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Field Handbook for Prescribed Fire Assessments in British Columbia: Logging Slash Fuels

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ECONOMIC & REGIONAL DEVELOPMENT AGREEMENT

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Field Handbook for Prescribed Fire Assessments in British Columbia: Logging Slash Fuels

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M. Alexander, M. Feller, and B. Lawson have reviewed the drafts of this handbook and made valuable comments. G. Montgomery edited the text and M. Romeo typed the manuscript. Our thanks go to all of the individuals and organizations above, and to the many others who contributed to this first step in developing a prescribed fire information system for British Columbia.

Fuel inventory methods closely follow McRae *et al.* (1979) with few modifications, and the authors wish to make special acknowledgement to that work.

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1 INTRODUCTION

Prescribed fire is an important site treatment in British Columbia for forest, range, and wildlife management. In 1988, over 135 000 ha in the province were treated with it. This FRDA Handbook contains standard methods of prescribed fire research assessments for logging slash fuels in British Columbia, and describes the procedures required for making pre-burn assessments, observations during the fire, and post-burn assessments. At this time, all procedures included are oriented toward documenting and evaluating broadcast prescribed fire. Eventually, these may be modified and other procedures added, such as those for evaluating seedling response.

This handbook is designed solely for voluntary assessments. It is intended to document the prescribed fire treatment and to assess the success or failure of specific fire prescriptions. Ultimately it may lead to the accumulation of a data base for a computerized prescribed fire management information system. The fate of an information system will depend on the successful application of the techniques described in this handbook and on the related research trials and experimentation.

The assessments are plot based. Sites must be stratified according to topography and ecosystem distribution, and fuel type and loading. A minimum of two plots per stratum are required for an assessment. One or more assessments may be done in any treatment site.

Training in the use of this handbook will be made available by the Ministry of Forests, but is not absolutely necessary if the procedures are followed closely. (Refer to Appendix 1 for a list of the required field equipment.) Read through the handbook carefully and refer to the text when completing the forms. Once experienced, two people can complete the pre-burn assessment in 1 day. The post-burn assessment will usually be completed by two people in less than half a day. Office time is required to complete some sections of the forms and this will vary in length, depending on such factors as file location of information and type of weather instrumentation.

It is anticipated that these assessments, complemented by research trials and experiments, will lead to the refinement of fire prescriptions and fire behavior and impact (fuel and site) models in British Columbia.

2 SITE IDENTIFICATION AND HISTORY

2.1 SAMPLE IDENTIFICATION

Assign a unique number to each set of two plots and record it on each field form and photo. An example: P86 - 2 - 08 - 001.

The components have the following meanings:

P	prescribed fire assessment
86	calendar year 1986
2	Forest Region (in this case Vancouver)
08	Forest District (in this case Campbell River)
001	assessment 001 in that district

Forest Region

Vancouver	2	Prince Rupert	3
Prince George	4	Kamloops	5
Nelson	6	Cariboo	7

Forest District

Vancouver		Prince Rupert	
Chilliwack	1	Lakes	1
Maple Ridge	2	Morice	2
Squamish	3	Bulkley	3
Sunshine Coast	5	Kispiox	4
Duncan	6	Kalum	5
Port Alberni	7	North Coast	8
Campbell River	8	Cassiar	9
Port McNeill	9		
Mid-Coast	10		
Queen Charlottes	11		

Prince George		Kamloops	
Prince George	1	Clearwater	1
McBride	3	Kamloops	2
Vanderhoof	4	Salmon Arm	3
Fort St. James	5	Vernon	4
Mackenzie	6	Penticton	5
Dawson Creek	7	Merritt	6
Fort St. John	8	Lillooet	7
Fort Nelson	9		
Nelson		Cariboo	
Cranbrook	1	Quesnel	1
Invermere	2	Williams Lake	2
Golden	3	Horsefly	3
Revelstoke	4	100 Mile House	4
Arrow	5	Chilcotin	5
Boundary	6		
Kootenay Lake	7		

Company

Record the company name where applicable.

2.2 SITE INFORMATION

Although the impact assessments are plot based, information about the entire treatment area is also required as it influences not only the fire objectives and prescriptions, but prescribed fire behavior as well. In addition, such information identifies the links to other data regarding forest management practices that may be important for evaluating the prescribed fire treatment.

2.2.1 Information links

Other inventory, data collection, and recording systems such as the Silviculture History Record, Pre-Harvest Silviculture Prescription (PHSP), and forest inventory are in use and may contain information relevant to prescribed fire monitoring.

Give the Silviculture History Record Key Number(s) or, in the case of TFL licences, the company designation for the site. Check the opening file and indicate whether or not a pre-harvest silviculture prescription was carried out. Make a photocopy of the forest cover map, outline the site, and attach the page to Form 1 (Appendix 2). Note any other relevant surveys carried out (e.g., pest, brushing and weeding, waste) and the file location of the data.

2.2.2 Site description

Record the following information:

BCGS and NTS mapsheet numbers and location. Note the mapsheet numbers to the most detailed scale available. Photocopy the appropriate portion, indicate the location of the site, and attach it to Form 1. Give a description of the location of the site, such as directions for reaching it by road (e.g., on the north side of Quesnel Lake, 1.5 km west of Abbott Creek, at the 12.5 km mark of spur road R-2 leading from Quesnel North Main).

Design and layout of site. On the forest cover map indicate the size of the opening and include a plan diagram showing the location of roads, landings, prescribed fire assessment plots, scale, and other important features.

Biogeoclimatic zonation. Record the biogeoclimatic (BGC) zone and subzone. Variants should be included if appropriate. Reference should be made to the Land Management Report or Handbook number that provided the basis for classification.

Latitude and longitude. Give the latitude and longitude to the nearest 10 seconds (± 05").

Elevation. Record the elevation (meters) or range of elevation over the site.

Slope. Record the range of slope (percent).

Aspect. Note the aspect as one or more of these:

flat	Fl	south	S
north	N	southeast	SE
northeast	NE	southwest	SW
northwest	NW	west	W
east	E		

3 OBJECTIVES AND PRESCRIPTIONS

If completed FS 117, 737, and 711 forms and burning plans are attached, disregard this section.

3.1 RESOURCE MANAGEMENT OBJECTIVES

State the resource management objectives for the site (e.g., production of timber products, range, watershed management, wildlife management, recreational use). When possible, express these objectives in quantitative terms to permit evaluation of success or failure of prescribed fire programs.

3.2 SILVICULTURE OBJECTIVES AND PRESCRIPTION

State the silviculture prescriptions that influence the setting of prescribed fire impact objectives. The most common parts of the silviculture prescriptions used are reforestation method (natural, planting, seeding), species selection, system/season/method of logging, and brushing and weeding needs. Specific concerns requiring special precautions should be stated. This might include noting a lack of good planting spots, site sensitivity (e.g., the need to conserve organic matter to maintain forest productivity), or vegetation management.

3.3 PRESCRIBED FIRE OBJECTIVES AND PRESCRIPTION

List the desired fire impact objectives in quantitative, measurable terms. Choose the prime fire impact objective and use it to determine the impact rank from side II of the Prescribed Fire Predictor (PFP) (Muraro 1975). The initial impact rank may be revised after consideration of all impact objectives to determine the prescription. Describe any potential constraints to meeting the prime burn objective, and state the rationale used to finalize the desired impact rank. Detail the prescription necessary to achieve the fire impact objectives, in terms of ranges of weather parameters and fuel moisture codes of the Canadian Forest Fire Weather Index System and the ignition, spread, and control ranks of the PFP. If revisions are made to the output from the PFP, include explanatory comments. Any special control concerns should be listed (e.g., adjacent values, smoke management). If another decision aid is used (see, for example, Brown et al. 1985), list inputs and outputs from the model.

4 PRE-BURN PROCEDURES AND PLOT DESCRIPTIONS

4.1 PROCEDURES FOR PLOT LOCATION

Stratify the site into uniform areas on the basis of topography and ecosystem distribution, and fuel loading and type (see Figure 1). Select one (or more) of the stratified areas for assessment. Criteria for stratum selection could be that:

1. the site/fuel combination best reflects average conditions for the setting and is frequently and extensively encountered;
2. the site and/or fuel type is one in which achieving the desired degree of burn impact in the past has been difficult; or
3. impacts on fuels and site in relation to objectives and prescriptions have never been quantified or verified.

