

Protocol for Soil Resource Stewardship Monitoring: Cutblock Level

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Foreword

The soil conservation provisions in BC's Forest Practices Code (FPC) and *Forest and Range Practices Act* and regulations (FRPA) recognize that it may take many years to fully understand soil disturbance effects on forest productivity or hydrologic function. Except for obvious losses of productive site through access development, FRPA and the processes for resource stewardship monitoring (RSM) and effectiveness evaluation (EE) consider soil disturbance observable on the ground at the time of completing operations as a proxy for longer-term effects. Other indicators presented here, including those related to slope stability, hydrologic function, biological function and organic matter retention are also considered essential for evaluating the extent to which forest management is consistent with desired results, as expressed by government objectives for soil values. The overall soil conservation framework for soil disturbance in BC (hazard ratings, disturbance types, cumulative limits) and other potential indicators of soil conservation that are included here are also being tested through validation (research), and it is expected that the framework will be revised from time to time as new knowledge arises. Therefore, part of RSM/EE is to identify needs for validation (research), in addition to information gaps related to policy implementation.

The method and indicators presented here are suitable for use one to two years after harvesting operations are completed. Some indicators of forest productivity, such as site index, have not been included in this document because they are more useful after longer time periods. Research efforts (validation monitoring) are underway to evaluate the linkage between soil disturbance at the time of operations and long-term forest productivity.

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Purpose of this Document

The following protocol was created to provide background information and instructions for data collection for Soil Resource Stewardship Monitoring of the BC Ministry of Forests FRPA Resource Evaluation Program (FREP).

Goal of Soil Resource Monitoring

The goal of soil resource stewardship monitoring is to determine whether FRPA standards and practices governed by regulation are achieving the desired result of protecting soils. Specifically:

“Do access structures have the least possible impact on productive soil loss and hydrologic function of the soil?”

“Are forest practices resulting in levels of site disturbance detrimental to soil productivity and hydrologic function?”

Objectives of the Monitoring Process

The objectives of cutblock-level soil resource stewardship monitoring are to:

1. quantify and describe:
 - the amount of soil disturbance within cutblocks
 - detrimental effects of soil disturbance on natural drainage patterns, potential for landslides, and erosion
 - aspects of green tree, woody debris and organic matter retention that are considered essential for maintaining soil biological processes and productivity.
2. compare these data with accepted operational standards where applicable and to determine if the results are consistent with the objective set by government for soils (i.e., to maintain soil productivity and hydrologic function).
3. test underlying soil value assumptions of FRPA that (a) sites are properly described and identified, (b) soil disturbance is not unduly concentrated, and (c) effects of permanent access are minimized.
4. monitor the data collected over time from various areas and site conditions, which will permit benchmark evaluations of soil conservation (stewardship) effectiveness in BC, and help identify areas requiring more information, direction, or technical support to ensure sustainable resource management for the benefit of all forest users in BC.

In addition, information collected will help identify areas that may need more information, either from more detailed stewardship monitoring or from applied research.

While Resource Stewardship Monitoring is not directed towards compliance or enforcement (C&E), incidents of possible or apparent non-compliance that become evident during the data collection process will be identified for C&E consideration.

Principles of Site Selection

For general information on the site selection process, refer to *Protocol for 2005 Resource Stewardship Monitoring* at http://www.for.gov.bc.ca/hfp/frep/7_rsm.html.

For resource stewardship monitoring, sample blocks are randomly selected from a list of all the candidate blocks within a defined sampling population. Stratification can be employed to make the sampling easier (e.g., sampling by Forest District; sampling sites that are less than 2 years old) or to reduce variability among sites (e.g., all sites with high sensitivity soils and harvested during summer).

For soil resource monitoring, the following factors are considered as posing higher risk of degrading soil disturbance, and may warrant a greater sampling effort during site selection and stratification:

- sites with high or very high hazard for soil degradation
- sites with summer skidding
- sites that were salvage harvested
- sites with partial cutting
- sites with ridged or hummocky terrain or catenas with mixes of distinctly different soil types
- small cutblocks
- steep slopes
- drier or wetter ecosystems
- specific prescribed practices meeting higher disturbance guidelines (e.g., stump removal or other aggressive site preparation)
- roadside work areas where these are considered to represent a large proportion of cutblocks.

The 2004/05 pilot focussed on randomly selected cutblocks that were logged without snow or frozen soil in the last two years. These were further broken down into two categories based on slope (greater or less than 30%) determined as “percent average slope” from the cutblock cruise summary.

In cases where insufficient blocks meet one or more of these criteria, the selection scope may be broadened (e.g., 3 years old instead of 2 years), but the additional categories will need to be considered as factors when analyzing the data. Please discuss this with Soil Value team members before proceeding outside of the agreed upon criteria for selection or stratification.

Indicators

The monitoring assessment is organized into six key indicator areas, each focussing on an aspect related to soil conservation in FRPA, or in a general stewardship context. The six areas and some rationale for their inclusion are listed below.

1. Lost productivity due to access construction

Permanent access structures like main roads and permanent spur roads, landings and burrow pits represent a fundamental change in the ground surface, reducing productive landbase and also affecting hydrologic function of large areas. Roads are often one of the main contributing factors in regard to slope stability and erosion/sedimentation issues both on and off the cutblock area. Because of these concerns, it is desirable to minimize the amount of permanent access constructed, and to rehabilitate any temporary access back into productive forest land. Access is tracked under FRPA at the cutblock level because it is very difficult to compliance monitor at a landscape level.

2. In-block area affected or potentially affected by landslides, drainage diversion (overland flow), or significant erosion

These represent losses, or potential losses, in productive landbase and/or hydrologic function, and may affect other FRPA resource values both on and off the cutblock area.

3. In-block area affected by disturbance to natural drainage patterns resulting in accumulations of water

These represent losses, or potential losses in hydrologic function and/or productive landbase and may affect other FRPA resource values both on and off the cutblock area.

4. Dispersed soil disturbance in the net area to be reforested

Widespread compaction or displacement of topsoil can affect both forest productivity and hydrologic function, affecting other FRPA resources values both on and off the cutblock area.

5. Green tree retention

Some soil organisms, such as beneficial mycorrhizas, require live trees retained on site. It is recognized that this is an important aspect of soil stewardship and needs to be tracked over time.

6. Organic matter retention

Organic matter is a key driver of ecosystem processes, acting as an important reservoir of on-site nutrient pools and longer-term productivity, and onsite hydrologic function (e.g., water relations for trees).

Getting Started: Background data needs and documentation (office)

The first step is to determine the “population” and select random samples as described in the Principles of Site Selection section. This may be done centrally under the provincial FREP program.

Review of existing information for each selected cutblock is essential to planning and executing the field portion of resource stewardship monitoring, and also for interpreting the results of field surveys. Establish a file for each cutblock to be sampled, and use the checklist below to ensure that copies of the following records and any other applicable information (e.g., C&E file notes, field monitoring reports, or actions; certification audits; Forest Practices Board audits) are placed in the file:

Office Checklist for Soil Conservation Effectiveness Evaluation	Copy has been placed in the EE file	Reviewed
1. Operational plan, including maps		
2. Post harvest or interim inspections (if available)		
3. Cutblock cruise summary		
4. Preliminary site plan data collection cards		
5. Air photos or satellite images		
6. Summary output from RESULTS		
7. Fire Hazard Assessment if available (previously Schedule 7 as per Appendix 3)		
8. Other item		

Review of Background Information: Includes maps and air photos

Cutblocks selected for monitoring need recent air photos. Air photo review, in conjunction with operational plans and maps, is used to:

- (a) make preliminary measurements and assessments of the 6 indicator areas
- (b) decide on features, including potential areas of inordinate disturbance, that need to be visited in the field
- (c) determine orientation of major soil disturbance and plan survey transects so they cross this disturbance on representative areas of the Standards Units
- (d) develop an overall travel plan for the field assessment.

An example of the photo method for use with standard air photos is presented in Appendix 4. A description of how to use OziExplorer software for completing this step is provided in Appendix 5. Methods for more detailed use of air photos in resource stewardship monitoring are available in Chapman (2005 initial draft is available from the author).

From the photo review, preliminary estimates can be made of:

- area of the block in permanent (unrehabilitated) access
- area of the block affected by inordinate soil disturbance¹
- area of the block affected by landslides, erosion and drainage alteration
- green tree and woody debris retention.

Based on the air photo review and other available information, a walk-through survey should be planned incorporating inspection of areas of inordinate disturbance, access structures, and features of interest, as well as areas that appear to represent average conditions on the block. Transects for quantitative evaluation of soil disturbance, and coarse woody debris are carried out at representative areas during the walkthrough, along with plots or other measures to estimate green tree retention. Detailed methods for transect layout are presented in Appendix 4.

¹ For the purposes of RSM, inordinate soil disturbance is defined as: “30% or higher disturbance on areas larger than 0.2 ha, or smaller areas if there is a high risk to other FRPA Resource Values.”

Field Gear Checklist

Use the following checklist to ensure that all field gear is available.

