecast is consistently greater than 20 cm deep.
- If fill slopes are favourable, measure from the top of the cut to the outside edge of the landing surface.

⇒ On level ground, include the compacted running surface, berms of unfavourable soil deeper than 20 cm, and associated ditches.

⇒ Measure landings using a hip chain traverse of the perimeter (the preferred method) or the representative length and width measurements, as described below.

5.2.1 Hip chain traverse



Complete a hip chain traverse to obtain a closure error of 10% or less. For most landings, four to eight stations will provide sufficient accuracy.

If landings are measured using a closed traverse, record the net landing areas directly on the FS 886 form.

5.2.2 Representative length and width measurements

⇒ Hip chain representative width and length measurements. Estimate one-quarter and three-quarters of the total distance on the centreline of each dimension (see Figure 6), and record the information on the Landing Area Calculation Card (FS 886; see Appendix 6).

⇒ Follow the calculation procedures on the Landing Area Calculation Card (FS 886). To calculate landing area without the area of roads that cross landings, follow these steps:

1. Determine the length of roads on landings from the road traverse.
2. Determine the area of roads on landings:

   area of roads on landings = length of roads on landings x average road width from the FS 881 card
3. Subtract the area of roads on landings from the total landing area before calculating the lower confidence limit for landings.
4. Use the percentage area errors from the FS 886 card for landings and the FS 881 card for roads to calculate the lower confidence limit for the proportion of the cutblock occupied by permanent access structures. Follow the calculation procedures on the bottom of the FS 889 summary card.

To be in compliance, the lower confidence limit for the proportion of the cutblock occupied by all permanent access structures must be less than the maximum allowable limit specified in the prescription.

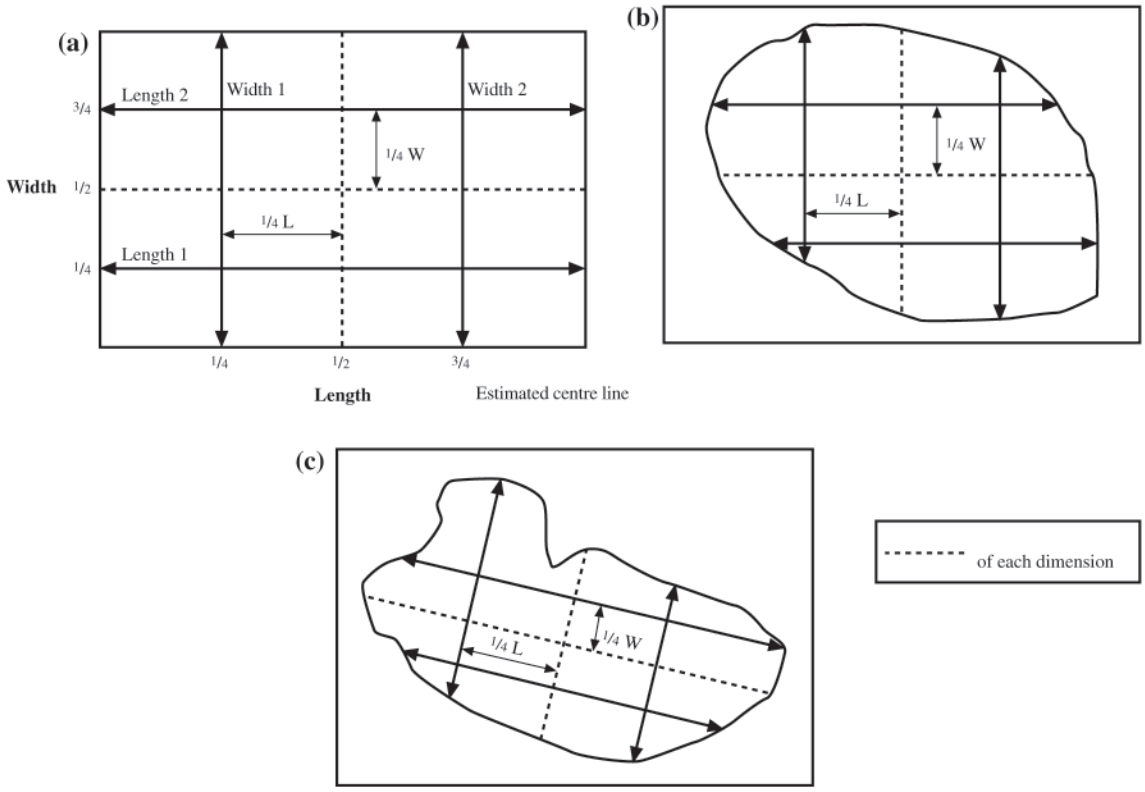


Figure 6. Idealized layouts for landing surveys. It can be (a) a rectangular landing, (b) an elliptical landing, or (c) a complex landing shape. Measurements are taken at points that approximate one-quarter and three-quarters of the length and width of each landing.

6 Survey methods for soil disturbance

Soil disturbance within the NAR includes such harvesting and site preparation disturbances as unrehabilitated excavated or bladed trails, compacted areas, corduroyed trails, dispersed trails (from repeated machine traffic and wheel or track ruts), and gouges and scalps as defined in the Operational Planning Regulation.

The average levels of soil disturbance in the survey area are determined by transect surveys. Transect surveys must be completed as soon as possible after the disturbance was created to avoid confusion caused by the re-establishment of minor vegetation.

Before doing a transect survey, the surveyor should walk the area to become familiar with the various soil disturbances, to confirm the planned orientation of the transects, and to compare disturbance assessments with co-workers.

Transect surveys are also used for assessing compliance with forest floor displacement limits, where such limits are required.

6.1 Site stratification

The objective of stratifying the NAR is to focus a survey on relatively homogeneous areas of soil disturbance that appear to exceed the limits in the prescription or site plan. The intent is not to focus a survey on areas where concentrated disturbance is anticipated (e.g., where trails converge at landings).

Stratification of a standards unit can only be done for either of the following two situations: a) the prescription clearly specifies that the soil disturbance limit applies to a certain size area within the standards unit (e.g., stratification down to one hectare would be appropriate if the prescription specified that the maximum soil disturbance limit of 10% applied to any given hectare of SU "B"),[4] or b) a survey is required on a roadside work area (described below), in which case it is necessary to have a separate stratum from the adjacent NAR, to assess compliance with the maximum soil disturbance limit of 25% that is set in regulation.

Where stratification of a standards unit is not permitted, surveying should be carried out only on the whole standards unit if it appears that the average level of soil disturbance over the entire unit exceeds the limit.

[4] The previous edition of the guidebook stated that any standards unit could be stratified down to a minimum of 1 ha and assessed for compliance with maximum soil disturbance limits.

6.1.1 Criteria for stratified areas

For areas where stratification is permitted the following criteria should be followed:

⇒ The minimum strata size cannot be less than the area to which the limit applies as specified in the prescription, and should not be less than 1 ha (the minimum recommended area for surveying).

⇒ Use the same disturbance categories as you would use in surveying the entire standards unit.

⇒ Ensure that soil disturbance within each stratum is relatively uniform.

⇒ Do not create strata only to encompass small areas where there is an unavoidable concentration of soil disturbance, such as areas immediately adjacent to landings where numerous trails may be converging, and areas surrounding major trail junctions, or surrounding individual skid trails. Note, however, that these areas can be included as part of a larger stratum.

6.1.2 Surveying roadside work areas

Roadside work areas are those sites located adjacent to haul roads and used during roadside harvesting operations for decking, loading, processing, and debris disposal. These areas can be subject to concentrated and high levels of soil disturbance. The maximum soil disturbance limit for roadside work areas is 25%, as required in the Timber Harvesting Practices Regulation.[5] Prescriptions may identify these areas as separate standards units from adjacent portions of the NAR, which will normally have much lower maximum limits for soil disturbance. If these roadside work areas are not identified as separate standards units, they should be considered as a separate stratum for survey purposes.

6.2 Classifying soil disturbance

⇒ Measure soil disturbance in the NAR with transect surveys, classifying survey points at fixed distances along transect lines. Classify survey points according to the soil conditions observed at the point and in the area around the point.

⇒ Always use the flow chart in Appendix 2 to ensure that soil disturbance is counted appropriately.

[5] Before June 15, 1998, roadside work areas had to be in compliance with maximum soil disturbance limits specified for the standards unit of which they were a part. As of June 15, 1998, roadside work area need only comply with the 25% limit established in the Timber Harvesting Practices Regulation, despite any limit that may be specified in a prescription.

6.2.1 Assessing the survey point

At each survey point along a transect line, determine whether soil disturbance exists in accordance with definitions that apply to the prescription for the area. The point observations in these surveys do not involve a fixed plot size.

To classify a survey point, first determine the type of disturbance directly below the point. For example, if the point falls on a small patch of undisturbed forest floor in the middle of a heavily disturbed area, classify the point as undisturbed (field symbol "–").

6.2.2 Assessing the area around the survey point

Most types of disturbance involve size criteria, where the extent of disturbance around the point must also be assessed. For example, a wide gouge (field symbol "W") must be gouged greater than 5 cm into mineral soil (or to bedrock) on at least 80% of a 1.8 x 1.8 m square.

The extent and type of disturbance in the area around the point is a secondary attribute that is also required to classify the point. For example, if the point is gouged deeper than 5 cm, but the area around the point is only scalped less than 5 cm deep, then the point could not be classified as a wide gouge (W). It may be classified as a wide scalp (field symbol "S"), which may or may not count depending on the assessed soil hazards.

⇒ Think of the area around the point as a sampling window. The sampling window:

- must include the survey point, but need not be centred around it (Figure 7);
- can be oriented in any direction;
- must be oriented to maximize the amount of disturbed area included within the window (Figure 7);
- must be of the size and shape of the disturbance being assessed; and
- can overlap with the sampling windows of adjacent points (Figure 8).

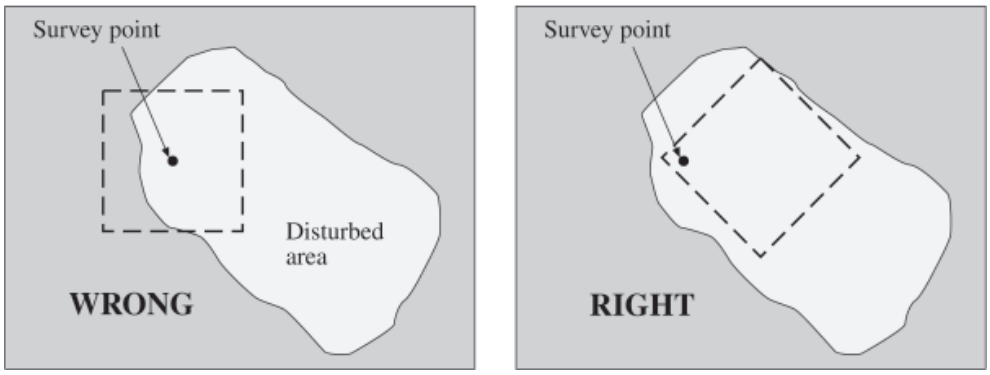


Figure 7. Sampling window orientation. Orient the sampling window to include the maximum amount of disturbed area. The survey window need not be centred around the survey point.