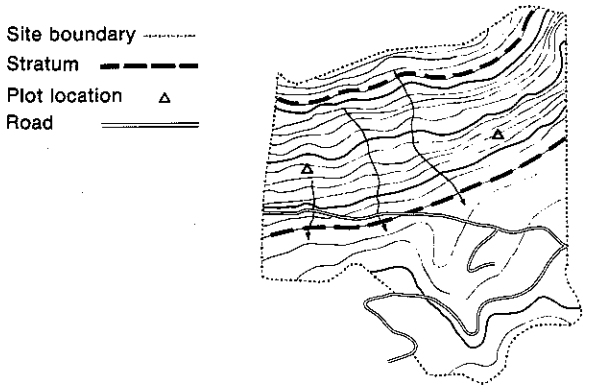


FIGURE 1. Stratification of a site into uniform areas (after Green et al. 1984).

Within each stratum to be assessed, select two plot locations representative of each stratum (two plots per stratum). Plot locations should meet, as nearly as possible, the following specifications:

1. Over an area of 30 x 30 m, the plot must be reasonably uniform in terms of slope, aspect, microtopography, and soil moisture and nutrient regime.
2. Skid trails, landings, and areas where soils have been seriously disturbed should be avoided. As skid trails may account for a significant portion of the stratum and will generally be affected by prescribed burning, it is therefore not necessary to avoid them at all costs.
3. The spatial distribution of slash must be as nearly uniform as possible within and between the 30 x 30 m plots.
4. The two plots should be distributed within the stratum to create a well-spaced, yet representative sampling scheme.
5. If possible, the plots should be located in such a way that they can be observed from a safe vantage point during the fire.

4.2 PLOT LAYOUT

Choose a starting point in the center of a selected plot area. In a random direction 17 m from the center, mark a corner by driving a rebar rod securely into the ground (Figure 2). Each of two people must then loop the ends of 30 m ropes (or poly chaining tapes) around this rod and proceed away from the corner point, carrying the ropes and a rebar rod. An angle of approximately 60° should be described between the two people. At the points where the ropes become taut, the rods must be pushed into the ground and the rope ends looped over them. The ends of a third 30 m rope should then be attached to these rods and the positions of the rods adjusted until all three ropes are taut.

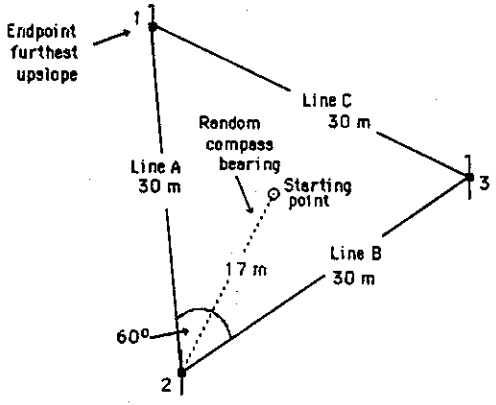


FIGURE 2. Plot layout.

NOTE: 1. In the interest of safety, rebar rods should be bent into a small loop at one end before placement.

2. Rods must be perpendicular to the ground surface.

3. Ropes should run as parallel as possible to the ground without becoming elevated or deflected by slash or vegetation.

4. Throughout the plot layout and sampling procedures, avoid disturbing slash along sample lines.

5. If necessary, adjust the plot location to avoid skid trails, excessive soil disturbance, or "atypical" slash loadings or distributions.

4.3 ENVIRONMENTAL INFORMATION

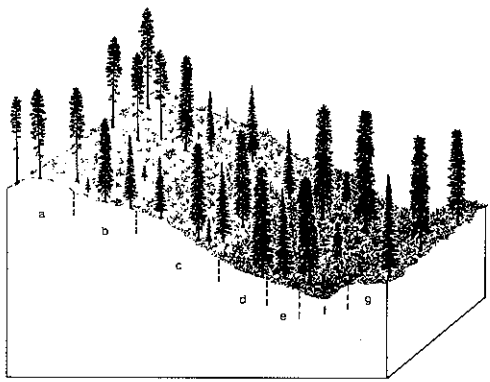
To assess site properties within and between the plots, describe each plot by the following parameters.

4.3.1 Topography

Slope. Record slope to the nearest 1%.

Aspect. Record aspect in degrees azimuth.

Slope position. Note the slope position of each plot in relation to the following categories (see Figure 3):



a) crest
b) upper slope
c) middle slope
d) lower slope
e) toe
f) depression
g) level

FIGURE 3. Slope positions.

Microtopography. Microtopography is an estimate of the height of mounds and the distance between them. Assign the microtopography to one of the following classes:

a) Smooth - no mounds, surface profile mostly linear (horizontal or inclined)

b) Moderately mounded - mounds to 1 m high

c) Extremely mounded - mounds more than 1 m high.

4.3.2 Soil description

Choose one representative location near but not inside either plot, and dig a soil pit to a depth of 50 cm or to bedrock. If a soil property requires verification, collect samples in plastic bags, and transfer them to paper bags or a drying tray within 1 day to retain them for later identification. Assess the following items, noting them on Form 2 (Appendix 2):

Organic layer description. Identify and determine the average thickness of the L, F, H, and O horizons. All types may or may not be present. If the horizons cannot be distinguished because of disturbance, estimate the total thickness for the entire organic layer. They may be identified as follows:

L - pre-harvest horizons that consist of "litter" materials, including foliage, fine twigs, cones, etc. Materials may be discolored, but do not show moderate or advanced signs of decomposition.

F - horizons that consist of partially decomposed materials in which skeletal structures are largely still discernible, although strongly discolored and at least partially disintegrated.

H - horizons that are dominated by fine humic substances in which the original structures are indiscernible upon rubbing.

O - horizons that are normally saturated with water and associated with hydrophytic vegetation (peat).

Mineral layer description. Identify and describe each of the major mineral soil horizons to 50 cm with respect to average thickness, texture, coarse fragment content, and color as specified below:

Ae - a leached horizon in the upper soil profile characterized by a grayish color.

Ah - an upper soil horizon enriched with organic matter that is darker (brown to black) than the underlying soil.

B - at or below the upper soil profile, variable colors; often reddish from iron precipitates or gray to brown from clay accumulation.

C - slightly altered or unaltered parent material in lower soil profile, or in upper profile due to recent deposition from colluviation, flooding, etc.

Color. Record the color and color modifier of each horizon as one of the following:

gray brown red black	(bright or dull, dark or light)
gleyed	(orange-colored mottles or dull yellowish, blue, or olive colors).

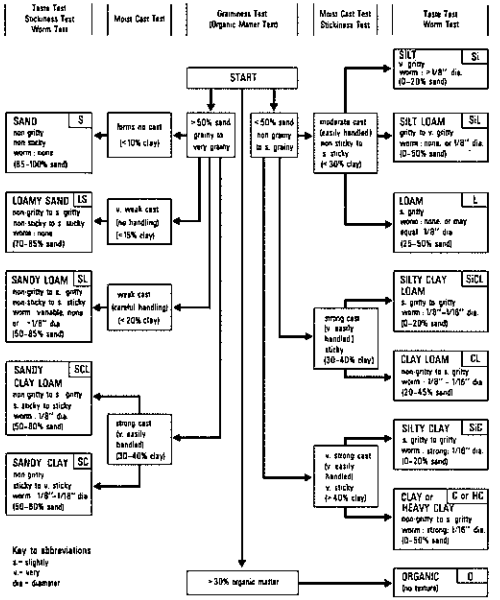
Note whether the soil is dry, fresh, or wet at the time the color is determined.

Special features. Note the type and depth (from top of first mineral horizon) of the following features:

- depth to which most rooting occurs
- restrictive layers: cemented horizon
  clay pan
  bedrock
  water table
  other (describe)
- seepage zone
- other (describe)

Texture. Estimate the texture of the mineral fine fraction (particles smaller than 2 mm in diameter) by referring to the key and/or by consulting the soil textural triangle (Figure 4).