Item	Description	In field gear?
1	100 m Eslon tape or equivalent	
2	2 m tape or equivalent	
3	Shovel for compaction evaluation and soil pits	
5	Clinometer	
6	Compass	
7	Soil disturbance survey Reconnaissance Survey Field Cards (FS 879) ^a or appropriate field paper for transect data	
8	Soil RSM cards (FS 1246)	
9	Silviculture Prescription (Site Plan) Plot Card for checking soil disturbance hazards (FS 39A, both halves) ^a	
10	<i>Soil Conservation Surveys Guidebook</i> ^a	
11	Silviculture Prescription (Site Plan) data collection field handbook LMH 47 ^a	
12	<i>Protocol for Soil Resource Stewardship Monitoring: Cutblock Level</i>	
13	Camera, preferably digital with high resolution	
14	Map, air photo, access notes, and other information on the site	
15	Calculator	
16	Personal field gear, food, water, any safety gear needed	
17	Hip chain for width and length measures (optional)	
18	Auger to check deeper soil layers in hazard rating checks (optional)	

^a Waterproof versions are often available, particularly of the forms. If necessary, these can be downloaded from the following web addresses:

FS 879: <http://www.for.gov.bc.ca/isb/forms/lib/FS879.PDF>

FS 39A: <http://www.for.gov.bc.ca/isb/forms/lib/FS39A.PDF>

LMH 47: <http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh47.htm>

Soil Conservation Surveys Guidebook: <http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/SOILSURV/soilconsurv.pdf>

Field Data Collection

The purpose of the field data collection phase is to:

- confirm estimates of access, soil disturbance, landslides, woody debris and green tree retention obtained from the air photo overview
- provide responses to stewardship questions with rationale for affirmative answers
- visit and evaluate each feature identified from the air photo
- evaluate sites where drainage or erosion may be of concern
- survey each transect planned from the air photo overview to evaluate dispersed and potentially inordinate soil disturbance
- evaluate the effectiveness of rehabilitation treatments
- using principles in LMH 47, confirm the soil disturbance hazard ratings and Standard Unit (SU) boundaries
- better evaluate factors which may have affected the results observed.

Use the following checklist to ensure that all relevant aspects of the field survey will be completed.

Item	Description	Survey required?	Survey completed?
a)	length and width estimates for typical roads and landings		
b)	size, location and rehab status of rehabilitated structures		
c)	structures built through materials unsuitable for rehab		
d)	landslides (area)		
e)	active erosion		
f)	areas with altered drainage		
g)	areas with inordinate soil disturbance		
h)	area and soil disturbance within roadside work areas		
i)	transects for dispersed soil disturbance	All SUs*	
j)	transects for green tree retention	All SUs	
k)	transects for woody debris	All SUs	
l)	other areas or features of interest		
m)	Check soil disturbance hazards and Standards Units	All SUs	
n)	Schedule 7 fire hazard survey if not previously completed		

* Other items may require survey in some situations.

Field Methods

1. Check the planned transects from the air photo review and make necessary adjustments.
2. Carry out the walk-through of the entire block and:
 - confirm measurements of access structures
 - cross all sensitive areas
 - evaluate soil disturbance hazards within each SU (refer to LMH 47)
 - record soil disturbance along planned transects
 - stop at other features and points of concern.
3. Conduct surveys for dispersed soil disturbance within each SU (Table 4), and cutblock level assessments of green tree retention (Table 5) and woody debris retention (Table 6). Use a 100 m tape, or equivalent, for the soil disturbance and woody debris surveys. Flag and label the PoC, the start and end of each transect, and the edges of any roadside work areas.
4. Complete all field forms and provide professional opinion on the state of soil and hydrologic function before leaving the site.

Filling in the Forms

This section provides detailed information for filling out the field cards (begins on following page).

Section

Instructions/Descriptions

Opening Information

Form A Side 1

Opening Identification				
Opening # _____	Opening ID _____			
License # _____	CP # _____ Block _____			
Evaluator _____	Date _____			
Licensee _____				
District _____	Year of Harvest _____			
Location Description _____				
Net area to be reforested (ha) _____ Gross area (ha) _____				
1. Estimating lost soil productivity due to access construction.				
1.1 Delineate and measure cutblock area in un-rehabilitated roads, landings, and borrow pits				
Structure ID	Area (length x width) m ²	Description	% of Cutblock 100 % x (area of structure/ total cutblock area)	
1.2 Delineate and measure cutblock area in rehabilitated access and effectiveness of rehabilitation treatments				
Structure ID	Area (length x width) m ²	Description	ER ¹	% of Cutblock 100 % x (area of structure/ total cutblock area)
¹ Effectiveness of rehabilitation treatments on access. ER (effectiveness of rehab) ranges from 0 (unproductive ground) to 1 (fully restored soil conditions), and is determined according to the following method [partial scores are possible], where: ER = a+b+c a) Was the rehabilitated area decompacted as necessary? Determine this by digging. Assign a score from 0 to 0.5 max and make any comments here, noting which feature the comment refers to: b) Was topsoil and/or burrpile debris, and woody debris re-spread with minimal mixing of subsoil? Dig to determine if the texture and organic matter content are similar to undisturbed soils on similar sites in the area, or if it is good rooting medium that is organic rich but free of voids and buried coarse woody debris. Assign a score from 0 to 0.5 max and make any comments here, noting which feature the comment refers to:				

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Opening Identification

Opening/License/CP/Block number – from RESULTS or post-harvest map

Evaluator – your name

Licensee – from history records

Date – date of evaluation

District – Forest District

Year of harvest – from RESULTS

Location description – additional info

NAR area ha – from RESULTS or photo interp

Gross area ha – from RESULTS or photo interp

1. Estimating lost productivity due to access

1.1 Roads, landings, and borrow pits

Structure ID – provide a unique number or symbol for each structure. Mark the location on the map/photo

Area – length × width; enter in m²

Description – describe the structure

% of cutblock – divide area of structure (divide by 10 000 to convert m² to ha) by gross area and multiply by 100%

1.2 Rehabilitated access

Structure ID – provide a unique number or symbol for each structure. Mark the location on the map/photo

Area – length × width; enter in m²

Description – describe the structure

% of cutblock – divide area of structure (convert to ha) by gross area

ER – determine ER based on calculation (enter a value between 0 and 1)

Section	Instructions/Descriptions
Section 1 Questions Form A Side 2	1.3 Additional information for answering the stewardship questions 1.3a <i>Does the total amount of permanent access seem excessive given the site conditions?</i> <p>Permanent roads and other structures represent a permanent deletion of land from productive growing site. Roads are necessary to gain access to the forest for timber harvest, fire suppression, recreation, or other needs. Excessive road construction reduces the amount of land available for growing trees and thereby reduces overall forest productivity. Roads also require maintenance, and poorly maintained roads pose a risk of erosion, slope failure and sedimentation of water sources used by people and fish. To determine whether the amount of permanent access is excessive, consider the following:</p> <ul style="list-style-type: none"> Are road widths greater than what would normally be needed considering the amount of traffic expected on the road? The 7 percent “threshold” for permanent access in FRPA is only a guideline, and logging operations can often be conducted efficiently with less access. In fact some jurisdictions in Western Canada and the Pacific Northwest specify limits for permanent access that are lower than 7 percent. Permanent access may exceed 7 percent and still not be considered excessive. For example, a mainline road often cuts through a small block, and switch backs are a necessary part of road construction on steep slopes. <p>1.3b <i>Are there portions of the un-rehabilitated access that should have been considered and treated as temporary access (i.e., it should have been rehabilitated)?</i></p> <p>Sometimes a temporary road or landing can be used to reduce skidding distances and thereby improve the efficiency of logging operations. Despite this, if an access structure (a) is not expected to provide access for timber harvesting and other activities that are not wholly contained in the cutblock, and (b) does not contain, materials unsuitable for the establishment of a commercial crop of trees, it should be considered temporary, and rehabilitated.</p> <p>Such temporary roads are only needed once, and may not be useful in the future because harvesting technology is likely to change over the long time frames of a forest rotation. For this reason, roads that will not be used until the next rotation are best considered temporary. Several lines of preliminary research indicate that compaction caused by road construction can be alleviated by rehabilitation techniques, and productive forests can establish on rehabilitated areas on many soil and site types throughout BC. Although costs of rehabilitation vary, failing to rehabilitate</p>



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FRPA Resource Evaluation Program

Resource Stewardship Monitoring

Section 1 Questions - Form A Side 2

Soils

LIC. _____ CP _____ BLK _____ DATE _____ EVALUATOR _____

c) Has the rehabilitated area been reforested, or is there a reasonable likelihood that natural revegetation and reforestation will occur as a result of ingress from the surrounding area? Assign a score from 0 to 0.2 max and make any comments here, noting which feature the comment refers to:

1.3 Questions
Note: If the answer to any of these questions is yes, provide a description, and indicate the feature on the map

1.3a Does the total amount of permanent access seem excessive given the site conditions? YES ☐ NO ☐

1.3b Are there portions of the un-rehabilitated access that should have been considered and treated as temporary access (i.e it should have been rehabilitated)? YES ☐ NO ☐

1.3c Do any individual access structures seem larger than necessary? YES ☐ NO ☐

1.3d Were pre-existing structures, such as old roads and trails, present in the NAR? YES ☐ NO ☐

1.3e Were pre-existing structures not used where it appears that they should have been? YES ☐ NO ☐

1.3f Are there rehabilitated areas where drainage control was not included in the rehabilitation treatments, but should have been? YES ☐ NO ☐

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temporary roads reduces the amount of growing site and thereby reduces forest productivity. When deciding whether rehabilitation should have been carried out, consider:

- Is the road or landing likely to be used for timber hauling before the trees planted on the cutblock are ready for harvest?
- Is partial cutting occurring or likely to occur in the area, so that ongoing access is required?
- Are there important reasons to keep the road open for forest management activities such as spacing, thinning, or for other reasons such as Non-Timber Forest Product harvesting, recreation, fire suppression, etc.?
- Are there reasons to believe that rehabilitation efforts will not succeed or will be too costly, including the presence of unsuitable material for rehabilitation, such as ballast, fine textured soils, calcareous subsoils, or where roads were constructed through blasted rock?

