Soil Conservation FRPA Effectiveness Evaluation

Introduction:

The soil conservation indicators presented in this document are intended to describe "on the ground" conditions for recently harvested areas. "Regulatory process" type indicators are included as ancillary information, and are important for evaluating the effectiveness of (a) government policy, (b) legislation, (c) management procedures, or other "processes" in maintaining soil conservation. These indicators were chosen to assess generally accepted soil conservation objectives. Legislated soil conservation objectives, set out by the B.C. Provincial Government, are yet to be finalized.

The indicators presented here are suitable for use for one to two years after harvesting operations are completed. Other indicators that could be assessed after a longer time have not been included here, but could be essential for detecting some sorts of damage (e.g. direct measures of forest productivity such as site index).

Site selection for effectiveness evaluation should consider both a "risk"-based approach, where sensitive or high-risk sites may receive more attention, as well as an "extent"-based approach, where the sites are selected based on how much area is affected by various practices.

Risk based sampling should consider the following factors for site selection:

- 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
- "sensitive soils"
- drier or wetter ecosystems
- specific prescribed practices meeting disturbance guidelines

The document provides:

(1) soil conservation FRPA effectiveness evaluation questions and indicators, along with proposed tables of criteria for scoring each indicator;
(2) a summary table for recording weighted scores for each indicator allowing calculation of an overall cutblock "score" for soil conservation; and
(3) a list of ancillary questions that do not contribute directly to the "score" for a cutblock, but are designed to provide addition information about management and other factors affecting the conditions observed on the cutblocks.

List of Indicators to date:

Permanent access structures

1. Percent of the cutblock area occupied by unproductive soil as a result of access construction

Erosion, landslides and gullies

2. Indication or likelihood of altered drainage or significant erosion occurring from roads, trails, and landings
3. Area of unproductive soil, or area that could potentially become unproductive soil, in the NAR as a result of landslides or gully erosion caused by construction, maintenance, or deactivation of roads, or by any effect of harvesting

Natural Drainage

4. Percent of the cutblock area that suffers, or is at significant risk of suffering, reduced productivity or disrupted ecosystem function as a result of changed natural drainage patterns in the NAR
5. The extent to which precipitation interception capacity has been altered

Disturbance in NAR

6. Percent of the cutblock area affected by concentrated and dispersed soil disturbance in the NAR

Soil Biology

7. Extent to which mature forest ectomycorhiza fungi are retained on site
8. The amount and diversity of habitat for dead wood-occupying soil biota on site

List of Ancillary Questions to date:

1. Does the amount of permanent access seem appropriate given the site conditions?
2. Do any access structures seem larger than necessary?
3. Do the sensitivity ratings for the standards units appear to be correct?
4. Were roadside work areas of an appropriate width for the harvesting system used and was an attempt made to minimize disturbance within the roadside work are?
5. Were skid trails and temporary access structures designed to minimize the amount of area occupied by these structures while keeping in mind there may be other factors to consider such as safety or efficiency?
6. On flat, valley bottom sites in wetter ecosystems, have forestry operations had a negative effect on precipitation interception on the block?
7. Has a mixture of tree species been planted?

FIELD ASSESSMENTS FOR SOIL CONSERVATION EFFECTIVENESS EVALUATIONS

1. Permanent access structures

Table 1. Effectiveness evaluation for limiting permanent soil degradation due to access structures.

Cutblock/Standards Units Objectives	Effectiveness questions	Indicators	Value	Methods
Permanent access minimized based on site conditions	Does permanent access cover the least reasonable area of productive soils?	Percent of the cutblock area occupied by unproductive soil as a result of access construction	Percent	Table for "Estimating lost soil productivity due to access construction"

Table 1a. Estimating lost soil productivity due to access construction.

Variable	Value
Percent of the cutblock area in permanent roads, landings, and borrow pits (determined as per the soil conservation surveys guidebook)	
Percent of the cutblock area in un-rehabilitated temporary access (do not double count structures that were included as permanent access)	
(Percent cutblock area in rehabilitated access) x (1- ER*)	
Total permanent lost production caused by access	(sum of the above)

* ER="effectiveness of rehabilitation", and is equivalent to the "expected productivity" of the rehabilitated area.
"Effectiveness of rehab" ranges from 0 (unproductive ground) to 1 (fully restored soil conditions), and is determined either through the assessment of a qualified person, or according to the following method where: ER = A+B+C+D

A. Was the rehabilitated area decompacted? yes = .5; no = 0
B. Was topsoil and or burnpile debris re-spread so that important soil characteristics of the surface layer (texture and organic matter) are equivalent to those of undisturbed soils on similar sites in the area? yes = .4; no = 0
C. Has the site been revegetated and reforested, or is there a reasonable likelihood that revegetation and reforestation will occur as a result of natural ingress from the surrounding area? yes= .1; no = 0
D. Has unfavourable subsoil material been mixed with surface soils? yes = -.25 no = 0

2. Erosion, landslides, and gullies

Table 2. Effectiveness evaluation for landslides and gullies.