Coarse fragment content. Estimate the percent of the soil volume occupied by coarse fragments (particles larger than 2 mm in diameter), using Figure 5.



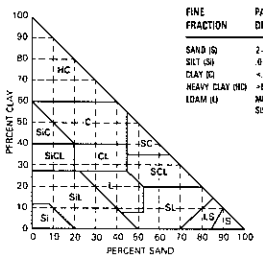


FIGURE 4. Soil texture key and triangle (from B.C. Ministry of Forests, information leaflet FS 238).

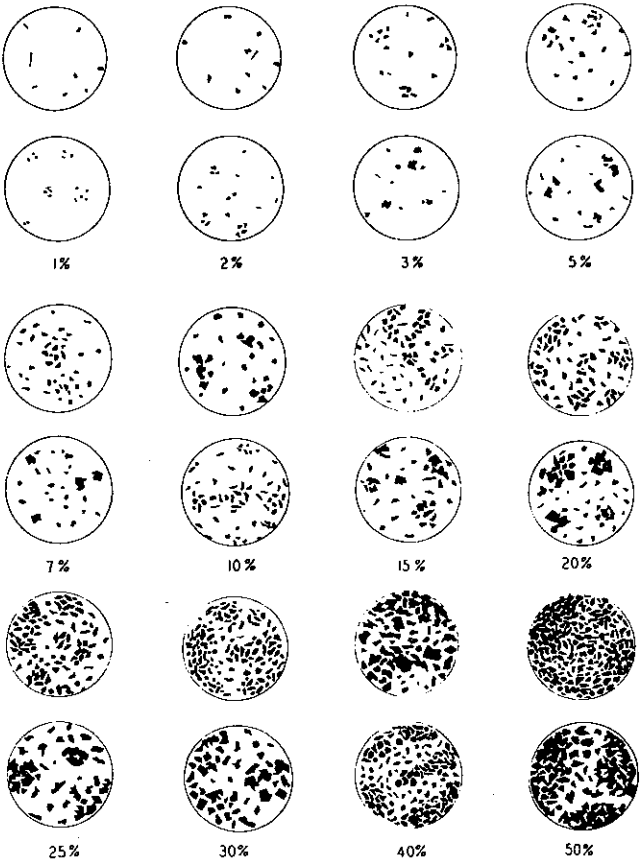


FIGURE 5. Comparison charts for visual percentage estimation (from Walmsley et al. 1980).

Soil nutrient regime. The soil nutrient regime is the capacity of a soil to supply nutrients for plant growth. Estimate the nutrient regime, using the guidelines in Table 1.

TABLE 1. Soil nutrient regime guidelines (from Walmsley et al. 1980)

	OLIGOTROPHIC A	SUBMESOTROPHIC B	MESOTROPHIC C	PERMESOTROPHIC D	EUTROPHIC E	HYPEREUTROPHIC F
DEFINITION	very poor nutritional status, very small supply of available nutrients	poor nutritional status, low supply of available nutrients	medium nutritional status, medium supply of available nutrients	rich nutritional status, plentiful supply of available nutrients	very rich nutritional status, abundant supply of nutrients	saline nutritional status excess salt accumulations
TEXTURE	very coarse	coarse	medium	fine	very fine	variable
ORGANIC MATTER CONTENT	low	moderate		high		variable
HUMUS FORM	acid mors	mor and moders		moders and muls		

Soil moisture regime. The soil moisture regime is the capacity of a soil to supply available water for plant growth. Estimate the moisture regime, using the guidelines in Table 2.

TABLE 2. Soil moisture regime guidelines (from Walmsley et al. 1980)

MOISTURE REGIME	DEFINING CHARACTERISTICS		FIELD RECOGNITION CHARACTERISTICS						SLOPE GRADIENT
			SOIL PROPERTIES						
	DESCRIPTION	PRIMARY WATER SOURCE	SLOPE POSITION	TEXTURE	DRAINAGE	DEPTH TO IMPERMEABLE LAYER	HUMUS FORM DEPTH	AVAILABLE WATER STOR. CAP.	
VERY XERIC	Water removed extremely rapidly in relation to supply. soil is moist for a negligible time after ppt	precipitation	ridge crests shedding	very coarse (gravelly-S) abundant coarse frag-ments	very rapid	very shallow (<0.5 m)	very shallow	extremely low	very steep (especially on south aspects)
XERIC	Water removed very rapidly in relation to supply, soil is moist for brief periods following ppt	precipitation			rapid				
SUBXERIC	Water removed rapidly in relation to supply soil is moist for short periods following ppt	precipitation	upper slopes shedding	coarse to mod. coarse (LS-SL) mod. coarse frag.	rapid to well	shallow (< 1m)	shallow	very low	steep
SUBMESIC	Water removed readily in relation to supply. water available for moderately short periods following ppt	precipitation						low	moderate
MESIC	Water removed somewhat slowly in relation to supply. soil may remain moist for a significant, but sometimes short period of the year Available soil moisture reflect climatic inputs	precipitation in moderately to fine-tex-tured soils & limited seep-age in coarse textured soils	mid-slope normal rolling to flat	moderate to fine (l-SiL) few coarse fragments	well to moderately well	moderately deep (1-2 m)	moderately deep	moderate	
SUBHYGRIC	Water removed slowly enough to keep the soil wet for a significant part of the growing season, some temporary seepage and possibly mottling below 20 cm	precipitation and seepage	lower slopes receiving	variable depending on seepage	moderately well to imperfect	deep (>2 m)	deep	high	slight
HYGRIC	Water removed slowly enough to keep the soil wet for most of the grow-ing season; permanent seepage and mottling present, possibly weak gleying	seepage			imperfect to poor	variable depending on seepage		variable depending on seepage	
SUBHYDRIC	Water removed slowly enough to keep the water table at or near the surface for most of the year, gleyed mineral or organic soils; permanent seepage less than 30 cm below the surface	seepage or permanent water table	depressions receiving	variable depending on seepage	poor to very poor	variable depending on seepage	very deep	variable depending on seepage	flat
HYDRIC	Water removed so slowly that the water table is at or above the soil surface all year; gleyed mineral or organic soils	permanent water table			very poor				

4.3.3 Vegetation description

During the growing season prior to the prescribed fire, prepare a floristic list and estimate of cover and distribution for the vegetation in the plots, making an inventory of all plant species rooted in soil horizons.

Plot layout. Within the area enclosed by the fuel sample triangles (approximately 390 m^2), make a simple visual estimate of the percent cover (the amount of ground surface area occupied by a downward projection of the "crown area" of the individuals of a particular plant species) and the

distribution of each plant species. Some estimates of vegetation cover may be difficult to obtain because of the presence of slash and logging disturbance.

Cover and distribution value by layer. Use Figures 5 and 6 to estimate percent cover and distribution. Use "T" (trace) to indicate less than 1% cover. The plants are assigned to one of three strata:

1. Shrubs - all woody plant species, including advance tree regeneration. Low woody trailing plants should be included in the herb category in spite of their woody appearance.[1]
2. Herbs - all herbaceous species (forbs and grasses).
3. Ground cover - estimate cover of mosses, lichens, and liverworts separately, without regard to individual species. Estimate cover of tree seedlings (less than 2 years of age) by species.

Use of Ministry of Forests plant species guides and scientific names is recommended.

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[1]Consult Walmsley et al. 1980, p. 141.

Class	Description	No. of plants in plot	DIAGRAM
1	rare individual, a single occurrence	1	
2	a few sporadically occurring individuals	2 - 5	
3	a single patch or clump of a species	1 patch occupying an area smaller than one quadrant of the plot	
4	several sporadically occurring individuals	≥6	
5	a few patches or clumps of a species	2 - 5 patches (each occupying an area smaller than one quadrant of the plot)	
6	several well spaced patches or clumps	≥6 patches (each occupying less than one quadrant of the plot)	
7	continuous uniform occurrence of well spaced individuals	many	
8	continuous occurrence of a species with a few gaps in the distribution	many	
9	continuous dense occurrence of a species	many	

FIGURE 6. Vegetation distribution codes (from Walmsley et al. 1980).