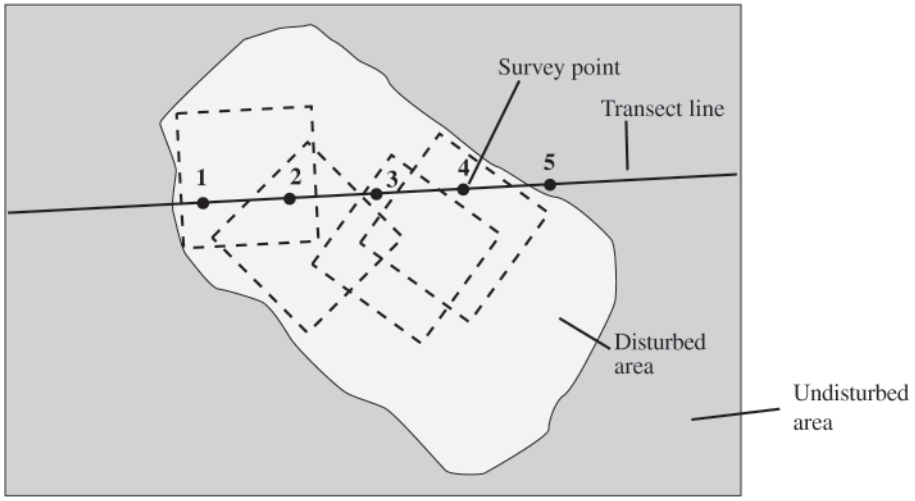


Figure 8. Sampling windows can overlap.

For soil disturbance to be classified within some gouging and scalping categories, a percentage (usually 80%) of an area must be disturbed to a certain level or depth. The percentage is set lower than 100% to account for the natural variation that occurs with some disturbances (e.g., small patches of forest floor that remain in a scalp).

Window dimensions are specified as a percentage of a square or rectangle. In practice, this means that the dimensions of the disturbance can be smaller if the area is 100% disturbed.

Figure 9 shows typical patterns of disturbance and the equivalent dimensions of smaller squares for two common window sizes (1.8 x 1.8 m for a wide scalp or wide gouge and 3.0 x 3.0 m for a very wide scalp).

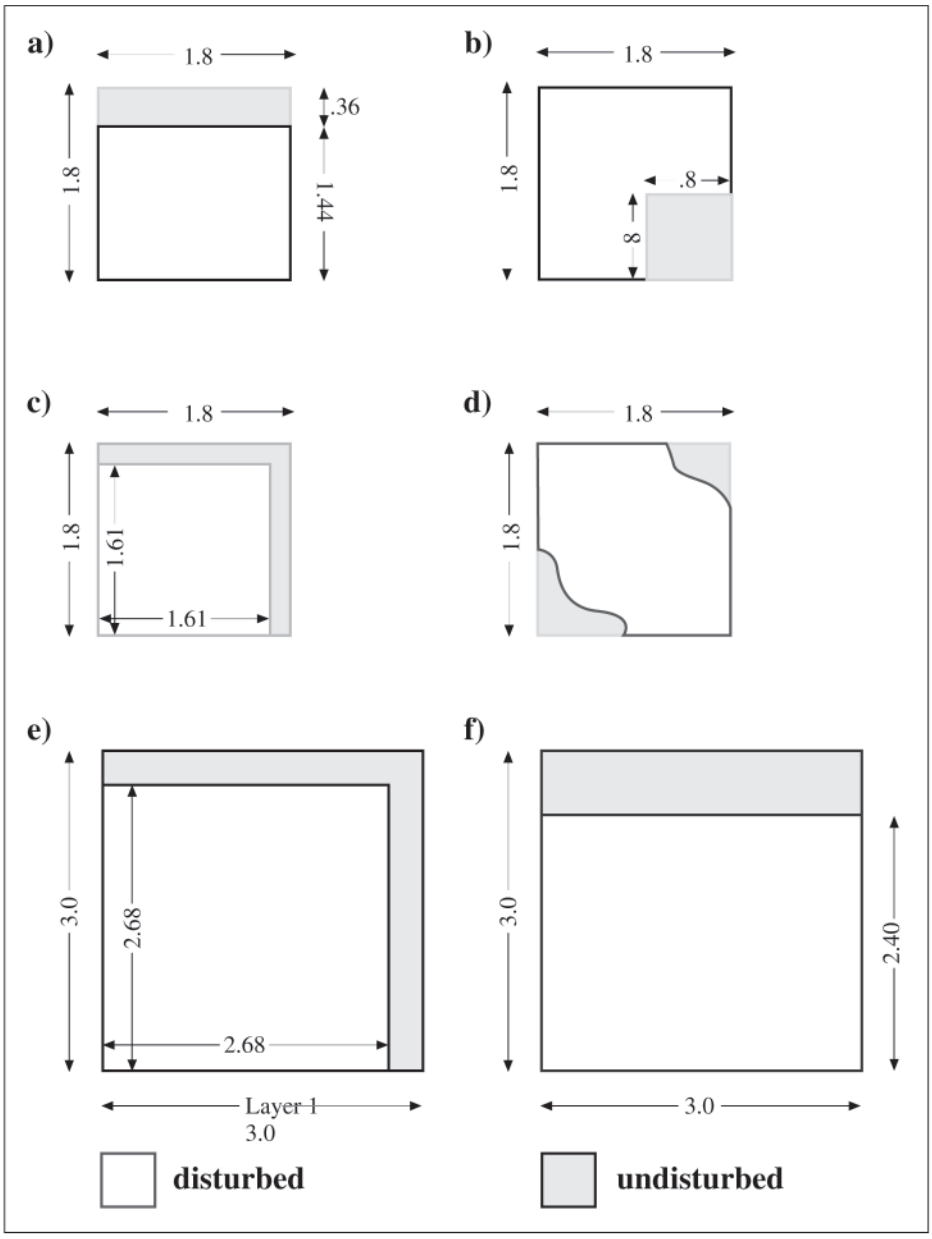


Figure 9. Equivalent sampling window sizes. Typical configurations for disturbance occupying 80% of a 1.8 x 1.8 m sampling window are shown in (a), (b), (c), and (d). Examples of disturbance occupying 80% of a 3.0 x 3.0 m sampling window are shown in (e) and (f).

7 Transect method for areas 10 hectares and smaller

For small areas typically 10 ha or less, the surveyor must establish a series of parallel transects within the survey area, with survey points assessed at defined intervals along each transect. Transects should be laid out to cover the area evenly with approximately 500 points. Two steps are then involved:

- A preliminary survey, using one-half the planned number of transects, must be completed and preliminary calculations made.
- If the preliminary survey results warrant it, the remaining transects must be sampled.

7.1 Preparation

⇒ Follow the steps below:

1. Walk through the survey area to determine the main orientation of soil disturbance, if any. See Figure 10.
2. Decide on a transect orientation that will cross the major disturbance at right angles. If the disturbance has no major orientation, locate transects in a convenient direction.
3. Record the transect bearing on the Transect Survey Field Card (FS 885; see example in Appendix 6).
4. Using Table 3, determine the transect and point spacing for the size of the survey area. Transect and point spacings are shown for areas up to 20 ha in size. It may be cost-effective to use this method for areas up to 20 ha if they have gentle terrain and a limited slash loading.
5. Determine the starting distance for the first transect from the point of commencement (POC) by picking a random number from Appendix 3.

   To select a random number, first choose a row from 1 to 40 and a column from 1 to 12. The number in the table at the intersection of the chosen row and column is the one to use as a random percentage. (If a number larger than 100 is selected, use the last two digits.) Multiply the selected random percentage by the transect spacing from Table 3 to determine the distance from the POC to the first transect.

Table 3. Transect and point spacings for small area surveys. Survey points established at these spacings will achieve a sample size of 500.

Area (ha)	Transect spacing (m)	Point spacing within transects (m)
1.0	5	4
1.5	6	5
2.0	8	5
2.5	10	5
3.0	12	5
4.0	16	5
5.0	20	5
6.0	24	5
7.0	28	5
8.0	32	5
9.0	36	5
10.0	40	5
11.0	44	5
12.0	48	5
13.0	43	6
14.0	46	6
15.0	50	6
16.0	45	7
17.0	48	7
18.0	51	7
19.0	54	7
20.0	57	7

7.2 Field survey layout

⇒ Follow the steps below:

1. Establish and label the point of commencement (POC) (see Appendix 5 for marking conventions).
2. Lay out a baseline perpendicular to the transect orientation and flag the location of each transect. Try to locate the baseline in the middle of the area you are surveying so that you have a reference point to help you accurately locate transects.
3. For the first transect, proceed along the baseline using the distance calculated in step 5 of the "Preparation" section. Figure 10 shows a typical layout for this small area method.
4. Sketch a map of the survey strata on the back of the Soil Disturbance Summary Card (FS 889; see Appendix 6). This will help you keep track of your progress and record the survey coverage.