1.3c *Do any individual access structures seem larger than necessary?*

Roads and landings need to be large enough for equipment to operate safely, and in some special cases, additional space is needed for log sorting or other activities. Sometimes operational efficiencies can be gained by having a larger working surface than would otherwise be necessary. Despite this, excessively large access structures reduce the amount of land available for growing trees and reduce forest productivity. Structures that are built large to facilitate log sorting or other activities may not need to be so large in future logging operations where piece size and species mix are likely to be different than today. Where such structures exist, the best approach would be to carry out rehabilitation on portions of the structure, thereby reducing their size. When deciding whether structures are larger than necessary, consider:

- Sorting operations may have necessitated a large landing for the current harvest, but this should not be used to justify leaving it unrehabilitated for the next harvest.
- Wide roads are not needed where visibility is good and little traffic is expected in the future.

1.3d *Were pre-existing structures, such as old roads and trails, present in the NAR?*

In many parts of BC, previous logging, mineral exploration or other activities have left soils in a disturbed state. Where pre-existing structures are present, current operations should be carefully planned so that cumulative effects are minimized. Ideally, the pre-existing structures would simply be re-used for the current operations. In reality, the pre-existing structures are unlikely to fully meet the needs of the new operation without some adjustments. For good soil conservation practice to occur, recognizing the presence of such structures is essential. Consider:

- Is there a history of previous cutting or mineral exploration, or ranching in the area?
- Are previously constructed roads, trails, borrow pits or other features present on the harvested area?
- Previously constructed structures may be obscured because of revegetation that has occurred.

1.3e *Were pre-existing structures not used where it appears that they should have been?*

If logging or other forest management operations are not planned in consideration of pre-existing access structures, cumulative effects could have a major effect on the productivity of future forests. The soil conservation provisions (i.e., disturbance limits) in FPC and FRPA were developed under the assumption that the growing site areas of the block had not been subjected to previous disturbance such as that associated with pre-existing trails. Research has shown that the greatest amount of compaction occurs to soil during the first few passes of heavy equipment. Where significant amounts of pre-existing disturbance are present, and subsequent harvesting operations do not attempt to re-use these structures, large portions of the growing site area can be subjected to alteration of soil properties due to compaction. Drainage problems that increase the risk of significant erosion should be fixed as part of good stewardship even if structures are not re-used. For determining whether pre-existing structures should have been used, consider:

- Are there examples of new roads and/or trails that run parallel to old structures on similar slope positions?
- Does it appear as if minor adjustments to road or landing locations could have facilitated skidding down existing trails?
- Would it have been possible to carry out simple rehabilitation techniques on the area to alleviate the cumulative effects of previous trail disturbance?
- Do cumulative effects of pre-existing disturbance and the effects of current operations appear to have resulted in inordinate disturbance?

1.3f *Are there rehabilitated areas where drainage control was not included in the rehabilitation treatments, but should have been?*

The most important aspect of rehabilitation is water control, because (a) disrupted drainage patterns are a cause of sedimentation and slope instability, and (b) productivity of the new forest is highly dependant on the moisture regime. For these reasons, it is essential that rehabilitation work incorporate structures and techniques to restore natural drainage patterns.

Consider the following:

- For rehabilitated skid roads on steep slopes, check to ensure that the subsurface was decompacted in an outsloping profile, so that water will not be trapped against the cut and be channelled down the inner ditch.
- Ensure that gentle swales and dips have been incorporated into long unbroken slopes of rehabilitated roads to prevent moving water from channelling over long distances.
- It is best practice to incorporate cross drainage into rehabilitated trails and roads even though the subsurface flow patterns are thought to have been restored through restoration treatments.

Section

Instructions/Descriptions

Section 2

Form B Side 1

		FRPA Resource Evaluation Program	Soils Resource Stewardship Monitoring Section 2 - Form B Side 1
LIC. _____ CP _____ BLK _____ DATE _____ EVALUATOR _____			
2. Estimating in-block area affected or potentially affected by landslides, drainage diversion or significant erosion from roads, landings or trails.			
LANDSLIDES			
2.1 Delineate and measure cutblock areas in new failures outside the road, landing or trail prism (include dry ravel)			
Failure ID	Description	Area (length x width) m ²	
2.2 Delineate and measure cutblock areas that could be affected by road, landing or trail construction or maintenance practices (e.g. roadcuts through material and/or slope conditions, known to have stability problems in the local area, often including clay textured materials on wet slope locations)			
Area ID	Description	Area Potentially Affected m ²	
2.3 Delineate and measure areas of water diversion, or potential water diversion, onto slopes, channels or structures (e.g., evidence of overland flow) – Describe potential concerns regarding stability and/or erosion that may be expected to occur.			
Area ID	Description	Area m ²	

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2. Estimating landslides, drainage and erosion

2.1 Landslides

Failure ID – provide a unique number or symbol for each failure.

Mark the location on the map

Description – describe the feature

Area – length × width; enter in m²

2.2 Construction and maintenance practices

Area ID – provide a unique number or symbol for each area.

Mark the location on the map

Description – describe the structure and nature of the concern

Area – length × width; enter in m²

2.3 Water diversion

Area ID – provide a unique number or symbol for each area.

Mark the location on the map

Description – describe the structure and nature of the concern

Area – length × width of the affected or potentially affected downslope area; enter in m²

Section

Instructions/Descriptions

Section 2 & 3

Form B Side 2



FRPA Resource
Evaluation Program

Resource Stewardship Monitoring
Section 2 & 3 - Form B Side 2

Soils

LIC. _____ CP _____ BLK _____ DATE _____ EVALUATOR _____

EROSION

2.4 Delineate and measure eroded areas, or those at significant risk of erosion in the cutblock (such areas are typically devoid of vegetation, but do not count unvegetated deposits)

Area ID	Description	Area m ²

2.5 Questions
Note: If the answer to any of these questions is yes, provide a description, and indicate the feature on the map.

2.5a Have harvesting practices or access construction led to or significantly increased the potential for mass movement or soil erosion? YES ☐ NO ☐

2.5b Are there any potential or existing off-site effects related to mass movement, erosion or sedimentation evident during your field or office review? YES ☐ NO ☐

3. Estimating in-block area affected by disturbance to natural drainage patterns as a result of forestry operations

3.1 Delineate and measure cutblock areas experiencing, or at risk of experiencing, altered drainage or standing water as a result of construction of roads, landings, trails, or inordinate soil disturbance (e.g. areas with evidence of saturated soils, drowned vegetation or regeneration problems due to raised water table, interception of ephemeral streams or seeps by ditchlines; or areas expected to experience these problems due to evident drainage problems)

Area ID	Description	Area Affected m ²

3.2 Questions
Note: If the answer to this question is yes, provide a description, and indicate the feature on the map.

3.2a Are there areas where measures should have been taken to restore natural drainage patterns, but were not? (eg. water-barring and cross-ditching as appropriate on various structures, ditching to control water across the back of landings) YES ☐ NO ☐

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2.4 Erosion

Area ID – provide a unique number or symbol for each area.

Mark the location on the map

Description – describe the structure and nature of the concern

Area – length × width of the affected or potentially affected area; enter in m²

2.5 Additional information for answering the stewardship questions

2.5a *Have harvesting practices or access construction led to, or significantly increased the potential for mass movement or erosion?*

If landslides or erosion are evident on the cutblock, it is important to determine the extent to which harvesting practices or access construction contributed to their occurrence, as compared to features that may have been formed by natural processes.

Consider:

- Are permanent roads and landings above new failures stable and in a condition where water was channelled into areas that could have or did cause a failure?
- Was inadequate water-barring, cross-ditching, culvert spacing and sizing evident along permanent roads in the vicinity of new failures?
- Should slope stability issues have been recognized in the planning process, or were construction practices not carried out in a manner consistent with the recognition of stability problems?
- Should measures (e.g., seeding) have been implemented to stabilize areas of exposed mineral soil to prevent erosion?

2.5b *Are there any potential or existing off-site effects related to mass movement, erosion or sedimentation evident during your field or office review?*

Major liabilities and costs can be experienced when harvesting creates off-site impacts on water or slope movement. A major cause of land-sliding is altered drainage from forest roads and trails. Consider:

- Are permanent roads and landings stable and in a condition where water will not be channelled into areas that would become unstable if saturated?
- Is appropriate culvert spacing and sizing evident along permanent roads?
- Have deactivated roads been left in a stable condition and with adequate drainage control?

- Are there sensitive or high risk areas or water bodies adjacent to or downslope of the cutblock that suggest special care should have been taken in harvesting, and does it appear that appropriate care was taken in the harvesting operations?
- Is erosion evident on running surfaces or in ditches of roads or trails

3. Estimating disturbance to drainage patterns

3.1 *Areas experiencing, or at risk of experiencing disturbance to natural drainage patterns*

Area ID – provide a unique number or symbol for each feature. Mark the location on the map

Description – describe the feature

Area – length × width; enter in m²

3.2 *Additional information for answering the stewardship questions*

3.2a *Are there areas where measures should have been taken to restore natural drainage patterns, but they were not carried out? (e.g., water-barring and cross-ditching as appropriate on various structures, ditching to control water across the back of landings)*

In-block areas affected by drainage diversion can have reduced productivity. Research has shown that the success of reforestation efforts on rehabilitated areas is highly correlated with the site moisture regime, and changes in moisture regime also affect the success of silviculture treatments in areas of the cutblock that have not themselves experienced soil disturbance. Consider:

- Is there evidence that water is collecting in areas that were previously mesic or drier, and does the changed water regime appear to be capable of affecting forest productivity?
- Is there evidence that dispersed soil disturbance such as rutting is leading to the channelling of water?