Cutblock/Standards Units Objectives	Effectiveness questions	Indicators	Value	Methods
Landslides and gullies	Have permanent access structures been re-vegetated, and/or have erosion control devices been used to keep sediment from entering streams?	Indication or likelihood of altered drainage or significant surface erosion[1] occurring from roads, landings or trails	Low Med High	Table for "Estimating likelihood of altered drainage or significant surface erosion from roads, landings or trails"
	Has construction, maintenance, or deactivation, or any effect of harvesting caused landslides or gully erosion in the NAR?	Area of unproductive soil, or area that could potentially become unproductive soil, in the NAR as a result of landslides or gully erosion caused by construction, maintenance, or deactivation of roads, or by any effect of harvesting	Percent	Table for "Estimating area occupied by landslides and gully erosion"

[1] significant surface erosion would involve sediment entering a stream or soil loss / infilling that would lead to lost production on an area >0.2 ha, but does not include landslides (mass wasting) or gully erosion which are recorded with the indicator below.

Table 2a. Estimating likelihood of altered drainage or significant surface erosion from roads, landings or trails.

Variable	Value		
Is there evidence of significant surface erosion from access structures	Yes	No	
	10		
Have inactive road surfaces been revegetated, or is there a likelihood that they will become revegetated as a result of natural in-growth within 2 years?	Yes	No	
points	0	5	
Are there any parts of roads (or other permanent access structures) in minor depressions and shallow draws, clay beds, seeps, springs, concave slopes, and any other poorly drained sites.	Yes:	No	
points	5	0	
Has appropriate water crossing spacing been maintained (e.g., culverts and cross-ditches)? Determine where culverts should have been placed based on combination of slope, soil texture, parent material compaction (e.g. compact basal tills), vegetation cover. Refer to Key to Soil Sensitivity to Erosion.	Yes	No	
points	0	5	
Is there evidence of sloughing or slumping of fills located below seepage zones	Yes	No	
points	5	0	
Where any portion of the access network intersect subsurface water, has this been recognised and appropriately dealt with?	Yes	No	
points	0	5	
Is there evidence of temporary or permanent ponding of water or mud on the uphill sides of roads caused by blockage of natural subsurface drainage	Yes	No	
points	5	0	
Likelihood of significant erosion from access	Low (<5)	Med (5-10)	High (>10)

Table 2b. Estimating area occupied by landslides and gully erosion in the NAR

Variable	Value
Area(s) of unproductive soil, or area(s) that could potentially become unproductive soil, occupied by landslides or accelerated gully erosion caused by construction, maintenance, or deactivation of roads, or by any effect of harvesting (subtract stable and potentially productive run-out zones).	Percent

3. Natural drainage patterns

Table 3. Effectiveness evaluation for disturbance to natural surface drainage patterns in the NAR.

Cutblock/Standards Units Objectives	Effectiveness questions	Indicators	Value	Methods
Natural surface drainage patterns	Have forestry operations in the NAR been accomplished with minimum disturbance to surface drainage?	Percent of the cutblock area that suffers, or is at significant risk of suffering, reduced productivity or disrupted ecosystem function as a result of disrupted natural drainage in the NAR	Percent	Table for "Estimating percent of the cutblock area affected by disturbance to natural drainage patterns as a result forestry operations"

Table 3a. Estimating percent of the NAR area affected by disturbance to natural drainage patterns as a result of forestry operations

Variable	Values
Percent of the cutblock area experiencing or at risk of experiencing altered drainage or raised water table as a result of construction of roads, landings, or trails (including non permanent "skid trail" structures or logs skidded in a random fashion) e.g. 1. areas with drowned vegetation e.g. 2. areas where soils below roads appear to suffer from dry soil conditions as a result of drainage blockage e.g. 3. long straight stretches of skid trail running up and down the slope without downslope obstructions (such as outsloping turn-ups, broad-based dips or pole culverts)	
Percent of the NAR area experiencing or at risk of experiencing altered drainage because of other forms of dispersed or concentrated soil disturbance (as defined in soil conservation survey guidebook)	
Total percent area	

4. Detrimental soil disturbance in NAR

Table 4. Effectiveness evaluation for concentrated and dispersed soil disturbance in the NAR.