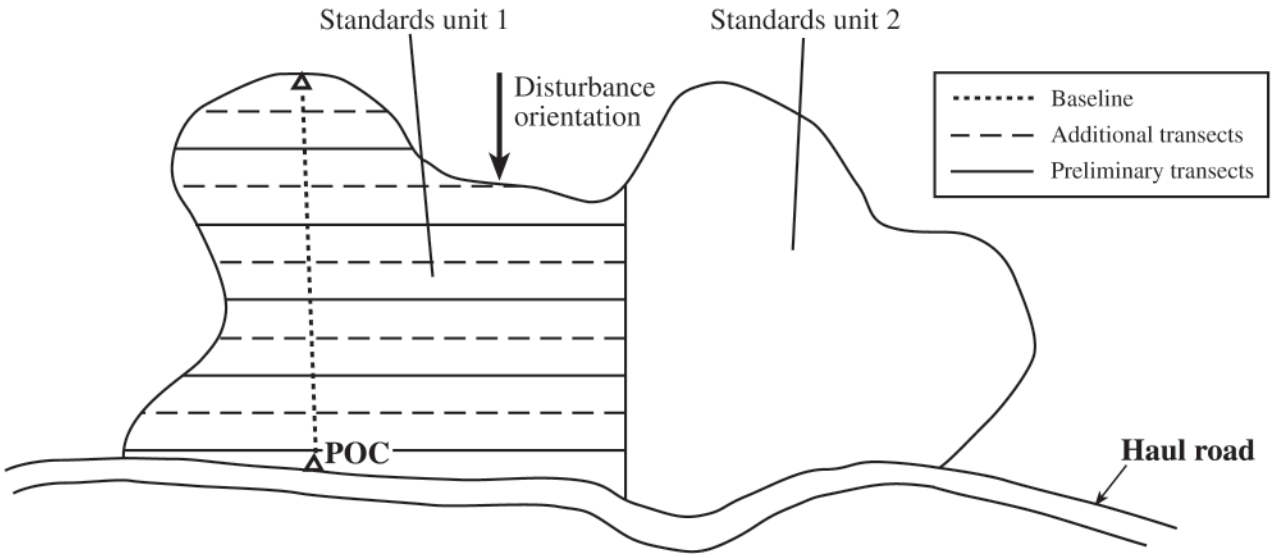


Figure 10. Typical transect survey layout for small areas (<10 ha). The layout shows the transect lines crossing the skidding disturbance. The solid transects are measured first; the dotted transects are added if necessary.

5. Chain along the transects in slope distance. Transects must be chained to ensure that sample points are located without bias. Various methods may be used as long as the points are determined objectively.

   The recommended method is for two people to chain 100-m segments and then make point observations while walking towards each other. A hip chain is not acceptable here, as it is difficult to locate sample points objectively when walking over or around obstacles.

   On uneven terrain, keep the chain near the ground (within 1 m) by hooking it under slash or running shorter distances. Leave flagging to mark the start and end of each transect segment (e.g., each 100-m section) you survey (see Appendix 5 for field marking conventions). Do not move the chain until those measurements are complete.

7.3 Observations along the transect

⇒ Tie or stake the chain taut and classify the soil disturbance directly below every survey point on the chain, using the spacing determined from Table 3. Record results on the Transect Survey Field Card (FS 885) using the symbols from Tables 1 and 2.

⇒ Measure to the edge of the survey area. Do not sample the zero point and do not count points that fall outside the survey area (e.g., permanent access structures, mapped non-productive areas).

7.4 Locating subsequent transects

⇒ At the end of a transect, move over the equivalent of two times the transect spacing. If you wish, mark the additional locations of the transect end points that could be completed in a full survey. Start the next transect.

7.5 Field calculation procedure

⇒ Use the Small Area Transect Survey Calculation Card (FS 897) to summarize the results from your preliminary survey. A completed example of this form is shown in Appendix 6.

1. Add up the number of points classified as counted soil disturbance and the total number of surveyed points. Enter these values in the "Preliminary Survey" column of form FS 897.
2. Calculate the preliminary percentages for counted disturbance by dividing the total for each by the total number of surveyed points.
3. For counted disturbance, obtain the confidence interval (CI) from the table on the back of the calculation card.

   "Sample size" on the card means the total number of survey points. The column head "%" means the percentage counted disturbance from step 2.
4. Calculate the upper and lower confidence limits for the preliminary counted disturbance. To do this, add and subtract the confidence interval to the percentage disturbed and to the percentage displaced.
5. Using the upper and lower confidence limits as shown in Table 4, determine whether further surveying is necessary.

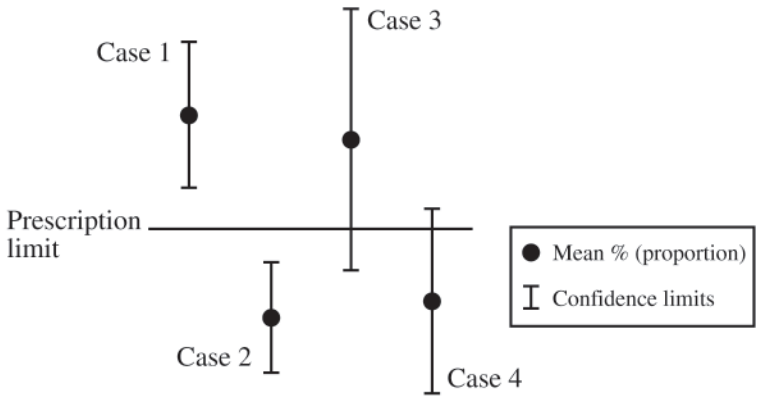


Table 4. Decision rules for comparing survey results to prescription limits

Case	Preliminary percentage	Confidence limit (CL)	Decision
1	Above	Lower CL is above the prescription maximum	Stop surveying
2	Below	Upper CL is below the prescription maximum	Stop surveying
3	Above	Lower CL is below the prescription maximum	Survey remaining transects
4	Below	Upper CL is above the prescription maximum	Survey remaining transects

7.6 Finalizing the survey

⇒ Follow the steps below:

1. If necessary, survey the remaining transects.
2. Subtotal the counted disturbance and then total number of points for the additional transects and record these numbers in the appropriate column.
3. Add these subtotals to the previous subtotals for the preliminary survey above to determine the final survey totals. Enter these survey totals on the FS 897 form in the top "Final Survey" box.
4. Calculate the final percentages for disturbance, as done in step 2 of the preliminary survey.
5. For counted disturbance, obtain the confidence interval (CI) from the table on the back of the calculation card.
6. Calculate the final upper and lower confidence limits for counted soil disturbance.
7. Calculate the non-compliance percentages for disturbance by subtracting lower confidence limits from the limits stated in the silviculture prescription.
8. If the final percentage disturbed and the lower confidence limit (cases 3 and 4) are still on opposite sides of the prescription limit, consider the area to be in compliance.

8 Transect method for areas larger than 10 hectares

For large areas, typically greater than 10 ha, the surveyor must systematically locate a number of grid centres within the area to be surveyed. To do this, points must be assessed at 1-m intervals along two 30-m transects radiating out from each grid centre. The number of grid centres depends on the size of the area to be surveyed. For areas up to 50 ha, a minimum of 30 grid centres is required. For areas larger than 50 ha, one grid centre for each additional 5 ha must be added. (These are recommended as the minimum number of grid centres.) Refer to Figure 11 for layout.

For a more precise estimate of the soil disturbance, it may be necessary to increase the number of grid centres. It is possible to calculate confidence limits for this survey, but they are wider than those obtained using the small area method. Whenever possible, the small area method should be used. In the case of large standards units, all parties (i.e., Forest Service district staff and license holders for the area in question) may wish to consider agreeing on a representative area that could then be surveyed more efficiently using the small area method.

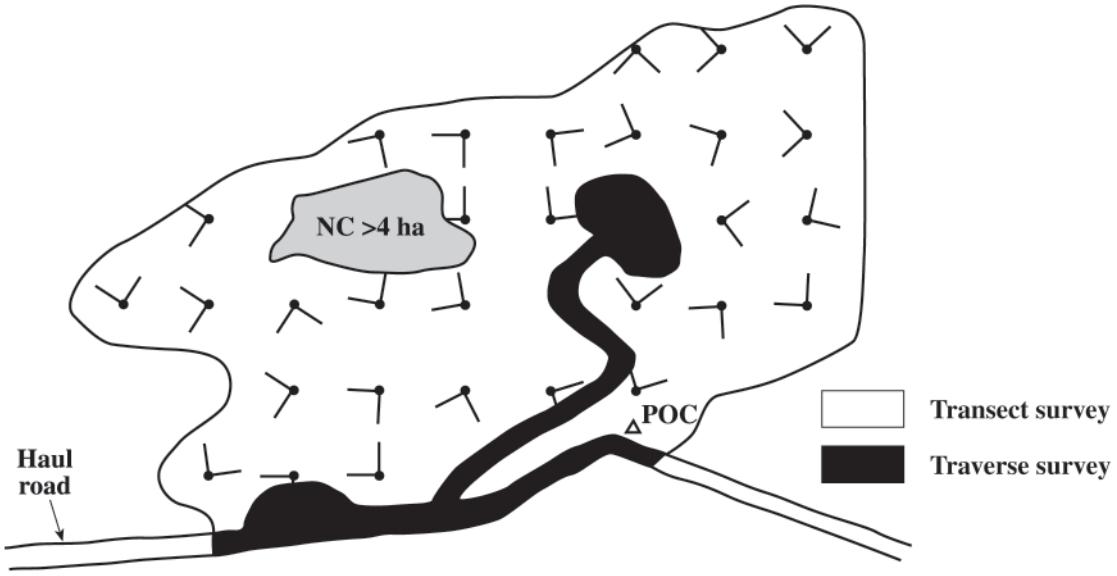


Figure 11. Transect survey layout for large areas (>10 ha). Establish regularly spaced grid centres on cardinal bearings from a random start. As also shown here, survey points are not established in areas of non-commercial cover greater than 4 ha or permanent access structures. Permanent access structures should be surveyed using the road traverse and landing survey methods.

8.1 Grid centres and grid layout

1. The first grid centre is located along a random bearing from the POC (selected from the table in Appendix 3). If the random bearing leads outside the survey area, add increments of 90° to the bearing until it leads into it. (See Appendix 4 for grid spacings to cover areas of various sizes.) Locate the first grid centre at one-half the grid spacing distance from the POC.
2. Flag each grid centre. Number the grid centres with unique numbers for each surveyor (e.g., 1, 2, 3… and 101, 102, 103…).
3. Use cardinal bearings (north, south, east, or west) to locate the remaining grid centres. Chain between grid centres in slope distance. Fill the entire survey area. This may require more or less than the target number of grid centres. The Transect Survey Field Card (FS 885) provides a space for recording the 45° offset spacing that allows diagonal shortcuts between grid centres on adjacent lines.

8.2 Transects and points

1. Fill in the random POC bearing on the Transect Survey Field Card (FS 885).
2. At each grid centre, choose a random bearing (from the table in Appendix 3) for the first transect, and add 90° for the second transect. If a grid centre falls outside the NAR, do not sample any transect points at that grid centre.
3. Mark the start and end of each transect exactly at the 0-m and 30-m marks with blue flags. If large changes in elevation occur, anchor the transect tape. Do not move the survey chain once it is set in place.
4. Record soil disturbance at the point directly below each metre mark. Fill in data on the Transect Survey Field Card, using the symbols from Tables 1 and 2.

As shown in Figure 12, do not sample portions of transects that are outside the NAR. Do not survey points on permanent access structures, outside the cutblock boundary or survey area, or within non-commercial cover greater than 4 ha. Do not sample points that land outside the NAR (e.g., if 12 m of a transect falls on a haul road, measure only the remaining 18 of the transect's 30 points; do not measure any of the points on the road). Mark each non-surveyed point with an X on the Transect Survey Field Card.