As a standard procedure it is best to walk the entire plot area and make a mental list of the plant species present. Then work through the strata, doing the shrubs first, then the herbs, and then the ground cover. Within each stratum concentrate on the individual species and work down from the most abundant to the least abundant species (except in the case of mosses, liverworts, and lichens).

For species that cannot be identified in the field at the time of sampling, assign a name or number to the plant and collect it in a plant press with some flowers or fruiting bodies (and roots if it is a forb or grass) for later identification. Local verified collections in herbaria may be available for comparisons. Classify each vegetation plot by ecosystem

association (e.a.) and note the classification reference. Use the two-digit code for the e.a. on the form.

4.4 FUEL SAMPLING AND ESTIMATE OF MINERAL SOIL EXPOSURE

Sampling of slash and forest floor for fuel load and consumption estimates, along with an estimate of mineral soil exposure, is based on triangular plots described by three 30 m line transects.

Pre- and post-burn slash loads are estimated for each 30-m transect, using a version of the line intersect sampling method[2] (see Figure 7). Slash smaller than 7 cm in diameter is tallied by size class, while pieces larger than 7 cm in diameter are measured individually.

To measure duff consumption, metal depth-of-burn pins are inserted in the forest floor at specified points along each transect. The depth of the moss and/or litter layer is measured prior to burning and the depth of burn and residual duff depth are measured post-burn. These three measurements combine to equal the total pre-fire forest floor depth.

It is important to differentiate between the pre-harvest forest floor materials and the fine slash and foliage which may have been deposited on the surface during harvesting. The moss layer or degree of litter discoloration are the best clues for identifying the pre-harvest forest floor surface (see Figure 15). If in doubt, observe the forest floor in an adjacent forested area within the same ecosystem.

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[2]A technique developed and described by Warren and Olsen (1964), Van Wagner (1968, 1982), Brown (1971, 1974), Brown and Roussopoulos (1974), Brown et al. (1982), and McRae et al. (1979).

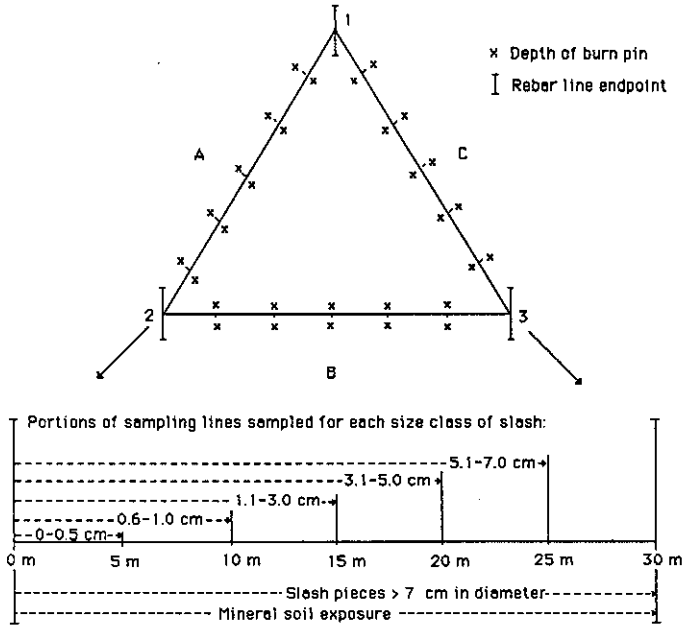

FIGURE 7. Plot layout, including depth-of-burn measurement locations and portions of lines sampled for each size class of slash.

4.4.1 Slash

Label the sides of the triangle A, B, and C and indicate their location on the plot diagram (on the fuel data form) relative to compass readings, the slope, and any landmarks such as cutblock edges and roads. As a convention, where possible, make the starting point for side A the point furthest upslope and proceed to B and C, moving in a counterclockwise direction from plot center.

Carry out the following procedures for each of the sample lines, beginning with side A (Figure 7).

1. Determine and record the slope of the line.
2. Count and record the number of twigs, branches, and small stems less than 7 cm in diameter that intersect the line. Use the following size classes and lengths of sample line:

Diameter size class (cm)	Portion of sample line tallied (m)
0 - 0.5	0 - 5
0.6 - 1.0	0 - 10
1.1 - 3.0	0 - 15
3.1 - 5.0	0 - 20
5.1 - 7.0	0 - 25

The actual diameter of each piece at the point of intersection with the sample line determines its size class. Use a "go-no-go" gauge (Figure 8) to train the eye to recognize size classes and to decide borderline cases. Counting can be done one size class at a time or pieces can be "dot tallied", depending on the preference of the crew.

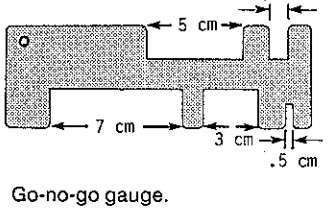

FIGURE 8. Go-no-go gauge.

3. After completing the count, estimate the percent (nearest 5%) species composition of all pieces less than 7 cm in diameter for that line. Tree species abbreviations are as follows:

Species	Symbol	Species	Symbol
green and Sitka alder	Dg	alpine larch	La
mountain alder	Dm	tamarack	Lt
red alder	Dr	western larch	Lw
arbutus	Ra	broadleaved maple	Mb
poplar	Ac	Rocky Mountain maple	Mr
trembling aspen	At	vine maple	Mv

Alaska paper birch	Ea	jack pine	Pj
common paper birch	Ep	limber pine	Pf
western birch	Ew	lodgepole pine	Pl
western redcedar	Cw	western white pine	Pw
yellow-cedar	Yc	whitebark pine	Pa
Douglas-fir	Fd	yellow pine	Py
alpine fir	Bl	black spruce	Sb
amabilis fir	Ba	Engelmann spruce	Se
grand fir	Bg	Sitka spruce	Ss
mountain hemlock	Hm	white spruce	Sw
western hemlock	Hw	western yew	Tw

4. Along the entire 30 m of sample line, record the species and measure the diameter of all intersecting pieces larger than 7 cm in diameter. Label unidentifiable but sound pieces with a "U", and decayed pieces with a "D". Consider a piece decayed if it can be kicked apart easily. Use calipers to measure each piece at the point of intersection with the sample line and record the diameter to the nearest 0.1 cm. To locate and remeasure at the same point post-burn, drive a 7.5-cm nail into each piece at the point of measurement, leaving approximately 1.0 cm of the nail exposed. At completion of each 5-m section, place an "X" in the species column of the fuel form and leave the diameter column blank.

The following tally rules[3] apply to all size classes of slash:

Rule 1: Particles qualifying for tally include downed, dead woody material (twigs, stems, branches, and bolewood) from trees and shrubs. Dead branches attached to boles of standing trees are omitted because they are not downed fuels. Consider a particle downed when it has fallen to the ground or is severed from its original source of growth. Cones, bark flakes, needles, leaves, grass, and forbs are not counted.

---

[3] Tally rules and diagrams are taken directly or adapted from Brown (1974) and McRae et al. (1979).

Rule 2: If the sampling line intersects the end of a branch or log, count it only if the line crosses the central axis of the piece (Figure 9).

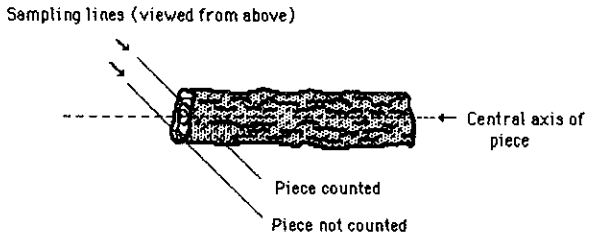

FIGURE 9. Tally Rule 2.

Rule 3: If the line exactly intersects the central axis, tally every other such piece (Figure 10).