Cutblock/Standards Units Objectives	Effectiveness questions	Indicators	Value	Methods
Limiting soil disturbance in the net area to be reforested (NAR)	Is a minimal amount of detrimental soil disturbances occurring on NAR in cutblocks?	Percent of the cutblock area affected by concentrated and dispersed soil disturbance in the NAR	Percent	Table for "Calculating percent of the cutblock area affected by concentrated and dispersed soil disturbance in a cutblock NAR"

Table 4a. Calculating percent of the cutblock area affected by concentrated and dispersed soil disturbance in a cutblock NAR.

Standards Unit:	**SU__**	**SU__**	**SU__**
Is the standards unit comprised of sensitive soils (Y or N) [2]**?**			
What proportion of the cutblock is occupied by the standard unit?			
Percent area of concentrated disturbance in any 0.2 ha areas of SU. For use on areas ≥ 0.20[2] ha where dispersed soil disturbance exceeds the allowable threshold (either 5% or 10) by 100%, Record the "SU-equivalent percentage" (calculated below) for *each* 0.20 ha that exceeds the allowable limits. "SU equivalent percentage" = "area affected by concentrated disturbance" (or "acd") / SU area; for disturbance between 2 and 2.5 times the threshold. "acd" = 50% of the .2 ha area for disturbance between 2.5 and 3 times the threshold, "acd" = 75% of the .2 ha area for disturbance over 3 times the threshold, "acd" = 100% of the .2ha area Example: For a 10 ha SU with sensitive soils, and concentrated disturbance observed in a roadside work area: If the acceptable SU disturbance is 5% and the total concentrated disturbance was found to be 12% in a 0.2 ha			

[2] For complex units with differing soil sensitivity, use the most restrictive soil sensitivity rating.
[3] Delineate 0.20 ha areas that are a minimum of 30m width, except where a naturally occurring landscape feature (e.g. a swale or low lying area) has smaller width and defines a distinctive soil type.

Standards Unit:	**SU__**	**SU__**	**SU__**
roadside work area, then "area affected by concentrated disturbance" = 75% of the .20 ha area. "SU equivalent percentage" = (.75 x .20) / 10ha = .15 ha / 10ha = 1.5 % of the SU			
a. roadside work areas (example area provided)	(2.8)		
b. rutting in wet areas			
c. scalping			
d. close spacing of trails			
e. Grazing (bare ground and pugging/hummocking, trails)			
f. Other concentrated disturbances……			
Concentrated 0.2 ha SU Sub-total:			
Percent area dispersed disturbance[3] in remainder of SU. (use Table 4.aa to summarize field tallies, and do not double-count concentrated disturbance areas above)			
SU Sub-total:			
Sum of pre-adjusted concentrated and dispersed SU disturbance for concentrated and dispersed disturbance:			
Adjustment calculation for NAR rehabilitated areas = (% SU in rehabilitated disturbance) x (1-ER) , see example in Table 1b)**:**			
Total adjusted concentrated and dispersed SU disturbance:			

[4] Record the sum of all detrimental disturbance types, see Table 4aa.

Table 4aa. Summary of dispersed disturbance categories in the NAR. (Note, This table does not directly factor into the indicator calculation, but will be useful for interpreting results of the effectiveness evaluation)

Record the actual amount of each category of dispersed disturbance over the entire standards unit.

Standards Unit:	**SU__**	**SU__**	**SU__**
Wheel or track ruts:			
Deep gouges			
Long gouges			
Wide gouges			
Wide scalps			
Very wide scalps (forest floor displacement equivalent)			
Dispersed trails/compaction (rutted, repeated traffic, livestock, etc.)			
Grazing related (bare ground and pugging and hummocking with dimensions equal to wide scalps)			
Other			
Total disturbance in the NAR			

5. Soil biology

Table 5. Effectiveness evaluation for soil biological properties.

Cutblock/Standards Units Objectives	**Effectiveness questions**	**Indicators**	**Value**	**Methods**
Maintain soil biological properties	Has soil biodiversity been maintained?	Extent to which mature forest ectomycorrhizal fungi are retained on site	Low Medium High	Table for estimating retention of mature forest ECM fungi
		The amount and diversity of habitat for dead wood-occupying soil biota on site	Low Medium High	Table for estimating decaying wood habitat for soil biota
		The extent to which forest floor is retained	Included in NAR disturbance assessment	