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Section 4

Form C Side 1



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Soils

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4. Description of the in-block soil disturbance hazards, areas affected by dispersed soil disturbance, potentially inordinate disturbance, and roadside work areas.

4.1 Determine the soil disturbance hazards for each SU. (For most-sensitive portions of SU. Attach form FS39A.)

Hazard	SU	SU	SU
Compaction			
Displacement			
Forest floor displacement			
Erosion			
Mass wasting			

4.2 Delineate and measure areas of inordinate disturbance ². (For areas greater than 0.2 ha, carry out a transect survey with 50 or more points. Attach FS879 for each transect and enter summary data in Table 4.6, use disturbance type codes ³, circle points with forest floor displaced.)

Area ID/ Transect No.	Area (l x w) m ²	Total disturbance %	Counted disturbance %	Description

² Areas larger than 0.2 ha with 30% or higher disturbance or smaller area if there is a high risk to other FRPA values.

³ Disturbance type codes:

Ts Wheel or track ruts 5-15cm deep	C Continuous scalps	R Unrehabilitated excavated and bladed trail
Td Wheel or track ruts > 15 cm deep	Y Unrehabilitated corduroy trail	
E Repeated machine traffic	A Unrehabilitated compacted area	
G Deep gouges	O Other scalps and gouges not meeting above types	
L Long gouges	r Rehabilitated TAS and compacted areas	
W Wide gouges	M Other machine traffic types	
V Very wide scalps		
C Wide scalps		

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4. Soil disturbance hazards, dispersed disturbance, inordinate disturbance, and roadside work areas

4.1 Soil disturbance hazards

Determine the soil disturbance hazards for each standards unit using form FS 39A. Follow the protocols in LMH 47.

4.2 Areas of inordinate disturbance

These are defined here as areas larger than 0.2 ha with 30% or higher disturbance, or smaller areas if there is a high risk to other FRPA resource values. Lay out a transect following the methods described in Appendix 3. Carry out a transect survey of at least 50 points for areas greater than 0.2 ha using form FS 879. The *Soil Conservation Surveys Guidebook* (<http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/SOILSURV/soilconsurv.pdf>) provides detailed information on methods for carrying out a soil disturbance survey transect. Record the features of the area in section 4.2, and the transect results in section 4.6.

Area/Transect ID – provide a unique number or symbol for each area/transect. Mark location on the map/photo

Area – length × width; enter in m²

Total disturbance % – from section 4.6

Counted disturbance % – see Appendix 2

Description – describe the area and nature of disturbance

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Form C Side 2



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4.3 Transects for dispersed disturbance in remainder of each SU. (Attach FS879 for each transect, use disturbance type codes, circle points with forest floor displaced)

SU/Transect No.	Transect length (m)	Total points	Total disturbance %	Counted disturbance %	Description

4.4 Delineate and measure disturbance associated with roadside work areas. (The edges of roadside work areas are typically found where the heavy disturbance or woody debris drops off substantially. Attach FS879 for each transect, use disturbance type codes, circle points with forest floor displaced)

RWA / Transect No.	Area (l x w) m ²	Total disturbance %	Counted disturbance %	Description

4.5 Delineate and measure areas of soil rehabilitation within the NAR, and determine the effectiveness of rehabilitation treatments (ER) using the method described in Table 1.

SU/Area ID	Rehabilitated Area (l x w) m ²	ER	Description

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4.3 Dispersed soil disturbance

Locate a transect in a representative portion of each standards unit. Carry out a transect survey of at least 100 points using form FS 879. Record the features of the area in section 4.2, and the transect results in section 4.6.

SU/Transect – provide a unique number or symbol for each SU/
transect. Mark location on the map

Transect length – record in m

Total points – number of points in transect

Total disturbance % – from section 4.6

Counted disturbance % – see Appendix 2

Description – describe the transect in relation to the standards unit, (e.g., is the transect representative of the entire SU, or of the most sensitive portion – it desirable that it is representative)

4.4 Roadside work areas

RWA/Transect – provide a unique number or symbol for each SU/transect. Mark location on the map and carry out a transect survey of at least 50 points total in RWA.

Area – length $\times$ width; enter in m²

Total disturbance % – from section 4.6

Counted disturbance % – see Appendix 2

Description – describe the nature of disturbance in the RWA

4.5 Rehabilitated areas

Provide information for areas of the cutblock with soil rehabilitation to restore productivity to areas with dispersed soil disturbance.

SU/Area ID – a unique number or symbol for each area. Mark transect location on the map

Rehabilitated area – record in m²

ER – see section 1.2 for the method

Description – describe the nature of the disturbance and rehabilitation

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Form D Side 1

4.6 Transect summaries

Record the results of FS 879 for all transects, and to calculate disturbance percentages. Use Appendix 2 to calculate counted disturbance, or leave it blank.

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4.6 Soil disturbance transect summaries												
Disturbance type	SU or RW/IN	SU or RW/IN	SU or RW/IN	SU or RW/IN	SU or RW/IN	SU or RW/IN	SU or RW/IN	SU or RW/IN	SU or RW/IN	SU or RW/IN	SU or RW/IN	SU or RW/IN
Ts Wheel or track cuts 5-15cm deep												
Td Wheel or track cuts > 15 cm deep												
E Repeated Machine Traffic												
G Deep gouges												
L Long gouges												
W Wide gouges												
V Very Wide scalps												
S Wide scalps												
R Unrehabilitated excavated and bladed trail												
Y Unrehabilitated corduroy trail												
A Unrehabilitated compacted area												
O Other scalps and gouges not meeting above types												
r Rehabilitated TAS and compacted areas												
M Other machine traffic not meeting above types												
4.6a Total disturbance in the unit												
Sum of areas of all disturbances above												
Counted disturbance in the unit												

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Section 4 Questions

Form D Side 2

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		Section 4 Questions - Form D Side 2	
LIC. _____ CP _____ BLK _____ DATE _____ EVALUATOR _____			
4.7 Questions (Note: If the answer to any of these questions is yes, provide a description, and indicate the feature on the map)			
4.7a	Do any of the soil disturbance hazards appear to have been incorrectly determined in the planning stage?	YES ☐	NO ☐
4.7b	Do any of the SU's appear to have been mapped incorrectly, or are there complexes that have not been recognized?	YES ☐	NO ☐
4.7c	Were any of the roadside work areas wider than necessary for the harvesting system used?	YES ☐	NO ☐
4.7d	Does there appear to be more soil disturbance within the roadside work areas than necessary? If so, discuss the relative trade-offs between the size and severity of disturbance within roadside work areas versus the use of conventional landings.	YES ☐	NO ☐
4.7e	Considering a range of factors, including safety and efficiency, does the amount of area occupied by skid trails and temporary access structures and / or the disturbance associated with these structures appear excessive?	YES ☐	NO ☐
4.7f	Were there features smaller than 0.2 ha, or other areas where soil disturbance was not recognized in the survey, but appeared to be a concern.	YES ☐	NO ☐
4.7g	Are there disturbance types present that should have been rehabilitated but the rehabilitation treatments were not carried out?	YES ☐	NO ☐

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4.7 Additional information for answering the stewardship questions

4.7a Do any of the soil disturbance hazard ratings appear to have been incorrectly determined in the planning stage?

A key feature of FRPA's soil conservation provisions is that management activities are guided by knowledge of site conditions. Techniques for evaluating the site conditions are provided in LMH 47. Because soil response to disturbance is highly dependant on properties such as site moisture, soil texture, and depth of soil development, these features need to be accurately assessed in order to develop and implement good forest management strategies. Unfortunately, inaccurate description of the soil disturbance hazards is not uncommon, and can have serious consequences for soil conservation. Consider:

- If soil texture is incorrectly determined, it is likely that the soil disturbance hazards will also be incorrect.
- Some standards units may have differing conditions in different portions of the unit. The correct soil disturbance hazards are determined on the most sensitive portions of the SU.
- Where standards units are characterized by intermixed complexes with different soil disturbance hazards, special provisions may be needed in the operations to protect soils.
- Soil compaction ratings are determined on the most sensitive soil horizon (>5 cm thick) within the top 30 cm of the surface.

4.7b Do any of the SU's appear to have been mapped incorrectly, or are there complexes that have not been recognized?

Determining the standards units prior to harvest is made somewhat difficult because the standing trees can obscure differences in site conditions. Once the harvesting is completed, the lack of trees, as well as the ability to observe machine impacts makes a retrospective look at the initial SU mapping a worthwhile exercise. During the walkthrough survey, refer to LMH 47 and consider the following to determine whether or not serious errors occurred in the mapping of standards units:

- The presence of complexes within sites with significantly different soil disturbance hazards is a common cause of excessive soil disturbance. Often, skidders have to traverse low lying wet spots to bring trees to the landing. Good management practices may have the skidders travelling along the high ground rather than repeatedly traversing a low lying area.
- Poor management practice may see the low lying area repeatedly traversed so that disturbance of it is almost complete, rather than creating one "crossing" and restoring water flows if necessary at the end of operations.
- If complexes were not recognized, try to envision what the initial site assessment personnel were able to see, and try to describe what you think went wrong and how it could be prevented in future.