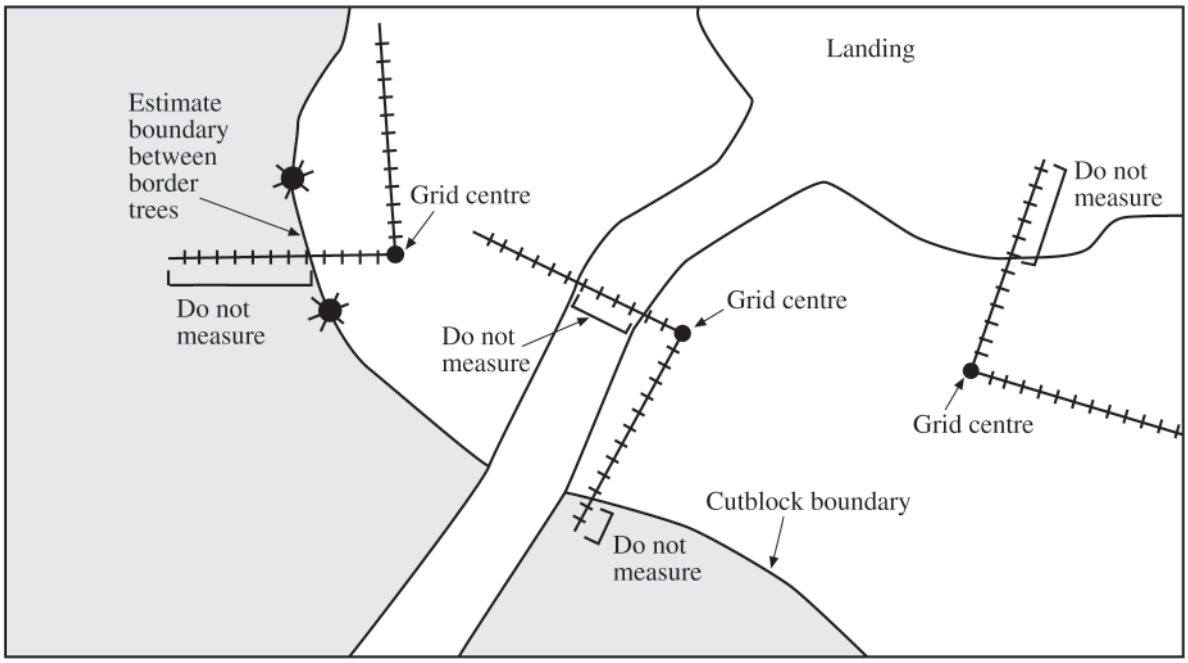


Figure 12. Omit points outside the net area to be reforested (NAR). Do not measure transect points outside the cutblock or on permanent access structures.

8.3 Calculations

1. Transfer the data for each grid centre from the FS 885 form to the Transect Survey Tally Card (FS 896). This optional form helps verify grid centre totals before the calculations are done.
2. Calculate statistics using either a spreadsheet or the Transect Survey Calculation Card (FS 895). The Ministry strongly recommends that a spreadsheet be used. (For more information on spreadsheet programs, contact the Forest Practices Branch in Victoria.)
3. Copy the lower confidence limit data from the bottom of form FS 895 to the Soil Disturbance Summary Card (FS 889) if the calculations were completed without the spreadsheet.
4. See Figure 13 for a flow chart of the tally and calculation procedure.

To be in compliance, the lower confidence limit for the proportion of counted disturbance must be less than the maximum allowable soil disturbance limit.

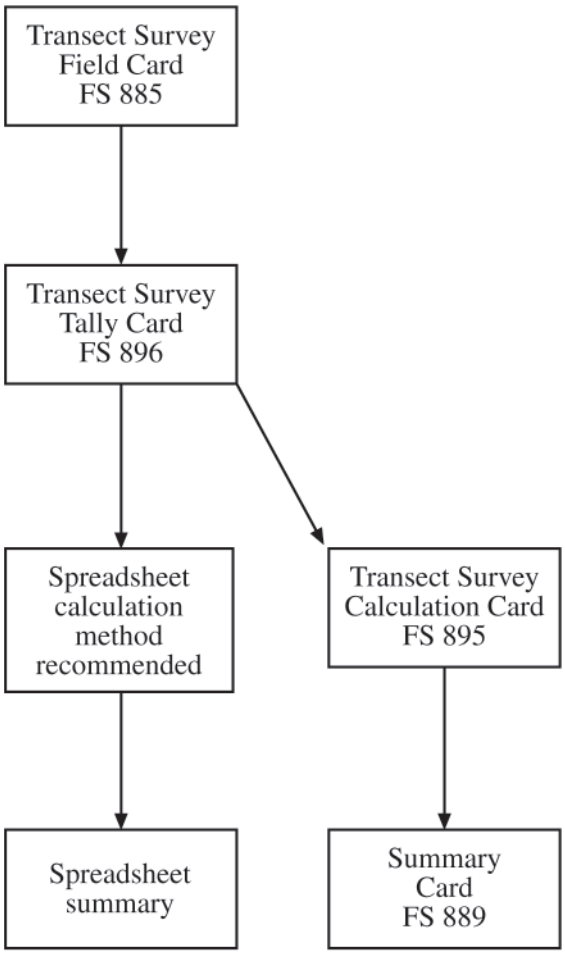


Figure 13. Flow chart for forms recording large area transect surveys.

9 Site summary

9.1 Mapping

The site and survey data on the front of the Soil Disturbance Summary Card (FS 889; see Appendix 6) should be filled out if calculations are performed manually; however, it is not necessary if the survey results are calculated using the spreadsheet method.

A site map should accompany any spreadsheet summary or card summary. The back of the FS 889 summary card can be used for mapping or else a separate map could be prepared.

The requirements for site mapping follow.

⇒ Use maps of a suitable scale (e.g., 1:5000 or 1:10 000).

⇒ Indicate the map scale and north arrow.

⇒ Mark the transects and point spacing or the grid bearing and grid spacing.

⇒ Number the transects or the grid centres, landings, and haul roads in the same way they were numbered on the field forms.

⇒ Clearly mark the boundaries of treatment units or standards units (if relevant).

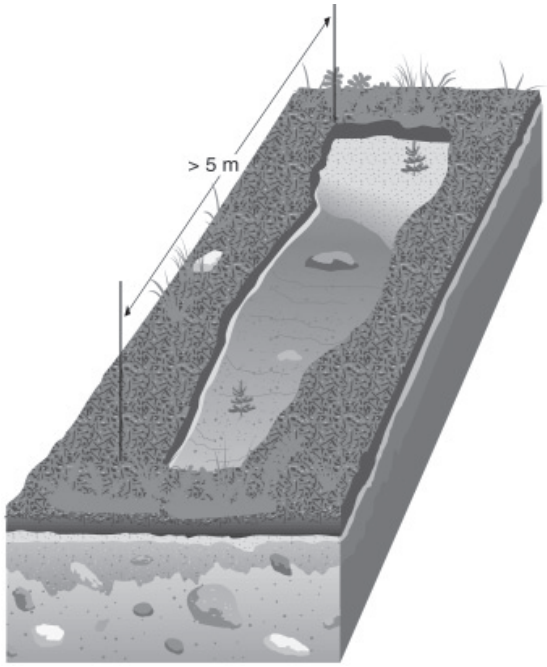
Appendix 1. Requirements and definitions for prescriptions approved under the Forest Practices Code 1995 Operational Planning Regulation (B.C. Reg. 174/95) (December 16, 1995–June 14, 1998)

The requirements and definitions of the 1995 regulation are the same as in the current 1998 Operational Planning Regulation, with the exceptions listed below.

1. Requirements for prescriptions approved under this regulation specified:
   - the maximum percentage of the NAR that could be occupied by temporary access structures and the action, if any, that would be taken to rehabilitate temporary access; and
   - the maximum percentage of the NAR that could be occupied by forest floor displacement.
2. Soil disturbance included continuous scalps as a category of counted soil disturbance.

The following provides a detailed description of continuous scalps and forest floor displacement.

Continuous scalp (C)



Continuous scalps were counted as a category of soil disturbance on areas under Forest Practices Code prescriptions approved or submitted for approval before June 15, 1998.

They are areas where the forest floor has been removed at the survey point and continuously for a length greater than 5 m. There is no width criterion for this category.

Continuous scalps are counted as soil disturbance on sites with:

- high or very high mass wasting hazard;
- high or very high surface erosion hazard;
- very high soil displacement hazard; and
- moderate or high likelihood of landslides, or where the hazards for soil displacement or surface soil erosion have not been assessed.

Forest floor displacement

Forest floor displacement, tallied by transect surveys (along with categories of soil disturbance), is symbolized on field survey forms with a circle drawn around the appropriate disturbance symbol.

Total forest floor displacement includes:

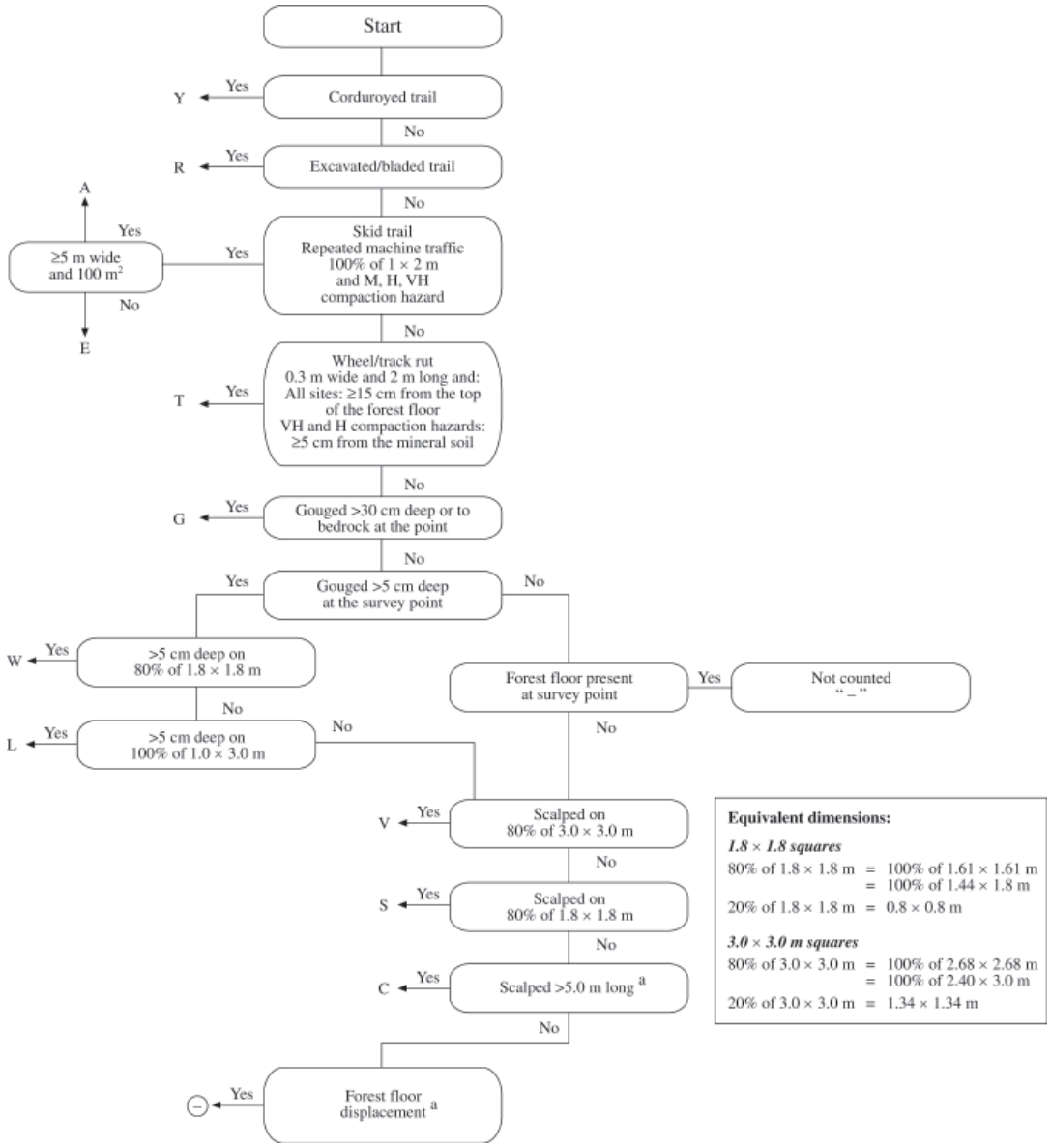
- any disturbance where forest floor has been removed;
- the exposed mineral soil surfaces of rehabilitated temporary access structures where forest floor is no longer present; and
- all areas where the forest floor has been completely consumed by prescribed burning.

Total forest floor displacement does **not** include:

- any disturbance where forest floor is not removed;
- intact or dislodged forest floor covered by deposits of mineral soil;
- any counted disturbance category covered with organic matter that does not qualify as forest floor removal (e.g., a rut where the forest floor is still intact);
- surfaces of rehabilitated temporary access structures where the forest floor has been restored in accordance with an approved rehabilitation plan (e.g., by application of a surface mulch);
- exposed mineral soil on mounds and berms created by mounding, disc-trenching, plowing, or other mechanical site preparation treatments, where the original forest floor is largely intact under the mound or berm; and
- exposed mineral soil resulting from mixing-type mechanical site preparation treatments, such as rototilling or bedding plow treatments.

Note: Do not count compacted areas, repeated machine traffic, or rut disturbance as forest floor displacement unless forest floor is removed at the survey point.

Appendix 2. Flow chart for correct assessment of soil disturbance survey points under the Forest Practices Code



[a] These categories are not counted on areas covered under prescriptions approved in accordance with the 1998 Operational Planning Regulation.

Note: This flow chart does not address rehabilitated areas. Where planned rehabilitation has been successful, exposed mineral soil surfaces should be recorded as forest floor displacement, if required, and not as soil disturbance.

Appendix 3. Table of random numbers

Row number	Column number											
	1	2	3	4	5	6	7	8	9	10	11	12
1	20	288	215	98	44	202	323	226	162	262	248	276
2	331	171	204	131	185	39	183	338	209	352	285	333
3	250	142	85	145	348	55	327	137	289	135	146	282
4	259	226	225	215	219	306	267	181	29	328	247	280
5	143	103	64	332	199	215	159	145	84	87	135	250
6	234	261	211	152	181	198	59	179	99	29	106	342
7	360	61	177	310	265	150	23	8	83	122	303	112
8	86	103	313	117	254	284	17	347	296	196	153	251
9	120	191	52	93	297	209	290	251	155	210	47	357
10	6	105	155	77	191	147	356	245	262	36	268	32
11	37	2	259	115	3	24	105	115	130	246	256	61
12	357	180	52	190	311	20	48	348	12	322	223	355
13	326	227	40	93	217	100	336	262	272	83	179	48
14	336	322	174	335	94	358	303	337	253	253	42	163
15	240	213	217	8	184	72	219	136	211	64	154	217
16	289	327	291	216	112	106	147	181	33	311	7	111
17	140	32	297	319	342	15	30	53	54	55	10	139
18	125	81	128	59	121	236	307	264	328	120	247	127
19	351	21	132	172	148	91	93	334	74	126	223	62
20	80	91	98	280	41	146	219	271	248	246	185	179
21	198	255	26	201	330	134	100	19	41	50	192	349
22	80	225	321	260	161	330	260	333	195	145	42	169
23	66	54	140	179	179	46	311	87	340	341	287	98
24	19	185	137	346	163	224	13	72	208	48	124	288
25	281	321	20	16	5	48	70	91	122	305	240	75
26	126	61	317	336	188	184	23	31	174	280	115	88
27	355	267	117	253	186	72	1	221	345	86	89	355
28	321	327	358	78	320	261	187	325	100	91	179	184
29	201	341	29	14	341	63	253	249	226	170	311	127
30	308	233	229	344	215	341	318	334	144	326	70	148
31	195	42	88	337	122	97	84	215	298	168	300	312
32	22	115	136	100	110	73	219	290	133	70	23	55
33	48	190	121	352	200	249	135	55	336	17	263	269
34	175	225	341	307	283	280	359	348	143	230	102	283
35	133	17	293	356	45	151	49	69	334	340	151	251
36	188	43	324	343	104	302	168	92	97	43	321	268
37	133	103	334	241	207	12	208	168	16	153	121	268
38	351	360	102	5	85	226	246	16	155	323	113	260
39	80	354	191	267	197	169	172	348	271	231	40	164
40	299	311	165	41	211	64	281	91	95	186	283	299

Select a row from 1 to 40 and a column from 1 to 12. Use the number at the intersection of the selected row and column.

Appendix 4. Grid spacing for large area method

For survey areas greater than 10 ha this table indicates the required number of grid centres and the spacing between them. Two perpendicular 30-m transects are established per grid centre.

Area (ha)	No. of GCs[a]	Spacing (m)	Area (ha)	No. of GCs[a]	Spacing (m)	Area (ha)	No. of GCs[a]	Spacing (m)	Area (ha)	No. of GCs[a]	Spacing (m)	Area (ha)	No. of GCs[a]	Spacing (m)
11	30	61	33	30	105	55	31	133	76	36	145	97	40	156
12	30	63	34	30	106	56	32	132	77	36	146	98	40	157
13	30	66	35	30	108	57	32	133	78	36	147	99	40	157
14	30	68	36	30	110	58	32	135	79	36	148	100	40	158
15	30	71	37	30	111	59	32	136	80	36	149	101	41	157
16	30	73	38	30	113	60	32	137	81	37	148	102	41	158
17	30	75	39	30	114	61	33	136	82	37	149	103	41	158
18	30	77	40	30	115	62	33	137	83	37	150	104	41	159
19	30	80	41	30	117	63	33	138	84	37	151	105	41	160
20	30	82	42	30	118	64	33	139	85	37	152	106	42	159
21	30	84	43	30	120	65	33	140	86	38	150	107	42	160
22	30	86	44	30	121	66	34	139	87	38	151	108	42	160
23	30	88	45	30	122	67	34	140	88	38	152	109	42	161
24	30	89	46	30	124	68	34	141	89	38	153	110	42	162
25	30	91	47	30	125	69	34	142	90	38	154	111	43	161
26	30	93	48	30	126	70	34	143	91	39	153	112	43	161
27	30	95	49	30	128	71	35	142	92	39	154	113	43	162
28	30	97	50	30	129	72	35	143	93	39	154	114	43	163
29	30	98	51	31	128	73	35	144	94	39	155	115	43	164
30	30	100	52	31	130	74	35	145	95	39	156	116	44	162
31	30	102	53	31	131	75	35	146	96	40	155	117	44	163
32	30	103	54	31	132									

[a] GCs = grid centres

Appendix 5. Field marking conventions

Transect surveys for areas 10 ha and smaller

Point of commencement (POC)

- Use two blue ribbons and two pink-striped ribbons.
- Label the first blue ribbon with "SDS" (for "soil disturbance survey"), the ID number on the survey form, the date, and the surveyor's initials (e.g., SDS FFR-1 94/04/27 S.T.).
- Label the second blue ribbon with the distance and bearing to the baseline (or first transect, if not using a baseline) (e.g., 42 m @ 104° to B/L 0+000).

Baseline (optional)

Choose a convenient colour and mark the location of each transect.

Transects

- Mark the beginning and end of the transect with one pink-striped ribbon and one blue ribbon at each location.
- Label the ribbon with "SDS," followed by start of transect (SOT) or end of transect (EOT), the transect number, and the bearing (e.g., SDS SOT T-3 @ 134°).
- Flag at 100-m intervals with pink-striped ribbon, labelling each ribbon with "SDS," the transect number, the distance, and the bearing" (e.g., SDS T-3 0+100 m @ 134°).

Transect surveys for areas larger than 10 ha

POC

- Use two blue ribbons and two pink-striped ribbons.
- Label the first blue ribbon "SDS" (for "soil disturbance survey"), the ID number on survey form, the date, and the surveyor's initials (e.g., SDS FFR-1 94/04/27 S.T.).
- Label the second blue ribbon with the distance and bearing to the first grid centre (e.g., 42 m @ 104° to GC-1).

Grid centres

- Use one blue ribbon and one pink-and-black-striped ribbon.
- Label the blue ribbon with "GC –," followed by the grid centre number, and a random bearing (e.g., GC-101, 143°).

Transects

- Mark the ground with blue flagging at the start and end of each transect, exactly at the 0-m and 30-m marks (or the appropriate endpoint if the transect goes outside of the NAR).

Road traverses

POC

- Use a new POC for each type of road surveyed (e.g., a haul road, a spur road, and a permanent skid trail would require three separate POCs).
- Use two blue ribbons and two pink-striped ribbons.
- Label the first blue ribbon with the word "Road –," followed by the road number, the ID number on survey form, the date, and the surveyor's initials (e.g., Road-1, FFR-1, 94/04/27, S.T.).
- Label the second blue ribbon with the distance to the first width cross-section, followed by "to R –," the road number, "x –," and the cross-section number (e.g., 18 m to R-1, x-1).
- Leave a blue ribbon on the cutbank at each width-measuring station.