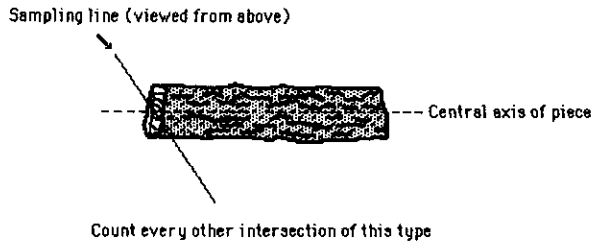

FIGURE 10. Tally Rule 3.

Rule 4: When the central axis of a piece coincides exactly with the sample line (Figure 11) do not count it. (This rarely occurs.)

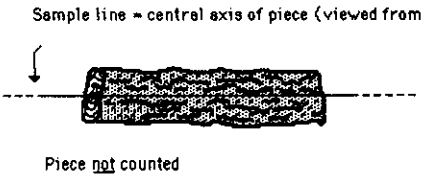

FIGURE 11. Tally Rule 4.

Rule 5: If the sample line intersects a curved or angular piece more than once, tally each intersection (Figure 12).

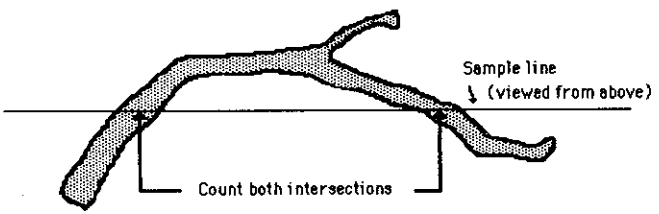

FIGURE 12. Tally Rule 5.

Rule 6: Visually reconstruct in a cylindrical shape the fragments of wood shattered during logging and the rotten logs that have fallen apart to determine: 1) the diameter class for pieces smaller than 7 cm and 2) diameter estimate for pieces larger than 7 cm. Put "E" on the form to indicate it is an estimate.

Rule 7: Tally uprooted stumps and roots if they are not encased in soil. Do not tally undisturbed stumps.

Rule 8: Regardless of size, count only those pieces whose central axis lies above the duff layer at the point of intersection (Figure 13).

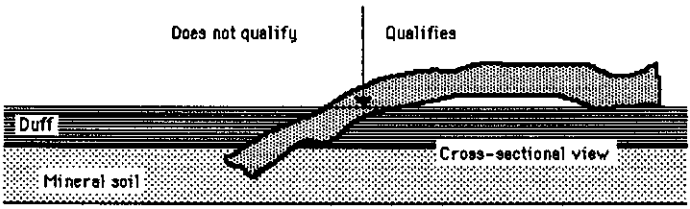

FIGURE 13. Tally Rule 8.

"Duff" (Figure 14) refers to partially to well-decomposed organic materials (i.e., the F and H horizons) lying between the moss/litter layer of the forest floor and the uppermost mineral soil horizon. Forest floor refers to both the litter and mosses, and the duff layers.

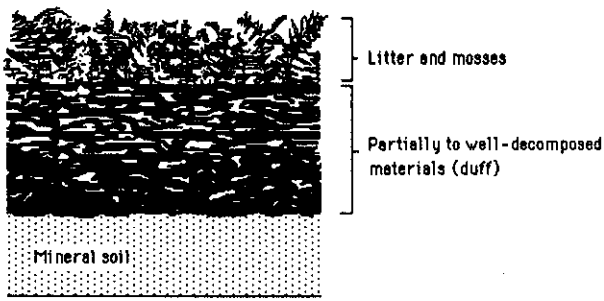

FIGURE 14. Litter and mosses, duff, and mineral soil layers.

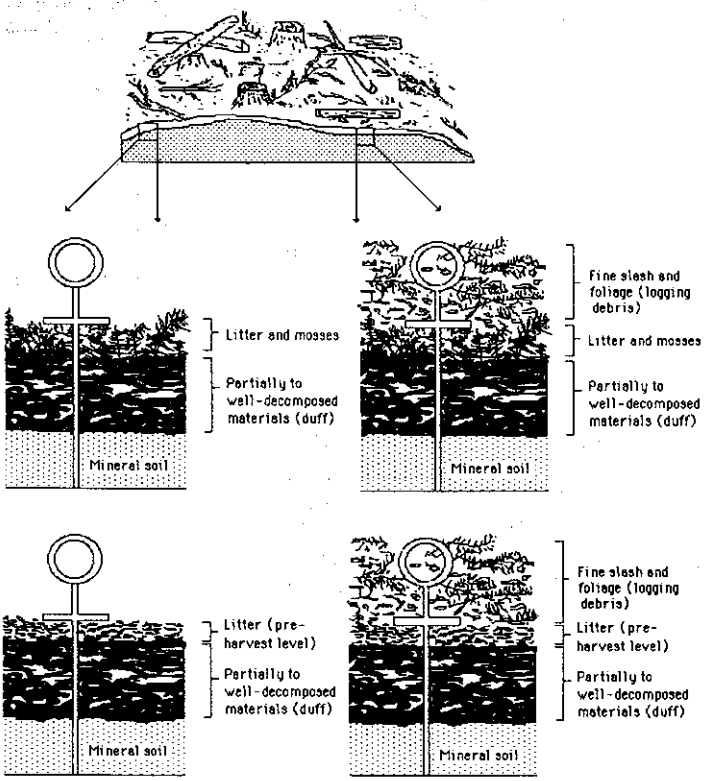

FIGURE 15. Depth-of-burn pin placement.

4.4.2 Forest floor

Carry out the following procedures for each of the sample lines, beginning with Side A.

1. Insert depth-of-burn pins at 10 points per line, located 1 m to the right and left of the 5, 10, 15, 20, and 25 m points (Figure 7). Place pins in undisturbed forest floor, the crossbar level with the surface of the pre-harvest litter or moss layer, being careful not to compact the materials in the process (Figure 15).

   Offset the point of pin placement a further 50 cm if the 1-m point coincides with a sound stump or log. Insert pins through decaying logs if their central axis is in the duff layer (Figure 16). A pair of pliers may be used to clip and shorten the pin if shallow rocky soils are encountered which prevent insertion to the level of the crossbar.

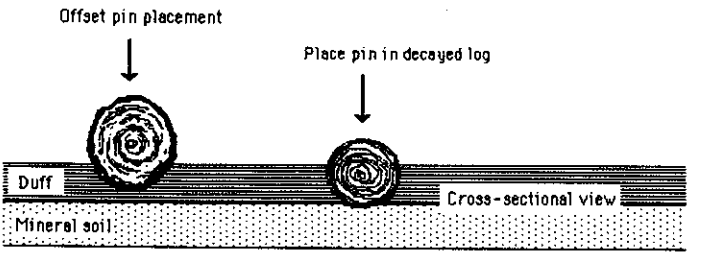

FIGURE 16. Place pins in decaying logs only if the log's central axis lies below the surface of the duff layer.

2. In conjunction with the placement of each depth-of-burn pin, measure and record the depths of the pre-harvest litter or moss layer if present (Figure 15). To determine impact objectives for the PFP, estimate the average thickness of the forest floor, as 0-5, 5-10, 10-15, or more than 15 cm thick. While making these

observations, do not disturb the forest floor at the pin locations, instead choose a spot in the immediate vicinity which is representative of the material in which the pin was placed. Record measurements taken inside and outside the triangle under the appropriate columns labelled "in" and "out" on the form.

Where an assessment is being done on an area which was logged several years ago, as for example a prescribed burn for site rehabilitation, there may be an accumulation of dead vegetative material suspended above the litter layer and below the larger woody fuel. Care must be taken to clear this material away (mostly dead herbaceous stems and branchlets) to access the litter or moss layer at the point of measurement.

4.4.3 Mineral soil exposure

Along each 30 m line of fuel transect, estimate the percent of mineral soil exposure. Walk along the transect, estimate the meters of exposed mineral soil, divide by 30 and multiply by 100 to obtain percent. Record the result on the fuel form.

4.4.4 Photography

Using 35 mm color slide film and a 50 mm lens, take a minimum of three horizontal pictures of each plot. To achieve continuity with post-burn photos, take them from the rebar end points, aiming the camera along each line (Figure 17) at a graduated range pole positioned at the 10 m mark. This procedure will allow the fuel, vegetation, and reference marker to be in focus. Lettering on the marker should not be less than 7 cm in height and should include the assessment identification, plot number, line designation, and graduation increment. These photos may also be used to assess vegetation competition with the crop species.