4.7c *Were any of the roadside work areas wider than necessary for the harvesting system used?*

In many areas, changing technology has made the roadside logging system more efficient than systems using dedicated landings. Roadside logging is also thought to have some soil conservation advantages because the roadside work areas often have lower overall soil disturbance compared to landings, and prevent the loss productive land from growing site as landings. However, where roadside work areas are too large, or where they have excessive soil disturbance, the perceived benefits may be lost. This is especially true where rehabilitation techniques are available that could restore productivity to temporary landings. When evaluating the effect of roadside work areas on forest productivity, consider:

- Roadside work areas where there are high levels of soil disturbance over large areas may negate their perceived benefits for soil conservation. Two tree lengths may be an acceptable width in many situations for a roadside work area, but they can often be smaller, or they may be discontinuous (i.e., not running the entire length of the road).

4.7d *Does there appear to be more soil disturbance within the roadside work areas than necessary? If so, discuss the relative trade-offs between the size and severity of disturbance within roadside work areas versus the use of conventional landings.*

In the past, a large part of the disturbance in roadside work areas was related to piling debris. Another factor affecting disturbance is the repeated traffic associated with skidders concentrating their activity in the area. To determine if disturbance is excessive, consider:

- Does it appear likely that a logging system based on the use of conventional landings, with or without rehabilitation would have created similar or lower amounts of soil disturbance (including temporary access and dispersed disturbance) over the entire cutblock?
- Was piling of debris within the roadside work area a major cause of soil disturbance?
- Was the road running surface used for piling, processing, and/or burning the debris
- Is the roadside work area a large proportion of the cutblock
- Was the road, and therefore the roadside work area, located in a portion of the cutblock where soils were relatively sensitive to soil disturbance (e.g., wet areas or fine textured soils), exacerbating the effects of machine traffic?

4.7e *Considering a range of factors, including safety and efficiency, does the amount of area occupied by skid trails and temporary access structures and/or the disturbance associated with these structures appear excessive?*

Close spacing of temporary roads and skid trails can increase operational efficiencies up to a point, but excessive trail densities may also result from poor logging design, changing weather conditions, or other factors. Soil rehabilitation can be a valuable tool for improving efficiency in the case of a temporary road, and it can also be used to repair mistakes or disturbance caused by unforeseen circumstances, changing weather etc. However, rehabilitation should not be used as a substitute for preventing soil disturbance, because (a) there are costs associated with it, and (b) the results of rehabilitation, though promising are still uncertain. To determine if there is excessive soil disturbance associated with trails, and temporary structures, consider:

- Does close trail spacing appear to have resulted in higher or lower levels of overall disturbance on the cutblock?
- Does it appear that rehabilitated areas are likely to have had productivity fully restored?

4.7f *Were there features smaller than .2 ha, or other areas where soil disturbance was not recognized in the survey, but appeared to be a concern.*

Please describe any features that were not picked up in the survey, but may have an impact on future forest productivity. Consider:

- The presence of significant amounts of ruts that do not meet the 5 cm depth or 2 m length criteria.
- Extensively trafficked but disturbance does not meet the requirements for compaction or size associated with scalps and gouges.

4.7g *Are there disturbance types present that should have been rehabilitated but the rehabilitation treatments were not carried out?*

Describe features where rehabilitation treatments were not carried out but should have been, or they were carried out incompletely. Consider:

- Are there unrehabilitated spur roads or landings that dead-end in the middle of the cutblock, with no obvious connection to future standing timber supplies?
- Are there trails that meet the requirements of excavated and bladed trails (i.e., cut height and length requirements), and should have been rehabilitated, but weren't?
- Are there rehabilitated areas where the rehabilitation treatments appear to have been poorly implemented? For example (1) a simple light scratching of disturbed and compacted areas may have been considered a treatment without full decompaction, (2) available topsoil or organic material may not have been respread, (3) full restoration of drainage patterns may not have been carried out on a cut and fill skid trail.
- Compacted areas 100 m² or large and greater than 5 m wide.

Section

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Section 5

Form E Side 1

[illegible]

5 Green tree retention

5.1 % of cutblock in wildlife tree patches

Estimate the area of wildlife tree patches in the office (preferably using OziExplorer or other software). Confirm estimate during walkthrough.

5.2 Estimated number of green trees/ha in the remainder of the block

Determine the number of green trees in NAR (do not include wildlife tree patches) initially in the office (preferably using OziExplorer or other software). Confirm estimates and collect details during walkthrough.

5.3 Description of green tree retention in cutblock

Collect these details during the walkthrough. It is not necessary to visit each green tree; instead record estimates for DBH and height during walkthrough.

Tree # – provide a number for each tree (easiest done during office procedure) and mark on map

Spp. – record species using codes on Reference Form – Side 2
(FS 1237-D2)

WT Class – record wildlife tree class using codes on Reference Form
– Side 1 (FS 1237-D1)

DBH (cm) – diameter in cm +/- 10%

HT (m) – height in metres +/- 10%

Comments – record comments on individual trees or all trees in NAR

Section

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Section 6

Form E Side 2



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6. Organic Matter						
6.1 Description of woody debris in cutblock (3 transects)						
No CWD in Transect 1 ☐ Transect 2 ☐ Transect 3 ☐						
Transect	Log	Species	Decay Class	Diam (cm)	Length (m)	Comments

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6 Organic matter

6.1 Woody debris

Determine the information for this part of the table by carrying out three 30 m transects in representative areas of each SU (usually along the soil disturbance transect or walkthroughs connecting these other transects). Attach additional sheets if necessary.

No CWD in transect – tick box if no CWD found on transect; if CWD found, record in table provided

Log – number each piece of CWD on transect that is >7.5 cm diameter and CWD class 1–4 (see Reference Form – Side 2 (FS 1237-D2))

Species – record species using codes on Reference Form – Side 2 (FS 1237-D2). If species unknown, record X

Decay Class – record CWD decay class using codes on Reference Form – Side 1 (FS 1237-D1) for CWD classes 1–4

Diam (cm) – diameter in cm +/- 10%

Length (m) – length in metres +/- 10%

Comments – record comments on individual CWD or transect.

Section

Instructions/Descriptions

Section 7 & 8

Form F Side 1

[illegible]

6.2 Fine organic matter

Enter point rating values for fuel loading factors from an existing Schedule 7 or complete the survey. A copy of the Schedule 7 form is presented in Appendix 3.

Fuel depth – enter corresponding value 1, 3, 5 or 7

Fuel size (% of all fuels that are <7.1 cm) – enter value 1, 3, 5 or 7

Horizontal fuel arrangement (% of area) – enter value 1, 3, 5 or 7

Vertical fuel arrangement (fine fuels <7.1 cm) – enter value 1, 3, 5 or 7

6.3 Additional information for answering the stewardship questions

6.3a Does it appear that measures to conserve fine organic matter should have been carried out on the site, but such measures were either neglected or ineffective?

Research in BC and elsewhere has demonstrated concern that considerable nutrient export can occur from cutblocks when whole tree harvesting is employed on nutrient poor soils. Such soils include gravely sandy glaciofluvial deposits, shallow developed soils in calcareous (high pH soils derived from limestone) or fluvial deposits, dry sites, or where frequent forest fires have reduced levels of organic matter. If the site is typical of these conditions, consider the following:

- Did most tops end up burned in debris piles?
- Were forwarding or processing at the stump not used in this block?

7 Photo section

Record photo numbers and other information that will help you identify where photos were taken. Photos should be taken of unusual features, innovative practices, or where soil conservation problems appear, including areas of inordinate soil disturbance, large access structures, landslides, or other features.

8 Quality control self assessment

This section is a self assessment of the data you have collected in order to:

- ensure calibrated data precision and accuracy
- ensure data consistency and eliminate data blanks and/or missing information.

Review the questions before and after data collection. Complete the questions before leaving the site.

Section

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Section 9

Form F Side 2

		FRPA Resource Evaluation Program	Soils Resource Stewardship Monitoring Section 9 - Form F Side 2
LIC. _____ CP. _____ BLK. _____ DATE _____ EVALUATOR _____			
9. Professional opinion / comments			
9.1	In your professional opinion, to what extent did the practices on this block maintain soil productivity and hydrologic function, given the the opportunities that were likely available? Poorly ☐ Moderately ☐ Well ☐ Very Well ☐ Don't know ☐ Rationale for opinion and general comments:		
9.2	Are there issues on this block that are of concern for the other FRPA Resource Values?		

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9 Professional opinion/comments

9.1 Did the practices maintain soil productivity and hydrologic function?

Tick one of: poorly, moderately, well, excellent or don't know. This is a subjective ranking of the cutblock, which will be used as a check against the objective data collected. A question you should ask yourself is – “did they do as well as they could have considering the forest they began with?” Note general comments as well as anything unusual about the cutblock in the comments section. Provide a rationale for your professional opinion. Additional information is available in Appendix 2 to help you in considering the following points:

- amount of permanent access – is the amount of access the minimum practical given the site conditions
- presence of landslides, altered drainage or erosion – the presence of these features is detrimental
- disruption of natural drainage patterns – harvesting operations should be conducted with minimal disturbance to natural drainage patterns
- soil disturbance in the NAR, including areas of inordinate disturbance and roadside work areas
- green tree retention – should be adequate to provide refugia for beneficial soil organisms
- amount of woody debris – presence of long (>12 m) logs in decay class 1, 2 and 3 in the harvested area is good.

9.2 Are there issues of concern for other FRPA Resource values?

This is a place to indicate issues of concern for FRPA Resource Values other than soils.

Additional information for completing the Professional Opinion

Section 9.1: Preliminary determination of soil conservation achievements

This section provides additional information for determining whether or not harvesting practices conserved soil productivity and hydrologic function. The threshold values provided here can be used to guide such decisions, along with consideration of the responses to stewardship questions related to each of the indicators.