Landing surveys

- Mark the start and end of each landing length and width measurement with a blue ribbon and a pink-striped ribbon.
- Mark the location of each transect on a sketch map of the landing in the field notes.
- If traversing the landing:
  - mark the starting point of the traverse with a blue ribbon and a pink-striped ribbon;
  - label the blue ribbon with an "L –," followed by the landing number and "POC Traverse" (e.g., "L-1 POC Traverse"); and
  - mark each station of the traverse by painting the ground with a blue cross or by leaving a blue ribbon.

Appendix 6. Soil conservation survey field, calculation, and summary forms

Number	Name	Purpose/Comments
FS 880 HSP 96/9	Traverse Survey Field Card (double-sided)	For collecting measurement data on roads, permanent logging trails, and pre-Code fireguards and backspar trails.
FS 885 HSP 96/8	Transect Survey Field Card (double-sided)	For collecting soil disturbance data in the NAR. Used for small *and* large area transect surveys.
FS 886 HSP 96/8	Landing Area Calculation Card (single-sided)	For collecting representative width and length measurements, and calculating areas, for landings.
FS 889 HSP 96/10	Soil Disturbance Summary / Field Map (double-sided)	Summary sheet for all soil disturbance survey calculations, including permanent roads and landings–for both small and large areas. Back side used for sketching map of survey strata.
FS 895 HSP 96/10	Transect Survey Calculation Card, including Calculation Procedure (double-sided)	For calculating statistical information from FS 896 tally card. Confidence limits entered into FS 889 form. *Note: there is also an MOF spreadsheet program to do calculations–available from the Forest Practices Branch.*
FS 896 HSP 96/10	Transect Survey Tally Card (single-sided)	For transferring data from FS 885 field cards. Used to tally large area transect survey totals.
FS 897 HSP 96/9	Small Area Survey Calculation Card / Table of 90% Confidence Interval Half-Widths (double-sided)	Summary card for small area survey of soil disturbance in the NAR (i.e., summary of FS 885 data).

Note: Forms can be downloaded or ordered through the forms index on Ministry of Forests website at: http://www.for.gov.bc.ca/isb/forms

FS 880 HSP 96/9 – Soil disturbance survey – Traverse survey field card

BRITISH COLUMBIA

SOIL DISTURBANCE SURVEY

TRAVERSE SURVEY FIELD CARD

SURVEYOR	DATE Y M D	IDENTIFICATION NO.
A. Nybody	96 | 06 | 27	FFR NE10

ROAD TYPE	LENGTH	HORIZONTAL WIDTH
MAIN	Estimated Length 300 m	Interval 30 m

Stn.	SD [1]	Gradient	HD [1]	S Width [2]	Gradient	H Width [2]	Comments
0+015	15		15			18.2	
0+045	30		30			22.3	
0+075	30		30			19.4	
0+105	30		30			23.9	
0+135	30		30			20.1	
0+165	30		30			21.1	
0+195	30		30			19.3	
0+225	30		30			18.1	
0+255	30		30			20.0	
0+285	30		30			18.7	
0+291	6		6			–	

1 Convert Slope Distance (SD) to Horizontal Distance (HD), using slope tables. Do not record slopes for gradients <15%.
2 Convert Slope Width (S Width) to Horizontal Width (H Width) using slope tables.

FS 880 HSP 96/9

FS 881 HSP 96/8 – Soil disturbance survey – Tranverse survey calculation card

BRITISH COLUMBIA

SOIL DISTURBANCE SURVEY

TRAVERSE SURVEY CALCULATION CARD

SURVEYOR	DATE Y M D	IDENTIFICATION NO.
A. Nybody	96 06 13	FFR-NE10

	MAIN AND SPUR ROADS				FIREGUARDS AND BACKSPAR TRAILS			
	MAIN			TOTAL				TOTAL
LENGTH (m)	291.0							
AVERAGE WIDTH (m)	20.11							
STD WIDTH (m)	1.856							
NUMBER OF WIDTHS MEASURED	10							
$\sqrt{\text{Number of Widths}}$	3.16							
CI WIDTH (m): CI_{Width}	0.812							
Area (ha)	0.585			0.585				
AREA ERROR (ha): "AE"	0.0376							
AE^2	0.0014			0.0014				
GCA OR NAR (ha)			GCA (ha)	19.3			NAR (ha)	
AREA (%)				3.03				
AREA ERROR (%)				0.195				
AREA % LCL_{90}				2.84				

CALCULATION PROCEDURE

1. Complete separate summaries for: a) main and spur roads, and
   b) fireguards and backspar trails (for areas approved prior to full compliance with the Forest Practices Code).
2. Calculate the average and standard deviation (STD) of the widths measured.
3. Calculate the road width confidence interval (CI_{Width}): $CI_{Width} = \frac{t \times STD_{Width}}{\sqrt{\text{Number of Widths}}}$ where "t" is from the t Table
4. Multiply length (in metres) by average width (in metres) and divide by 10,000 to calculate the road area in hectares. Enter the sum of the road areas in the column labelled "Total".
5. Calculate Area Errors (AE) in hectares for each type of road: $AE = \text{Road Area} \times \sqrt{.0025 + \frac{(CI_{Width})^2}{\text{Average Width}^2}}$

   where Total Road Area = the total area disturbed by all haul roads, or all fireguards and backspar trails, as appropriate.
6. Calculate the squares of the Area Errors (AE) and enter the sum of these squares in the column labelled "Total".
7. Calculate the percentage area disturbed: $\text{Area \%} = \frac{\text{Area (ha)}}{\text{GCA or NAR (ha)}} \times 100.$

   Use Gross Cutblock Area (GCA) for permanent roads, and Net Area to be Reforested (NAR) for fireguards and backspar trails.
8. Calculate the Area Error in hectares: $\text{Area Error (ha)} = \sqrt{\text{sum of } AE^2}$
9. Calculate the Area Error in percent: $\text{Area Error (\%)} = \frac{\text{Area Error (ha)}}{\text{GCA or NAR (ha)}} \times 100.$
10. Calculate the lower 90% confidence limit for area % (LCL_{90}): Area % - Area Error %

FS 881 HSP 96/8

t TABLE
90%, one-sided

n - 1*	t
5	1.476
6	1.440
7	1.415
8	1.397
9	1.383
10	1.372
11	1.363
12	1.356
13	1.350
14	1.345
15	1.341
16	1.337
17	1.333
18	1.330
19	1.328
20	1.325
21	1.323
22	1.321
23	1.319
24	1.318
25	1.316
26	1.315
27	1.314
28	1.313
29	1.311
30	1.310
>30	1.310

where "n" is the number of road widths or grid centres (not transects).

FS 885 HSP 96/8 – Soil disturbance survey – Transect survey field card – example for large block method

BRITISH COLUMBIA

SOIL DISTURBANCE SURVEY

TRANSECT SURVEY FIELD CARD

SURVEYOR	DATE Y M D	IDENTIFICATION NO.
A. Nybody	96 | 07 | 29	FFR-NE16

RANDOM NO. ROW	RANDOM NO. COLUMN	POC BEARING AND DISTANCE	GRID / TRANSECT SPACING	45° OFFSET SPACING (spacing x 1.41)	POINT SPACING
15	6	72° 34 m	68 m	95.9 m	1.0 m

GC/TRAN-SECT NO.	101		102		103		104		105		106	
BEARING	56	146	100	190	186	276	92	182	286	16	86	176
1	x	–	–	–	–	–	–	–	–	–	–	T
2	–	–	–	–	–	–	–	–	–	–	–	–
3	–	–	–	–	–	E	–	–	–	–	–	S
4	–	–	–	–	–	E	–	–	–	–	–	S
5	–	E	–	–	G	E	–	–	W	–	S	x
6	S	E	–	S	–	–	S	–	W	–	–	–
7	S	E	–	S	–	–	S	–	–	–	–	–
8	–	E	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	x	–	–	–	–	T	–	–
12	–	–	–	–	–	x	–	–	–	T	–	–
13	–	–	–	T	–	–	–	x	–	–	E	–
14	–	–	–	T	–	–	–	–	–	–	E	–
15	–	–	–	–	–	–	C	–	–	–	E	–
16	–	–	x	–	–	–	C	–	–	–	E	–
17	W	–	x	–	–	–	C	–	–	–	–	–
18	W	–	–	–	–	–	–	–	–	–	–	–
19	–	–	–	–	–	–	–	–	–	–	–	–
20	–	–	–	–	–	–	–	–	–	–	–	–
21	–	–	–	–	–	–	–	–	–	–	–	E
22	x	S	–	–	–	L	–	–	–	–	–	E
23	–	S	–	–	T	L	–	–	–	–	–	E
24	–	–	–	–	T	–	–	–	x	–	x	E
25	–	–	–	–	–	S	E	–	–	–	–	–
26	–	–	–	–	–	S	E	–	–	–	–	–
27	–	–	–	–	–	–	–	–	x	–	–	–
28	–	–	–	–	–	–	–	–	–	–	–	–
29	–	–	–	–	–	–	–	–	–	–	–	–
30	–	G	–	–	–	–	–	–	–	–	–	–

FS 885 HSP 96/8

FS 886 HSP 96/8 – Soil disturbance survey – Landing area calculation card

BRITISH COLUMBIA

SOIL DISTURBANCE SURVEY

LANDING AREA CALCULATION CARD*

SURVEYOR	DATE Y M D	IDENTIFICATION NO.
A. Nybody	96 06 21	FFR-NE12

LANDING SUMMARY TABLE*

LANDING NUMBER	1	2	3					
LENGTH 1 (m)	55.5	33.2	69.1					
LENGTH 2 (m)	49.7	33.0	52.4					
AVG. LENGTH (m)	52.6	33.1	60.8					
WIDTH 1 (m)	33.1	5.9	43.4					
WIDTH 2 (m)	28.9	11.0	38.6					
AVG. WIDTH (m)	31.0	8.45	41.0					
								TOTAL
AREA (ha)	0.163	0.028	0.249					0.440

GCA (ha)	12.5
AREA (%)	3.52
AREA ERROR (%)	0.25
LOWER AREA LIMIT(%)	3.27

CALCULATION PROCEDURE:

1. Calculate the average of the two length measurements for each landing.
2. Calculate the average of the two width measurements for each landing.
3. Calculate the area of each landing in hectares by multiplying the average length by average width and dividing by 10,000.
4. Sum the area of all **landings** and enter this value in the column labelled "Total."
5. Divide the total **landing** area in hectares by the **gross** cutblock area (GCA) and multiply by 100 to calculate the percent area.
6. Calculate the area error by multiplying the area (%) by .0707 (e.g., 3.30% x .0707 = .23%).
7. Calculate the lower area limit by subtracting the area error % from the area % (e.g., 3.3% - .23% = 3.07%).