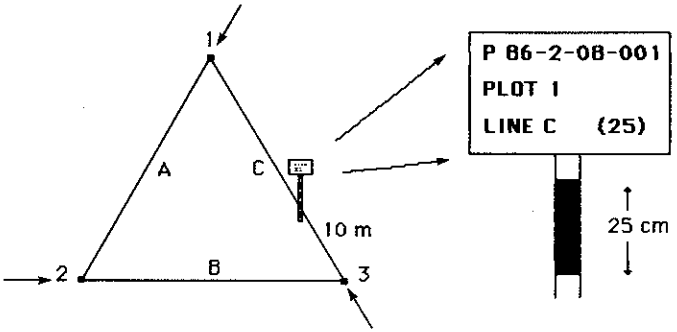

FIGURE 17. Camera locations, angles for plot photos, and reference marker.

4.5 PRE-BURN FIRE WEATHER

Ideally, weather should be monitored from a station located on-site for the entire fire season. The minimum period of daily on-site weather observations for an assessment is 3 weeks in advance of the prescribed burn. A weather station located in a suitable opening adjacent to or near the prescribed burn block is acceptable if there is little change in slope, aspect, or elevation. If the weather station is located on a nearby site where it has little risk of being damaged by an escaped burn, weather observations can be taken during the fire from this installation. Turner and Lawson (1978) provide complete details on weather station location and fire weather recording. Included in Appendix 3 is a summary of this information.

Fire weather observations needed for the calculation of component moisture codes and indexes of the Canadian Forest Fire Weather Index (FWI) System (Canadian Forestry Service 1984) are temperature, relative humidity, wind speed, and precipitation[4], all measured at noon standard time. List all observations and calculations of FWI System fuel moisture and fire behavior indexes. Weather observations that have been estimated in place of missing data should be clearly indicated with a circle drawn around the observations. If all-season data are not collected, start-up codes must be taken from the most representative permanent station and adjusted to on-site conditions. Include the full season's weather record for the permanent station from which start-up values for the on-site weather station were derived. List the procedures used to adjust the permanent station codes to on-site conditions and attach them to the weather record forms. Interim adjustment procedures have been distributed to Regional Protection Section's of the Ministry of Forests.[5]

A recording or standard rain gauge should be placed on-site for the entire season if daily on-site weather observations cannot be taken over the full season. Precipitation data, even on a weekly or monthly basis, are useful for making adjustments to a Drought Code derived from a weather station that is nearby but not on-site. Three weeks of daily on-site precipitation observations will provide adequate data for the calculation of a Duff Moisture Code representative of on-site conditions.

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[4]If electronic sensors are being used for measurement, calibrate them frequently with a sling or fan psychrometer and standard rain gauge.

[5]Bell, P.A. 1980. An interim procedure for estimating CFFWI starting values for prescribed burn sites. 5 p. and appendices.

5 OBSERVATIONS DURING THE FIRE

Personnel who are responsible for monitoring the prescribed burn should be independent of ignition and suppression crews to be able to devote full attention to the monitoring activities. Observational personnel should be included in the ignition briefing prior to light up, so that they are aware of the proposed ignition pattern. Observational points can then be selected for best advantage while crew safety is ensured. At least one person should be designated as an official observer, but two people would be preferable if a lot of photography and video taping are planned. If someone cannot be allocated for burn monitoring, then the minimum observations made during the burn should be an accurate map of the ignition pattern and the burn day's 1200 PST weather readings.

5.1 FIRE WEATHER

Fire weather has already been discussed in Section 4.5. In addition to the fire weather observations taken at 1200 h local standard time on the burn day from the on-site weather station (indicate burn day on weather record form with * adjacent to the date), observations of temperature, relative humidity, and wind speed and direction should be taken again just prior to start-up of ignition (indicate time of observation), before the weather station is taken down. These observations need to be recorded for adjustment of the Fine Fuel Moisture Code (FFMC). Weather readings at 1200 h PST and/or those prior to light-up may have to be taken with hand-held instruments if the weather station must be removed before the fire. If so, these readings should be taken in the open at the weather station site and indicated as hand-held readings on the weather record form. If hand-held weather readings cannot be made on-site, record their location on the weather form adjacent to the readings. Conversion of hand-held wind speed to standard 10 m height is given in Appendix 3. If hand-held wind measurement is not possible, use the Beaufort scale. Calculate fire weather codes and indexes for the day of the fire and enter these in the PFP (side I) to calculate behavior and impact ranks. Adjust the FFMC for ignition time, slope, and aspect, using procedures outlined in Appendix 4. If a nearby weather station has hourly weather data available during the prescribed burning operation, try to obtain these additional data, especially if major control problems are encountered.

If fuel moisture sticks are used, record the time and final readings for the burn day. They can be used to provide an estimate for the FFMC (see Appendix 4 for procedures) if the weather station has been taken down. They can also be used on different aspects/slopes and in adjacent standing timber to examine fine fuel moisture content differences which may cause control difficulties (e.g., when the timber is drier than the slash).

5.2 FIRE BEHAVIOR

This handbook is designed to document burns that have a center or perimeter firing pattern or are narrow strip headfires. It may not be possible, therefore, to document rate of spread except in the most general way (e.g., by recording the Spread Rank from the PFP). Rate of spread documentation will not be required in these procedures, but great care should be taken to provide an accurate ignition sequence map, which will enable ignition rate and technique information to be extracted later.

Estimate and record the average Spread, Ignition, and Control Ranks for the fire. Impact rank should be calculated from the actual slash and forest floor consumption and mineral soil exposure documented for the burn.

If spotting occurs outside the fire perimeter, note the time, distance from the fire front, and location on the prescribed burn map. Make notes on control difficulties and reasons for any control problems (e.g., major changes in wind direction and speed).

Describe general fire behavior including, where appropriate, convection column height and direction as well as smoke color (white, gray, black). Note any breakdowns or shifts in convection column or firestorm, or any erratic fire behavior. Following the fire, note the length of time of smouldering combustion and any mop-up problems and fire persistence.

5.3 IGNITION PATTERN AND EQUIPMENT

Provide an accurate map of the ignition pattern (layout and timing of ignition lines) that actually occurred. Note and explain any delays in ignition sequence (e.g., breakdown in ignition equipment may cause delay).

Indicate the type or combination of ignition equipment used, as well as the fuel mixture and total amount used.

5.4 PHOTOGRAPHY

Photography (35 mm camera) is helpful in documenting many aspects of fire behavior, ignition patterns and techniques, convection column build-up, and control problems. Photos taken every 10 minutes (start-up to complete ignition) from a fixed location will normally document the treatment well. An audio tape recorder or written notes detailing time and location for each photo are essential for a useful photographic record. To prevent errors resulting from inaccurate timing, monitoring personnel should synchronize their watches. Color video equipment will also provide valuable documentation of fire behavior characteristics listed above.

6 POST-BURN PROCEDURES

6.1 FUEL SAMPLING

As soon as possible but preferably before rain or snow disturbs the unburned forest floor, relocate sample lines by using the plot diagram, rebar endpoints, and 30 m ropes. NOTE: avoid stepping on depth-of-burn pins! Resample fuels as follows:

1. Relocate depth-of-burn pins. With a knife, scrape away any ash that will become soluble and measure from the bottom of the crossbar to the top of the unburned forest floor (or to the mineral soil if it has been exposed, see Figure 18) and record the depth of burn. Using a "soil" knife, expose a cross section of the unburned forest floor, adjacent to the pin, down to its boundary with the mineral soil. Record this measurement to nearest 0.5 cm. Where the duff consists largely of decaying wood, indicate this on the form next to the depth with a "DW".