Exceeding the threshold for any indicator suggests that harvesting practices as they were carried out may not be fully consistent with soil conservation objectives. The stewardship questions can be used to confirm such suggestions. As a general rule, confirmation that soil conservation objectives have not been met is indicated when (a) the value for the indicator exceeds the threshold **and** (b) a positive response is returned for one of the stewardship questions related to the indicator.

If the response to the stewardship question does not confirm the indicator score, or a positive response is returned for a question without the indicator value exceeding the threshold, then the evaluator needs to use their professional judgment and provide rationale when completing the professional opinion section (9.1) of soils RSM card.

For cutblocks where thresholds were not exceeded, and no stewardship questions received a positive response, it is likely that harvesting practices did very well in achieving soil conservation objectives.

Where it appears that soil conservation objectives, as they are understood at this time, have not been met, blocks should be noted and may be scheduled for future monitoring to determine longer term effects on soil productivity and other FRPA values.

Preliminary determination of soil conservation achievements		
Indicator	Thresholds and scores	
	Acceptable	Soil conservation objectives may not have been met
1. Percent of the cutblock area occupied by unproductive soil as a result of access construction	<7%	>7%
2. In-block area affected or potentially affected by landslides, drainage diversion, or significant erosion occurring from roads, landings or trails	0 m ²	>200 m ²
3. Percent of the NAR area affected by disturbance to natural drainage patterns	0	>200 m ²
4. Percent of the cutblock area affected by concentrated and dispersed soil disturbance in the NAR		
a. for sensitive soils (see Appendix 2 for determining which disturbance types to count)	<5%	>5%
b. for non-sensitive soils (see Appendix 2 for determining which disturbance types to count)	<10%	>10%

Help

For additional information on completing these field forms, please contact your regional soil scientist or Shannon Berch, BC Ministry of Forests, Victoria 250-952-4122.

References and additional information

Soil Conservation Surveys Guidebook

Appendix 1

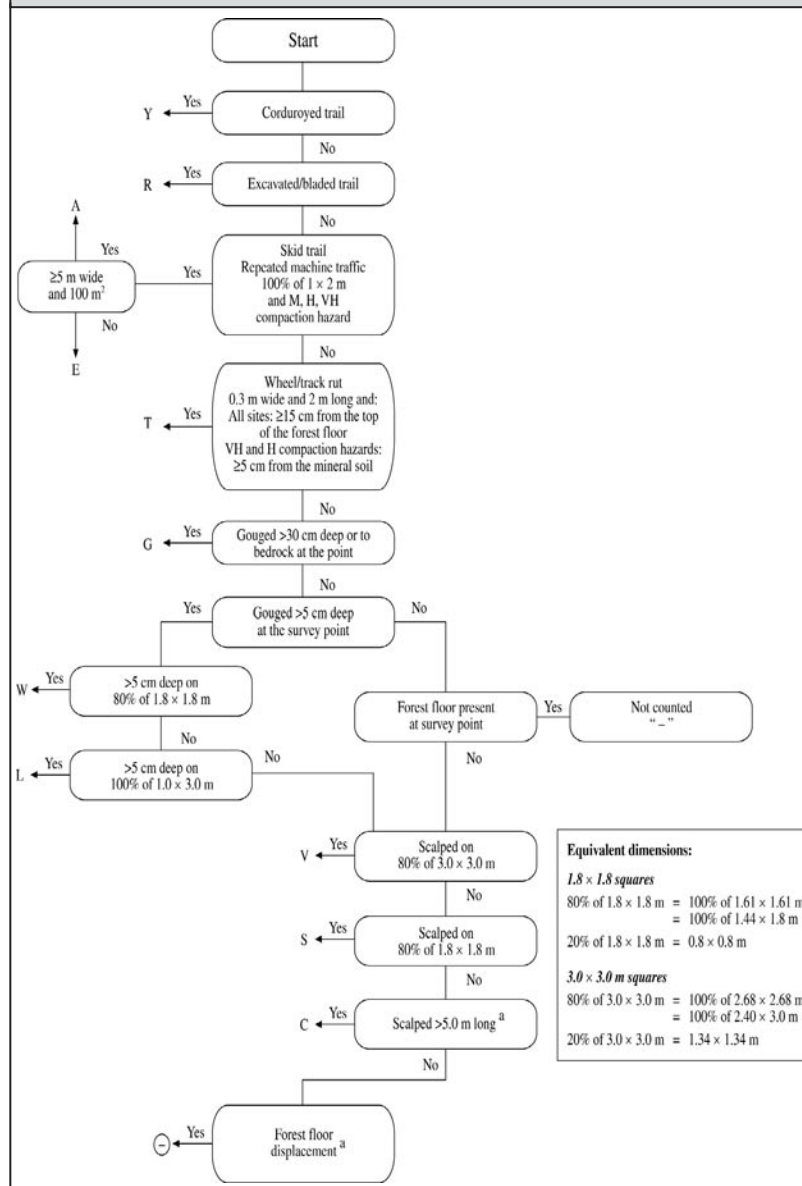


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Appendix 1 -- Form H Side 1

Appendix 1. Flow chart for assessment of soil disturbance survey points.



Appendix 2



BRITISH
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Appendix 2 -- Form H Side 2

Appendix 2. Counted soil disturbance categories and recommended limits according to hazard ratings				
Soil disturbance hazard ³	Soil sensitivity rating	Categories counted in allowable soil disturbance ⁴	Allowable soil disturbance (% NAR)	
<u>Coast and Interior</u>				
Assessment of soil hazards not required		Always + S +E + T + 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 + T + A	5	
			<u>Coast</u>	<u>Interior</u>
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 + T + A	5	10
Soil compaction	M	Always + E + A	5	10
Soil compaction	L	Always	5	10
Likelihood of landslides	L	Always	5	10
<div><div><div>4</div><div>Assessing the hazards for soil compaction, soil displacement, and soil erosion need not be done if the harvesting method is cable or aerial.</div></div><div><div>5</div><div>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; "T": 5-cm-deep ruts; "E": repeated machine traffic; and "A": compacted areas.</div></div></div> <div>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 + T," the soil disturbance limit would be 5%.</div>				

Appendix 3

SCHEDULE 7

[am B.C. Reg. 148/96, s. 8.]

FIRE HAZARD ASSESSMENT

(section 31)

POST HARVESTING

Fuel Loading Factors	Site Characteristics and Point Ratings			
1. Fuel Depth	<20 1	20 to 40 cm 3	40 to 60 cm 5	>60 cm 7
2. Fuel Size (% of all fuels that are <7.1 cm)	<15% 1	15 to 30% 3	31 to 45% 5	>45% 7
3. Horizontal Fuel Arrangement (% of area)	Fuel coverage <20% 1	Fuel coverage 20 to 50% 3	Fuel coverage 51 to 80% 5	Fuel coverage >80% 7
4. Vertical Fuel Arrangement (fine fuels <7.1 cm)	Mixed with soil 1	On ground 3	Partially elevated 5	Mostly elevated 7
5. Vegetation (Contributes to Fuel Load)	None 0	Low 1	Moderate 3	High 5
6. Cedar Slash Component	<20% 1	20 to 40% 2	41 to 60% 3	>60% 4
			Hazard Assessment Subtotal	

Appendix 4: Example Air Photo Overview

Figures 1 and 2 illustrate the process of air photo review for resource stewardship monitoring. In this example, the 10.8 ha block consists of a single standards unit, and is entered by a single road. Three wildlife tree patches occupy a total of 0.8 ha (est'd). The NAR area indicated on the SP was 9.8 ha. Soil compaction and displacement hazards were indicated as high, and the surface erosion hazard moderate. No slope stability indicators were noted in the SP, sandy soil materials were identified as an unfavourable subsoil material occurring at 24–55 cm depth. A root removal treatment was planned, so the limit for soil disturbance in the NAR was set at 20%.

In Figure 1, three areas of potential inordinate soil disturbance (A, B, C) were identified, and rough estimates of their areal extent were made (est'd total of 0.37 ha – including one large area (C) of converging trails occupying an estimated 0.25 ha). A possibly rehabilitated area was apparent (D), and a landing (E) was shown on the operational plan map, but was not readily identified from the photo. It may have been rehabilitated, so size and status will be determined in the field. Road area (F) was estimated at 0.38 ha using a computer drawing program after scaling the image to the map obtained from the operational plan (e.g., a block width or road length clearly comparable to the paper plan). Roadside work areas were not visible on the photo, possibly because of only moderate resolution, so their presence and extent will be evaluated in the field survey.

The planned walkthrough is shown in white and red on Figure 2, starting at the Point-of-Commencement (PoC) indicated. The objective is to visit all features of interest as well as areas representing typical conditions on the block. Features that were not apparent on the air photo can be identified with a unique letter, and information on their extent and characteristics would be included in the field tally sheets. In the example, disturbance associated with the road, and the possible existence of a roadside work area can initially be observed on the drive into the block.

In-block soil disturbance transects are pre-located using the photo and **each transect will be surveyed in the field using a separate soil disturbance data card (listed in field gear checklist)**. These are shown in red on Figure 2. The in-block disturbance transects are labelled with “T1, T2, T3”, etc. and are designed similarly to meet the following criteria:

1. go at right angles to the major disturbance
2. be representative of the entire area being surveyed, including block edges.

The target is 100 points. Achieve this by determining approximate total length of transects from photo and divide by 100 to get sample point spacing to nearest metre. Actual number of points may be more or less, but simply complete the survey to the block edge.

Coarse woody debris transects can be incorporated into portions of T1, T2 and T3, or they can be established separately in areas representative of the standards unit.