***Use for landings, borrow pits, truck pull-outs, etc.**

FS 886 HSP 96/8

FS 889 HSP 96/10 (front) – Soil disturbance survey – Soil disturbance summary (example from large block data on the FS 885 form)

BRITISH COLUMBIA

SOIL DISTURBANCE SUMMARY

SURVEYOR	DATE Y M D	IDENTIFICATION NO.
A. Nybody	96 06 19	FFR-NE16

LICENSE NO.	LICENSEE	CP	BLOCK	BCGS OPENING
A99423	LOGWANA	10	4	82K 044-009

REGION	DISTRICT	TU OR SUBSTRATUM Number	of
		1	1

GCA	NAR	SOIL HAZARD RATINGS	COMPACTION	DISPLACEMENT	EROSION	MASS WASTING	FOR. FLOOR DISPLACEMENT
			H	H	H	M	H

COUNTED SOIL DISTURBANCE CATEGORIES (please 3)

- ☐ COMPACTED AREAS
- ☐ WIDE SCALPS
- ☐ CONTINUOUS SCALPS
- ☐ REPEATED MACHINE TRAFFIC
- ☐ 5 cm DEEP WHEEL / TRACK RUTS

SOIL DISTURBANCE SUMMARY

PERMANENT ACCESS STRUCTURES

	LANDINGS	HAUL ROADS	PERMANENT TRAILS	PERMANENT ACCESS
MEAN				
AE %				
			LCL:	

SUMMARY

	SP ALLOWABLE	LOWER 90% CL	NON-COMPLIANCE AMOUNT
COUNTED DISTURBANCE	10.0%	10.1%	0.1%
DISPLACEMENT	25.0%	24.5%	0.0%
PERMANENT ACCESS			

FOREST FLOOR REDUCTION:	SP LIMIT	UPPER 90% CL	NON-COMPLIANCE AMOUNT
AVERAGE DEPTH OF FOREST FLOOR REMAINING AFTER BURNING:	cm		

CALCULATION PROCEDURE FOR LOWER CONFIDENCE LIMIT (LCL) FOR LANDINGS AND PERMANENT ACCESS STRUCTURES:

1. Enter the Percentage Area Errors (AE) from the calculation cards corresponding to each disturbance type.
2. Calculate the pooled Confidence Interval:

$$CI_{\text{Permanent Access}} = \sqrt{AE\%^2_{\text{Landings}} + AE\%^2_{\text{Roads}} + AE\%^2_{\text{Permanent Trails}}}$$

3. Calculate the Lower Confidence Limit as:

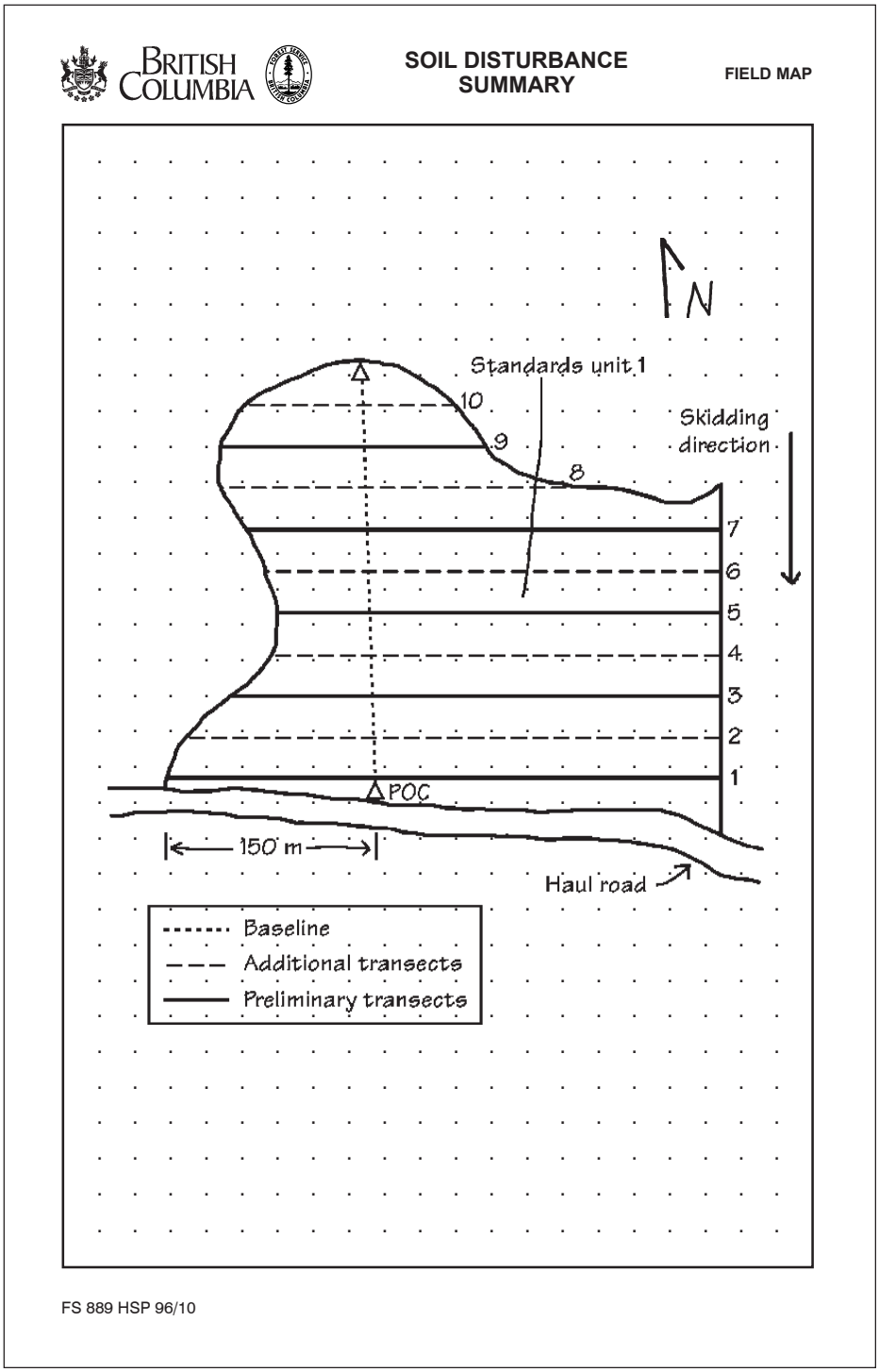
$$LCL_{\text{Permanent Access}} = \text{Total Permanent Access} - CI_{\text{Permanent Access}}$$

similarly for Counted Disturbance and Forest Floor Displacement.

COMMENTS

FS 889 HSP 96/10

FS 889 HSP 96/10 (back) – Soil disturbance summary – Field map



FS 895 HSP 96/10 (front) – Soil disturbance survey – Transect survey calculation card (example from large block data on the FS 885 form)

BRITISH COLUMBIA

SOIL DISTURBANCE SURVEY

TRANSECT SURVEY CALCULATION CARD

SURVEYOR	DATE Y	M	D	IDENTIFICATION NO.
A. Nybody	96	06	19	FFR NE16

		A	B	C	D	E	F	G	H	I	J	K
	GRID CENTRE	COUNTED PRODUCT (H) X (L)	DISPLACE PRODUCT (H) X (J)	SKIDROAD PRODUCT (H) X (K)	TOTAL POINTS SQUARED	COUNTED DISTURBANCE SQUARED	DISPLACE SQUARED	SKIDROADS SQUARED	TOTAL POINTS SURVEYED	COUNTED DISTURBANCE	TOTAL DISPLACE	SKIDROADS
	101	638	1218	-	3364	121	441	-	56	11	21	-
	102	232	870	-	3364	16	225	-	56	4	15	-
	103	580	1160	-	3364	100	400	-	58	10	20	-
	104	413	826	-	3481	49	196	-	59	7	14	-
	105	232	638	-	3364	16	121	-	56	4	11	-
	106	696	1102	-	3364	144	361	-	56	12	19	-
1.	Total	2791	5814	-	20 301	446	1744	-	349	48	100	-
2.	Mean								58.17			
3.	Proportion									0.1375	0.2865	-
4.	Proportion^2									0.0189	0.0821	-
5.	Mean %									13.75	28.65	-
6.	SE %									2.474	2.795	-
7.	LCL %									10.1	24.5	-

* Calculate these numbers only if Skidroad Disturbance is >6% and you are on a site with a High Displacement or Erosion Hazard, where the prescription was approved under the 1994 Silviculture Practices Regulation.

FS 895 HSP 96/10

FS 895 HSP 96/10 (back) – Soil disturbance survey – Calculation procedure for large area method

CALCULATION PROCEDURE (retain four decimals in intermediate calculations):

1. Total each column in Row 1.

2. Calculate the mean number of surveyed points per grid centre in Cell H2.

3. Use the cell references in brackets to calculate the proportion of the total points surveyed with Counted Disturbance, Total Displacement and Skidroads.*

$$\text{Proportion Counted Disturbance} = \frac{[I1]}{[H1]} \qquad \text{Proportion Total Displacement} = \frac{[J1]}{[H1]} \qquad \text{Proportion Skidroads} = \frac{[K1]}{[H1]}$$

   where the text in square brackets specifies the cell references on the form (e.g., [H1] = Total of Points Surveyed).

   * For Forest Practices Code surveys, calculate Counted Disturbance and Total Displacement.

   For areas with prescriptions approved under the 1994 Silviculture Practices Regulations, if you are on a site with a High Soil Displacement or High Surface Erosion Hazard, also calculate Skidroads.

4. Calculate the square of the proportions (Proportion^2).

5. For Counted Disturbance, Total Displacement and Skidroads, calculate: Mean % = 100% x Proportion (from Step 3).

6. Calculate the Standard Error (SE %) for Counted Disturbance, Total Displacement and Skidroads, using the cell references shown in the formulas below (the text in square brackets indicates the cell references on the form (e.g., [H2] = Mean of Points):

$$SE_{\text{Counted \%}} = 100\% \times \sqrt{\frac{[E1] - (2 \times [I3] \times [A1]) + ([I4] \times [D1])}{n \times (n - 1) \times [H2]^2}}$$

$$SE_{\text{Displacement \%}} = 100\% \times \sqrt{\frac{[F1] - (2 \times [J3] \times [B1]) + ([J4] \times [D1])}{n \times (n - 1) \times [H2]^2}}$$

$$SE_{\text{Skidroads \%}} = 100\% \times \sqrt{\frac{[G1] - (2 \times [K3] \times [C1]) + ([K4] \times [D1])}{n \times (n - 1) \times [H2]^2}}$$

   where n = number of grid centres.