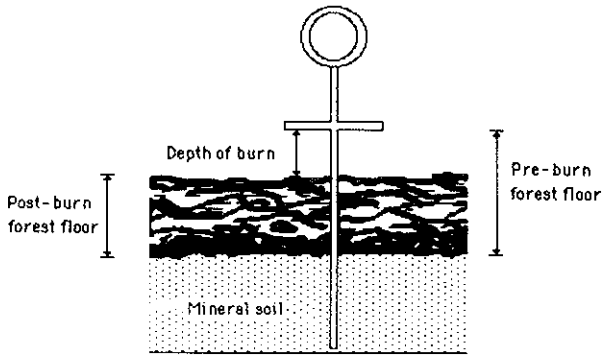

FIGURE 18. Depth-of-burn measurement.

2. Repeat the sampling of slash belonging to size classes smaller than 7 cm as per pre-burn procedures. Tally those pieces that are charred but still solid, along with those that have not been burned. Do not include in this tally, pieces with

nails in them that now conform to one of the smaller size classes. These will be measured and recorded with the larger than 7 cm slash. Do not sample exposed roots in the duff layer.

3. Remeasure slash larger than 7 cm in diameter at the nail point. It is common for slash to move during burning, therefore care must be taken to match the post-burn tally with the pre-burn data. It may be necessary to hunt around for some of the "nailed" pieces, and other pieces not measured pre-burn may now intersect the sample line. Measure only those pieces nailed pre-burn. If a pre-burn inventoried nailed piece cannot be located, enter "NF" (not found) on the tally form.

6.2 MINERAL SOIL EXPOSURE

Repeat procedures outlined in Section 4.4.3. When you visually recognize mineral soil, be sure that it is not a recent deposit on top of an unburned forest floor. This can be a common situation because of the repositioning of large fuels during combustion. If this is the case, it is not considered mineral soil exposure.

6.3 PHOTOGRAPHY

Photograph the plot the same as in pre-burn procedures, from the rebar endpoints along each of the sample lines and with the reference marker positioned at the 10 m location. Having print copies of pre-burn slides on hand helps to ensure that consistency is achieved.

6.4 PERMANENT PLOT LOCATION

Following post-burn fuel sampling, mark plots to permit their relocation for future assessments. These assessments may pertain to the effects of the burn treatment on such silvicultural concerns as rates of revegetation and seedling survival and growth.

Leave rebar rods in place, spray with orange paint, and flag for greater visibility. Place a creosote-treated fence post securely in the ground adjacent to the plot and attach to it a metal "research plot" sign (obtainable from Regional Forest Sciences Sections of the Ministry of Forests). Scratch the assessment identification and plot number on the back of the sign using an electric engraving pencil or sharp nail.

6.5 FUEL CALCULATIONS AND CENTRAL FILING OF DATA

Send originals or clear photocopies of all data forms to:

Planning, Development and Research Section
Protection Branch
Ministry of Forests
1450 Government St.
Victoria, B.C. V8W 3E7

Retain one set of all data forms on file.

The data can be entered on the Protection Information System at any district or regional office of the Ministry of Forests. The computer program will output fuel loading and consumption data by species and fuel class, as well as litter and duff information for each depth-of-burn pin.

For those without access to a protection terminal, please contact John Parminter in Protection Branch, Victoria for a PC-based version of the program, or alternative arrangements for data analysis.

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APPENDIX 1. Field equipment list[1]

	Pre-burn	Burn	Post-burn
Recording			
Field handbook, forms, pencils, clipboards	x	x	x
Plot layout, location			
Altimeter (in meters, set at known elevation)	x		
Clinometer (%)	x		
Compass	x		
Flagging tape	x		x
3 - 30-m ropes (small diam.) or poly chaining tapes flagged at 5-m intervals	x		x
6 - 1.5-m #4 steel rebar rods	x		(relocate, leave)
2 - Creosoted fence posts and research post signs			x (leave)
Plot Sampling			
35-mm camera with 50-mm lens, color slide film	x	x	x
Metric tape measure in centimeters	x		x
Shovel	x		x
Soil knife	x		x
Plastic bags	x		
Plant press	x		
60 depth-of-burn pins	x		(relocate, remove)
2-m graduated range pole with photographic ID marker	x		x
Go-no-go gauge	x		x
Large metric (60 cm) caliper	x		x
Hammer, 7.5-cm nails (200 pre-burn/6 post-burn)	x		x
Pliers	x		
Weather			
FTS 6100 or equivalent weather station	x	x	
Optional			
Hand-held anemometer		x	
Portable fan or sling psychrometer	x	x	
Plant species guides	x		
Tape recorder		x	
Video camera		x	
Binoculars		x	
PVC standard rain gauge	x		
Fuel moisture sticks and balance or scale	x	x	
Precipitation gauge	x		

[1]Quantities are given on the basis of one assessment (two plots).

APPENDIX 2. Field forms

Form 1

Unique No.:P __ __ - __ - __ __ - __ __ __ Date: __ __ Y __ __ M __ __ D

Recorded by: _____

SITE (Section 2)

Forest Region: _____ Company: _____

Forest District: _____ Company designation: _____

Cutting Permit: _____ Silv. history key no(s).: _____

Other surveys file location PHSP: YES ____ NO ____

_____ BGC zonation: _____

_____ Reference: _____

BCGS no.: _____, NTS no.: _____

Location: _____

Attach to this form:

1) Portion of forest cover map with setting outlined.

2) Portion of NTS sheet with site location indicated.

Latitude: __ __ ° __ __ ' __ __ " Longitude: __ __ __ ° __ __ ' __ __ "

Range of: Elevation: ____ to ____m. Slope: ____ to ____%. Aspect: ____ to ____°

OBJECTIVES and PRESCRIPTIONS (Section 3)

Check forms attached:

____ FS 117 ____ FS 711 ____ FS 117A ____ burn plan

Resource management objectives: _____

Silviculture objectives and prescriptions: _____

Prescribed fire objectives and prescriptions: Use side II of PFP to complete the following:

Prime objective of burn (check (√) one, evaluate others)	Desired % reduction or exposure	Impact rank using prime objective	Impact rank revised*	% Reduction and exposure from PFP using prime objective	% Reduction and exposure from PFP revised*
( ) Reduced forest floor estimated duff depth ____ cm					
( ) Exposed mineral soil					
( ) Elimination of fuels by size class					

*Reason for revision(s): _____

Prescribed fire objectives: _____

Form 2

Unique No.: P __ __ - __ - __ __ - __ __ __ Date: __ __ __ __ __ __
Y Y M M D D

Recorded by: _____

Use the PFP to complete:

Burning Conditions Required To Meet Desired Objectives								
Impact Rank	Desired Control Rank	Drought Code	Duff Moisture Code	Desired Spread Rank	Ignition Rank	Fine Fuel Moisture Code	Wind Speed (10 m) km/h	Conditions Satisfactory YES/NO

Range of satisfactory conditions:

If PFP was not used, what decision aid was used? _____

Specify all inputs and outputs of that decision aid or attach the information:

Inputs: _____

Outputs: _____

Comments on prescribed fire prescription: _____

Control concerns: _____

ENVIRONMENT (Section 4.2)

Topography:

	Plot 1	Plot 2
Slope	__ __ __ %	__ __ __ %
Aspect	__ __ __ °	__ __ __ °
Slope position	_____	_____
Microtopography	_____	_____

Soil Pit Description:

Horizon	Thickness (cm)	Texture	Coarse fragment %	Color

Nutrient regime _____
Moisture regime _____
Rooting depth _____ cm
Seepage zone depth _____ cm
Restrictive layer (depth/type) _____ cm/_____
Other features _____

Form 3

Unique No.: P __ __ - __ - __ __ - __ __ __

Recorded by: _____

ENVIRONMENT (cont'd)

Vegetation:

Ecosystem classification reference: _____

Ecosystem association: Plot 1 ____ e.a. Plot 2 ____ e.a.

	Plot 1		Plot 2	
Shrubs	%	Dist.	%	Dist.

Herbs	%	Dist.	%	Dist.