Table 5a. Estimating retention of mature forest ECM fungi

Distance from cutblock to nearest old growth character forest	> 2 km	0 – 2 km	0 km (i.e. contiguous)	
points	0	2	4	
Number of green trees retained on cutblock	no retention	green trees < 1 per ha	< 25% basal area retention to at least one green tree per ha	25% basal area retention or patch retention
points	0	2	5	10
Species diversity of green trees retained on cutblock (characteristics of pre-harvest stand age-class distribution)	0% of original tree species	33% of original tree species	66% of original tree species	100% of original tree species
points	0	2	4	6
Age classes of green trees	< 0.5m tall	advanced regeneration (0.5-3m tall)	semi-mature (<15m tall)	mature >15m tall
points	0	2	5	10
Index rating:	Low = 0 - 6	Medium = 8 - 16	High = > 16	

Table 5b. Estimating amount and diversity of habitat for dead wood-occupying soil biota

Amount of woody debris[1]	0 – 10 % of gross merchantable volume[2]	10 – 30 % of gross merchantable volume	> 30 % of gross merchantable volume	
points	0	5	10	
Species diversity of CWD	0% of original tree species	33% of original tree species	66% of original tree species	100% of original tree species
points	0	1	2	3
Index Rating	Low = 0 - 3	Medium = 6 - 8	High = 11 - 13	

[1.] Amount of woody debris estimated based on three 30 m transects located randomly in NAR and using method for CWD in *A Field Estimation Procedure for Downed Coarse Woody Debris*, Taylor 1997, and for slash in *Field Handbook for Prescribed Fire Assessments in British Columbia: Logging Slash Fuels*, Trowbridge et al. 1989.

[2.] Gross merchantable volume based on cruise data.

DETERMINING SOIL CONSERVATION EFFECTIVENESS

Table 7. Indicator summary table and thresholds.

Indicator	**Thresholds and scores**			
1. Percent of the cutblock area occupied by unproductive soil as a result of access construction	<4%	4 to <7%	7 to 10%	> 10%
Score	12	8	4	0
2. Indication or likelihood of altered drainage or significant surface erosion occurring from roads, landings or trails	Low	Medium	High	
Score	6	3	0	
3. Area of unproductive soil, or area that could potentially become unproductive soil, in the NAR as a result of landslides or gully erosion caused by construction, maintenance, or deactivation of roads, or by any effect of harvesting	0%	<1%	1-2	>2%
Score	0	-2	-6	-12
4. Percent of the cutblock area that suffers, or is at significant risk of suffering, reduced productivity or disrupted ecosystem function as a result of disrupted natural drainage in the NAR	<1 %	1-3%	>3%	
Score	6	4	2	0
5. Percent of the cutblock area affected by concentrated and dispersed soil disturbance in the NAR a. for sensitive soils b. for non-sensitive soils	 <2% <4%	 2-3.5% 4 to <7%	 3.6-5% 7 to 10%	 >5% > 10%
Score[4]	12	8	4	0
6. Extent to which mature forest ectomycorrhizal fungi are retained on site	Low	Medium	High	
Score	0	2	4	
7. The amount and diversity of habitat for dead wood-occupying soil biota on site	Poor	Moderate	Good	
Score	0	2	4	

[4] See Table 7a for an example of calculating a weighted score for the cutblock.

Table 7a: Calculating weighted score for dispersed and concentrated disturbance (*with example calculation*)

Standards Unit	**SU1**	**SU2**	**SU3**
Sensitive or non-sensitive? (from Table 3b)	Ye	No	Yes
Proportion of the area (from Table 3b)	.25	.35	.40
Percent of area affected by concentrated and dispersed disturbance (from Table 3b)	1.5 %	8 %	5.5 %
SU score (based on thresholds in Table 5)	6	2	0
SU contribution to weighted cutblock score	6*.25=1.5	2*.35=0.7	0*.4=0
Weighted Cutblock Score (sum of SU contributions to weighted cutblock score)	=1.5+0.7+0=**2.2**		

By adding the scores for all the indicators, an overall soil conservation effectiveness score can be calculated. The overall soil conservation score is expressed as a percentage of the maximum possible score of xx points.

Table 8. Total soil conservation effectiveness evaluation score for the cutblock.

Indicator No.	**Score**
1	
2	
3	
4	
5	
6	
7	
Total	
Maximum possible points	
Percent of possible points	

Table 9. Ancillary questions to be considered.

Record field observations and comments for the following questions:

1. Does the amount of permanent access seem appropriate given the site conditions?
2. Do any access structures seem larger than necessary?
3. Do the sensitivity ratings for the standards units appear to be correct?
4. Were roadside work areas of an appropriate width for the harvesting system used and was an attempt made to minimize disturbance within the roadside work are?
5. Were skid trails and temporary access structures designed to minimize the amount of area occupied by these structures while keeping in mind there may be other factors to consider such as safety or efficiency?
6. On flat, valley bottom sites in wetter ecosystems, have forestry operations had a negative effect on precipitation interception on the block?
7. Has a mixture of tree species been planted?