Areas of potential inordinate soil disturbance are delineated on the photo (A, B, and C in the example here) and also checked for during the walkthrough. Upon initial overview, a decision is made as to whether the disturbance appears inordinate, and if so, a series of parallel transects are surveyed, with these transects labelled with “Ta, Tb, Tc, etc.” to

designate the feature being surveyed. These are parallel transects with closer sample point spacing, using the same criteria (above) for in-block disturbance transects. The target is 50 points for all potentially inordinate (concentrated) disturbance from the same stratum. Areas with similar disturbance characteristics can be grouped into one stratum. In the example Figure 2, although we did not find inordinate disturbance on this cutblock, we are showing area C as having warranted a survey, designated as Transect “Tc.”

Roadside work areas are surveyed with transects using the same procedure as inordinate soil disturbance.

In the example in Figure 2, the walkthrough begins at the (PoC), and proceeds along the edge of the wildlife tree patch to transect (T1), which is established in the southeast portion of the block to evaluate soil disturbance, green tree retention, and coarse woody debris. A second transect (T2) is established through the middle of the block to evaluate dispersed soil disturbance, with an initial evaluation of the potentially inordinate disturbance (area C) made at the one end that is crossed. A third transect (T3) is established in the northwest portion after looking at any area of potentially inordinate disturbance (area A). Returning, the extent of potentially inordinate disturbance at area B is evaluated, along with possibly rehabilitated area below the landing (D), and further transects are put in area C (Tc). Then, the state of disturbance and rehabilitation of the landing itself is evaluated (E). Finally, estimates of road length and width are evaluated by walking down the road (F) back to the start point (PoC). If it became apparent there was disturbance associated with a roadside work area, an additional transect would be established there (i.e., label the new feature a unique letter, like G in this example, and the Transect would then be Tg).

Throughout the entire exercise, evaluations are made of the soil disturbance hazard ratings for the Standards Units (cutblock), and the appropriateness of the Standard Unit boundaries (or lack thereof). Texture (compaction hazard) should be checked regularly based on local experience with soil variation.

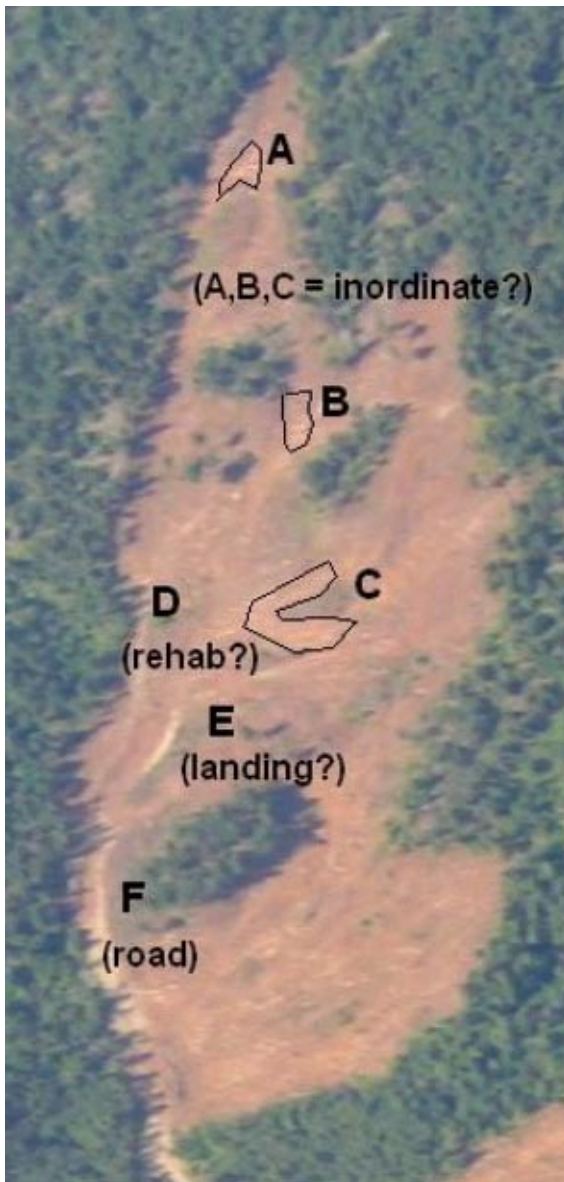


Figure 1. Digital image of CP364-3, on TFL 23, showing features of interest for soil conservation effectiveness evaluation.

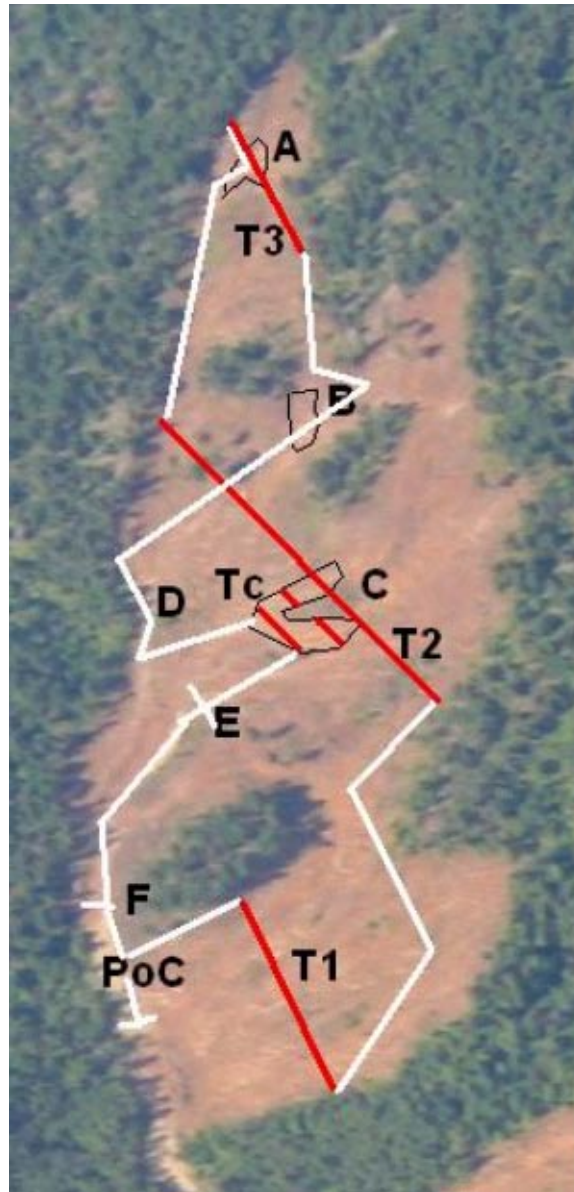


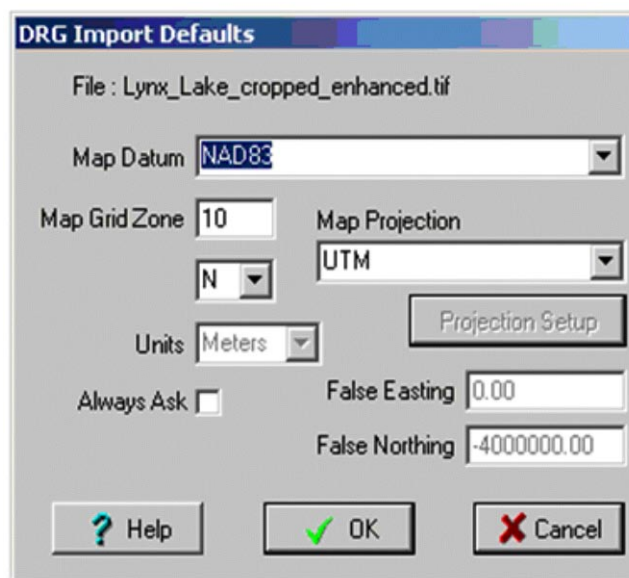
Figure 2. Digital image of CP364-3, on TFL 23. The white lines show the planned walkthrough. Red lines indicate expected locations of soil disturbance and coarse woody debris transects.

Appendix 5. Procedures for reviewing and analyzing air photos using OziExplorer

This section will describe how to load a geo-referenced TIFF image of the area into OziExplorer, and to use the software to determine the size of features, areas, and to prepare a map showing the location of walkthroughs and survey transects. The image will also be useful after field checking for recording information obtained during the field survey and preparing a final map for the area.

A. Loading in the image

- File>Import Map>Single DRG map. This will initiate a wizard that will guide you through a 3 step process
- Step 1: Find the image file of the map you want to import
- Step 2: Specify the name and path of the OziExplorer map file you want to create
- Describe import defaults:



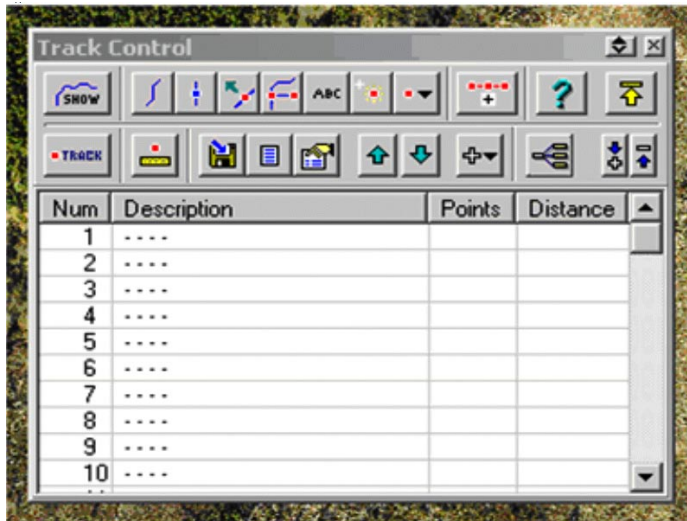
For this example:
Map Datum was set at NAD83;
Map Grid Zone 11,
Map projection UTM
Click OK

The map will now be displayed. You can navigate around the window using the map view or the slider bars on the side of the display. A zoom command is available on the top menu bar.