7. Calculate the Lower Confidence Limit (LCL %): LCL% = Mean % - t x SE

   where 't' is the value from the t-Table shown on the Traverse Survey Calculation Card (FS 881).

FS 896 HSP 96/10 – Soil disturbance survey – Transect survey tally card (example from large block data on the FS 885 form)

Province of British Columbia — Ministry of Forests

SOIL DISTURBANCE SURVEY

TRANSECT SURVEY TALLY CARD

SURVEYOR	DATE Y M D	IDENTIFICATION NO.
A. Nybody	96 | 07 | 29	FFR-NE16

		COUNTED SOIL DISTURBANCE														
GRID CENTRE	TOTAL DIS-PLACE.	TOTAL COUNTED	SKID-ROADS (R)[1]	RUTS (T)	EXT. UNI. COMP. (E)[2]	WIDE GOUGE (W)	DEEP GOUGE (G)	LONG GOUGE (L)	V. WIDE SCALP (V)	CORD. TRAIL (Y)	WIDE SCALP (S)	CONTIN. SCALP (C)	WIDE AREA (A)	NOT COUNTED – or ⊖	NOT SURV'D (X)	TOTAL SUR-VEYED
101	21	11			4	2	1				4			47	2	58
102	15	4		2							2			54	2	58
103	20	10		2	3		1	2			2			48	2	58
104	14	7			2						2	3		52	1	59
105	11	4		2		2								54	2	58
106	19	12		1	8						3			46	2	58

[1] Skid Roads pre-Code—Excavated/Bladed Roads in Code.
[2] Extensive Uniform Compaction pre-Code—Repeated Machine Traffic in Code.

FS 896 HSP 95/11

FS 897 HSP 96/9 (front) – Small area survey calculation card (data have not been provided for these calculations)

BRITISH COLUMBIA

SOIL DISTURBANCE SURVEY
SMALL AREA SURVEY CALCULATION CARD

SURVEYOR	DATE Y	M	D	IDENTIFICATION NO.
A. Nybody	96	07	29	FFR-NE15

TOTAL POINTS	PRELIMINARY SURVEY	+	ADDITIONAL TRANSECTS	=	FINAL SURVEY
Counted (C)	28		33		61
Displaced (D)	51		56		107
Total (T)	255		255		510

COUNTED DISTURBANCE	PRELIMINARY SURVEY
Proportion (%) (C/T) x 100%	11.0%
CI	2.7%
Proportion (%) - CI	8.3%
Proportion (%) + CI	13.7%

FINAL SURVEY		
12.0%		
2.0%	SP LIMIT	NON-COMPLIANCE
10.0%	9.0%	1.0%

FOREST FLOOR DISPLACEMENT	PRELIMINARY SURVEY
Proportion (%) (D/T) x 100%	20.0%
CI	3.4%
Proportion (%) - CI	16.6%
Proportion (%) + CI	23.4%

FINAL SURVEY		
21.0%		
2.4%	SP LIMIT	NON-COMPLIANCE
18.6%	30.0%	–

COMMENTS Soil disturbance would have been higher if rehabilitation of excavated trails had not been completed.

FS 897 HSP 96/9

FS 897 HSP 96/9 (back) – Small area transect survey calculation card

ONE-SIDED 90% CONFIDENCE INTERVAL HALF-WIDTHS (%) FOR THE BINOMIAL DISTRIBUTION

	SAMPLE SIZE												
%	100	150	200	250	300	350	400	450	500	550	600	650	700
1	1.8	1.4	1.2	1.0	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.6
2	2.3	1.8	1.5	1.3	1.2	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.8
3	2.7	2.1	1.8	1.6	1.4	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.9
4	3.0	2.4	2.0	1.8	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1.1	1.0
5	3.3	2.6	2.2	2.0	1.8	1.6	1.5	1.4	1.4	1.3	1.2	1.2	1.1
6	3.6	2.8	2.4	2.1	1.9	1.8	1.6	1.5	1.5	1.4	1.3	1.3	1.2
7	3.8	3.0	2.6	2.3	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.4	1.3
8	4.0	3.2	2.7	2.4	2.2	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.4
9	4.2	3.3	2.8	2.5	2.3	2.1	2.0	1.8	1.7	1.7	1.6	1.5	1.5
10	4.4	3.5	3.0	2.6	2.4	2.2	2.0	1.9	1.8	1.7	1.7	1.6	1.5
11	4.5	3.6	3.1	2.7	2.5	2.3	2.1	2.0	1.9	1.8	1.7	1.7	1.6
12	4.7	3.7	3.2	2.8	2.6	2.4	2.2	2.1	2.0	1.9	1.8	1.7	1.6
13	4.8	3.9	3.3	2.9	2.7	2.4	2.3	2.1	2.0	1.9	1.8	1.8	1.7
14	5.0	4.0	3.4	3.0	2.7	2.5	2.4	2.2	2.1	2.0	1.9	1.8	1.8
15	5.1	4.1	3.5	3.1	2.8	2.6	2.4	2.3	2.1	2.0	2.0	1.9	1.8
16	5.2	4.2	3.6	3.2	2.9	2.7	2.5	2.3	2.2	2.1	2.0	1.9	1.8
17	5.3	4.3	3.7	3.3	3.0	2.7	2.5	2.4	2.3	2.1	2.1	2.0	1.9
18	5.4	4.4	3.7	3.3	3.0	2.8	2.6	2.4	2.3	2.2	2.1	2.0	1.9
19	5.6	4.5	3.8	3.4	3.1	2.8	2.6	2.5	2.4	2.2	2.1	2.1	2.0
20	5.7	4.5	3.9	3.4	3.1	2.9	2.7	2.5	2.4	2.3	2.2	2.1	2.0
21	5.7	4.6	4.0	3.5	3.2	2.9	2.7	2.6	2.4	2.3	2.2	2.1	2.0
22	5.8	4.7	4.0	3.6	3.2	3.0	2.8	2.6	2.5	2.4	2.3	2.2	2.1
23	5.9	4.8	4.1	3.6	3.3	3.0	2.8	2.7	2.5	2.4	2.3	2.2	2.1
24	6.0	4.8	4.1	3.7	3.3	3.1	2.9	2.7	2.6	2.4	2.3	2.2	2.1
25	6.1	4.9	4.2	3.7	3.4	3.1	2.9	2.7	2.6	2.5	2.4	2.3	2.2
26	6.1	4.9	4.2	3.8	3.4	3.2	2.9	2.8	2.6	2.5	2.4	2.3	2.2
27	6.2	5.0	4.3	3.8	3.5	3.2	3.0	2.8	2.6	2.5	2.4	2.3	2.2
28	6.3	5.0	4.3	3.8	3.5	3.2	3.0	2.8	2.7	2.5	2.4	2.3	2.2
29	6.3	5.1	4.4	3.9	3.5	3.3	3.0	2.9	2.7	2.6	2.5	2.4	2.3
30	6.4	5.1	4.4	3.9	3.6	3.3	3.1	2.9	2.7	2.6	2.5	2.4	2.3
31	6.5	5.2	4.5	4.0	3.6	3.3	3.1	2.9	2.8	2.6	2.5	2.4	2.3
32	6.5	5.2	4.5	4.0	3.6	3.3	3.1	2.9	2.8	2.6	2.5	2.4	2.3
33	6.6	5.3	4.5	4.0	3.7	3.4	3.1	3.0	2.8	2.7	2.5	2.4	2.4
34	6.6	5.3	4.6	4.0	3.7	3.4	3.2	3.0	2.8	2.7	2.6	2.5	2.4
35	6.6	5.3	4.6	4.1	3.7	3.4	3.2	3.0	2.9	2.7	2.6	2.5	2.4
36	6.7	5.4	4.6	4.1	3.7	3.4	3.2	3.0	2.8	2.7	2.6	2.5	2.4
37	6.7	5.4	4.6	4.1	3.7	3.5	3.2	3.0	2.9	2.7	2.6	2.5	2.4
38	6.8	5.4	4.7	4.1	3.8	3.5	3.2	3.0	2.9	2.7	2.6	2.5	2.4
39	6.8	5.5	4.7	4.2	3.8	3.5	3.3	3.1	2.9	2.8	2.6	2.5	2.4
40	6.8	5.5	4.7	4.2	3.8	3.5	3.3	3.1	2.9	2.8	2.6	2.5	2.4
45	6.9	5.6	4.8	4.2	3.9	3.6	3.3	3.1	3.0	2.8	2.7	2.6	2.5
50	6.9	5.6	4.8	4.3	3.9	3.6	3.3	3.1	3.0	2.8	2.7	2.6	2.5

Appendix 7. Counted soil disturbance categories and recommended limits according to hazard ratings

Soil disturbance hazard[a]	Soil sensitivity rating	Categories counted in allowable soil disturbance[b]	Allowable soil disturbance (% NAR)	
			Coast and Interior	
Assessment of soil hazards not required		Always + S + E + T5 + A	5	
Likelihood of landslides	M, H	Always + S	5	
Soil erosion	VH	Always + S	5	
Soil displacement	VH	Always + S	5	
Soil compaction	VH	Always + S+ E + T5 + A	5	
			Coast	Interior
Soil erosion	H	Always	5	10
Soil erosion	M, L	Always	5	10
Soil displacement	H, M, L	Always	5	10
Soil compaction	H	Always + E + T5 + A	5	10
Soil compaction	M	Always + E + A	5	10
Soil compaction	L	Always	5	10
Likelihood of landslides	L	Always	5	10

[a] Assessing the hazards for soil compaction, soil displacement, and soil erosion need not be done if the harvesting method is cable or aerial.

[b] Under the "Categories counted" column, the term "Always" includes soil disturbance that is always counted, namely excavated or bladed trails, corduroyed trails, 15-cm-deep ruts, deep gouges, long gouges, wide gouges, very wide scalps. The meaning of the other symbols are: "S": wide scalps; "T5": 5-cm-deep ruts; "E": repeated machine traffic; and "A": compacted areas.

Combine the categories measured for different hazard ratings if that will result in more categories being counted or a lower allowable disturbance limit. For example, on a site with a Very High compaction hazard and a High surface erosion hazard, the categories counted are "Always + S + E + A + T5," the soil disturbance limit would be 5%.