B. Using the track feature to delineate polygons, and determine areas

1. To delineate areas of inordinate disturbance, roadside work areas, landings, eroded areas or other features:

- View>Tracks>Track control



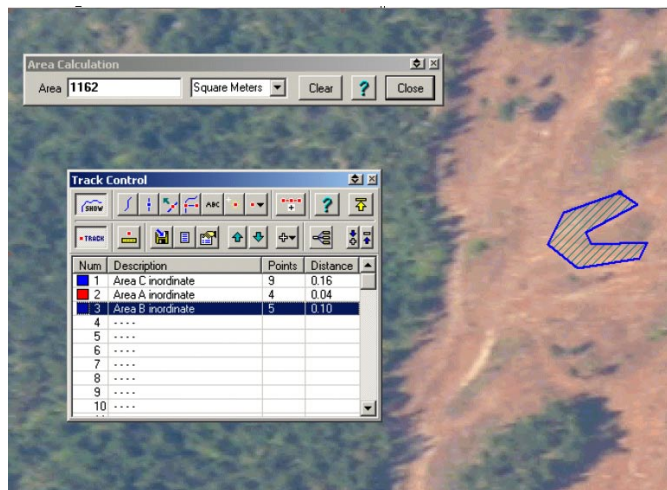
Proceed to load a track as follows:

- Activate track function by clicking on the track icon.
- Delineate the area using as many points as needed, and clicking the mouse for each point along the track.
- To close a polygon, click on the initial point on the track.
- Save the track by clicking on the save icon on the track control.
- To create a second track, place the cursor in a blank track, click the mouse, and then bring the new (blank) track to the top of the list using the blue arrow button.



2. To determine the area of a polygon:

- Options>Area Calculation

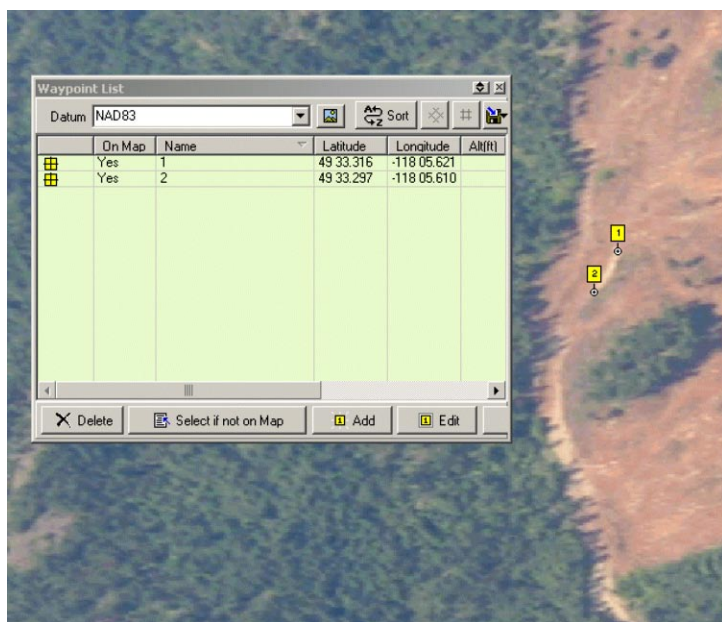


C. Creating waypoints and calculating distances

Waypoints are used as a point of reference for GPS, and mark specific locations of interest. For example a point of commencement (POC) for a survey could be defined as a waypoint, or the location of a road width measurement.

1. To create a waypoint.

- Activate waypoint function by clicking on the waypoint icon.
- Place the waypoint cursor on location of interest, and click to create a waypoint. Repeat as necessary.
- The new waypoint will appear in the waypoint list along with its GPS coordinates. Save the waypoint by clicking on the save icon on the waypoint list.



-
- Distance Between Waypoints**
- | <u>From Waypoint</u> | | <u>To Waypoint</u> | |
|----------------------|-------------|--------------------|-------------|
| Name | Description | Name | Description |
| 1 | | 1 | |
| 2 | | 2 | |
| | | | |
- Great Circle**
- Distance : 0.0378 Km
 True Bearing : 160.3 Deg
 Magnetic Bearing : 142.5 Deg
- Rhumb Line**
- Distance : 0.0378 Km
 True Bearing : 160.3 Deg
 Magnetic Bearing : 142.5 Deg
- ? Help Close



E. Using the route editor feature to show walkthroughs and survey transects on a map

1. To create a route.

- A route is created when waypoints are linked. Mark point of commencement (POC) and end of planned walkthrough (or survey transect) using waypoints as explained under section C. Creating waypoints. Repeat as necessary.
- Once the waypoints are displayed on the map, activate the route editor feature under View>Route Editor.
- Select a route from the upper list (e.g., R1) and depress 'Add Wp' to add waypoints in a route. This feature allows you to click on top of waypoints to trace a route. On the map, position cursor on first waypoint i.e., POC, press left button. Next, move cursor on waypoint marking the end of walkthrough (or survey transect) and press left button. A route is automatically traced by linking the waypoints on the map with the upper "show" button depressed. Repeat as necessary.
- The list of waypoints in a route is displayed in the lower list as you add them. To see that list in full details (i.e., distances and bearing of new route), press the 'Show' button to the right of that list.
- View and edit the route properties by clicking on the properties icon to the top of that route editor window.
- Save the new route by clicking on the save icon on the main tool bar.



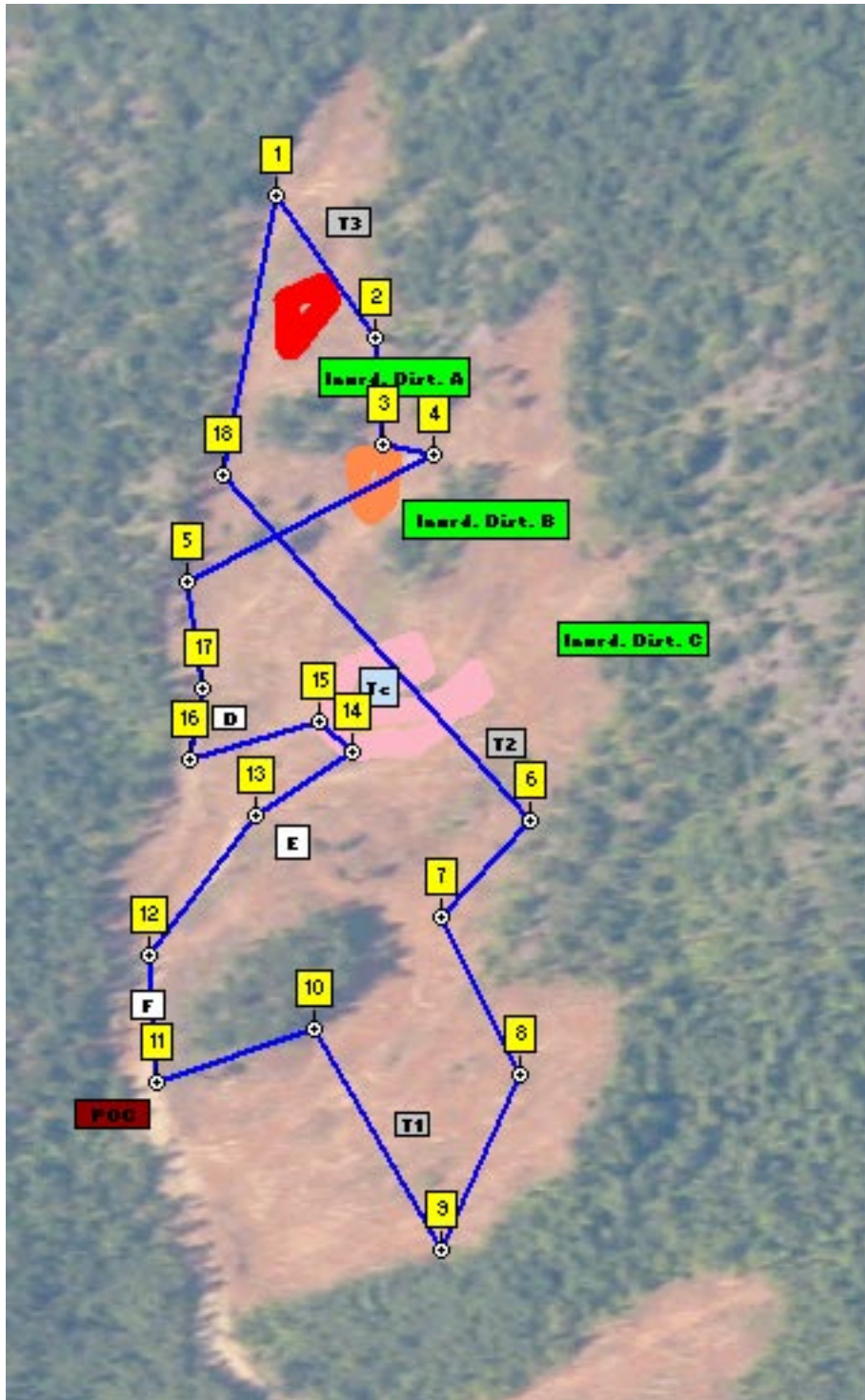


Figure 1. Image of map from OziExplorer showing waypoints, routes, and areas delineated.