Mosses and ground cover	%	Dist.	%	Dist.
Mosses				
Lichens				
Liverworts				
Tree seedlings				

Form 4

Unique No.: P __ __ - __ - __ __ - __ __ __ Plot ____

FUEL ASSESSMENTS

(Sections 4.4 and 6.1 in Handbook)

Recorded by: Pre-fire ________ Post-fire ________

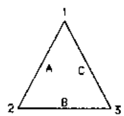
Date Pre-fire ________ Post-fire ________

Line			Species and diameters of slash pieces larger than 7 cm in diameter (indicate location of 5,10,15,20 and 25 m marks)									
A	Pre	sp.										
		dia.										
	Post	dia.										
B	Pre	sp.										
		dia.										
	Post	dia.										
C	Pre	sp										
		dia.										
	Post	dia										

Intersections by pieces smaller than 7 cm

class		0-0.5	0.6-1.0	1.1-3.0	3.1-5.0	5.1-7.0
length		5 m	10 m	15 m	20 m	25 m
A	Pre					
	Post					
B	Pre					
	Post					
C	Pre					
	Post					

Plot diagram



direction ⟷

slope
1 → 2 = %
2 → 3 = %
3 → 1 = %

% Species composition of slash < 7 cm

Species								
Line A								
Line B								
Line C								

% Mineral soil exposure

pre-burn	A	B	C
post-burn			

Notes

Pre-burn depth of mosses and litter (cm)

Line	5 m		10 m		15 m		20 m		25 m	
	in	out	in	out	in	out	in	out	in	out
A										
B										
C										

Depth of burn (cm)

A										
B										
C										

Post-burn duff depth (cm)

Line	5 m		10 m		15 m		20 m		25 m	
	in	out	in	out	in	out	in	out	in	out
A										
B										
C										

Form 5

Unique No.:P __ __ - __ - __ __ - __ __ __   Date: __ __ __ __ __ __
Y Y M M D D

Recorded by: ______________________________

WEATHER, INDEXES, AND FFMC ADJUSTMENTS (Section 4.5 and 5.1)

Location of weather station: ______________________________

Elevation of weather station: _____ m; Aspect: _____ °; attach fire weather records or fill in:

Fuel moisture stick final readings: Slash: __________ % MC adjacent stand: ______________ % MC

Date: __________________________ Time: ____________

	Temperature		RH	Wind		Rain	FFMC		DMC			DC			ISI	BUI	FWI	Backup	
	(°C)	(°C)	(%)		(km/h)	(mm)	1	2	3	4		5	6		7	8	9	(mm)	(%)
Date	Dry Bulb	Wet Bulb	Relative Humidity	Direction	Speed	24 Hour	Rain Code	Fine Fuel Moisture Code	Rain Code	Drying Factor	Duff Moisture Code	Rain Code	Drying Factor	Drought Code	Initial Spread Index	Buildup Index	Fire Weather Index	Rain	Relative Humidity
	← start up →																		
Total																			

Attach the following to this form:
- off-site fire weather records used for start-up codes
- on-site fire weather records
- hourly fire weather records from nearby station if available for burning period
- reference the source of FWI calculations (e.g., tables, computer program, etc.)

Form 6

Unique No.: P __ __ - __ - __ __ - __ __ __

Weather, Indexes, and FFMC adjustments (cont'd) Burn Day: __ __ __ __ __ __
Y Y M M D D

Final weather observations prior to burning operation	Temperature (°C)		RH (%)	Wind speed 10 m (km/h)	Time "T" of wx. obs. (PST 24 hr)
Location: _____	dry bulb	wet bulb			

Standard daily FFMC 1200 hrs PST	Diurnal adjusted FFMC Time "T"	Aspect of plots (N,E,S,W)	Avg. slope of plots (%)	Slope/Aspect adjusted FFMC	FFMC from on-site moisture sticks

Fire Behavior Observations (Section 5.2)

Predictions and observed ranks of PFP on burn day:

Fuel hazard rating (FS 117)	Avg. slope used for PFP	Ranks							
		Predicted				Observed			
		ignition	spread	control	impact	ignition	spread	control	impact

Comments on acceptability of burn day: _____

Control problems:

Map ID.	PST 24 hr clock	Control problem, reason, action taken	Distance from fire front (m)

Fire behavior comments: _____

Form 7

Unique No.: P _ _ - _ - _ _ - _ _ _

Ignition Pattern and Equipment (Section 5.3)

Check ignition equipment used:

____ hand drip torch ____ hand propane torch

____ helitorch: fuel mixture/amount _____

____ flying drip torch: fuel mixture/ amount _____

____ PFRC/PREMO Aerial Ignition System: number of balls _____

Equipment/fuel problems: _____

Prescribed burn map: indicate setting design and layout, ignition sequence and time (PST 24 hr), spotting or control problem or attached another map with this information.

weather station = W
plots =
ignition sequence =
spread direction =
spot fire =

Photography (Section 5.4):

PST 24 hr clock	Photo No.	Location, description, explanation

APPENDIX 3. Fire weather recording summaries[1]

OBSERVING PRACTICES

Time of Observations:

- 1200 h Noon Local Standard Time (1300 h Daylight Saving Time) is Standard Observation Time.
- If specified time is missed by more than 15 minutes, note actual time of observations in the monthly record.

Precision Standards; Accuracy of Measurement:

Temperature

- Both wet and dry bulb temperatures should be observed and recorded to the nearest half degree Celsius.

Relative Humidity

- Enter table for correct station elevation with wet and dry bulb temperatures. RH is recorded to nearest whole percent.

Precipitation

- Measure and record rainfall to at least the nearest 0.2 mm.
- For hail, measure or estimate water equivalent as rain.
- For snow, measure water equivalent as rain, if possible; if not, measure snow depth to nearest 0.2 cm and record water equivalent as same number of millimeters.

Wind Speed

- Measure at least a 10 minute average. Record to nearest 1 km/h.

Sudden Weather Changes During Afternoon:

- Weather changes after Standard Observation Time such as:
  1. rain showers;
  2. sharp increase in wind speed;
  3. clearing skies with sudden RH drop will cause FWI calculated at noon to be in error.

---

[1]From Turner and Lawson, 1978.

- Revised FWI calculation may be made as follows:
    1. take new set of weather readings;
    2. use yesterday's moisture codes as starting values;
    3. recalculate all codes and indices for the day. This is a valid procedure between 1200 and 1600 h only. Normally, the official record for the day consists of only the indices calculated for noon, not the revised calculations.

Recording Practices:

- Record weather observations directly into the permanent record to reduce errors.
- Identify the observer and note if noon has been missed by more than 15 min.
- Take care with computerized recording sheets, errors are easy to make.

Missing Observations:

- A continuous daily weather record is important.
- If a day is missed, fill it in as follows:
    1. use recording instrument records if available; (e.g., hygrothermograph);
    2. use values from nearest similar station;
    3. take average of day before and day after;
    4. make rough estimate from knowledge of general weather pattern.

WEATHER STATIONS

Location Standards:

- Fire weather station should be located:
    1. where it represents the general elevation, topography, vegetation, and local weather patterns of the general area of concern. Avoid sheltered valleys and exposed peaks and ridge tops. Level or nearly level ground is preferred. Avoid north and east exposures (aspects) and concave or dish-shaped topography;

2. at the center of a forest clearing with a diameter of at least 10 times the height of surrounding timber;
3. at least 100 m from any water source;
4. at least 10 m or twice the height of the object away from reflecting and radiating surfaces such as parking lots or white buildings;
5. at least a distance equal to 1.5 times the height of the object away from any large building, tree, or dense vegetation;
6. at least 5 m from any road;
7. at least 50 m from any source of dust;
8. to windward of any of the above features.

It should also be fenced with open pole or wire fencing no higher than 1.2 m.

Instrument Exposure Standards:

- Wet and dry bulb thermometers must be ventilated. If an electric fan is used, make sure the wet bulb is farthest from the fan if the fan blows the air. It is preferable it have the fan pull the air, and the wet bulb thermometer mounted closest to the fan.
- These thermometers, together with maximum and minimum thermometers if used, must be mounted in a Stevenson-type screen. The screen should be:
  1. wooden, with double louvered sides, double roof;
  2. painted white;
  3. rigidly mounted on a wooden framework, with the floor 115 cm above ground and the door facing north.
- Recording instruments, such as hygrothermographs, should be in a separate screen from the thermometers.
- Precipitation gauges must be:
  1. rigidly mounted at the correct height for each specific gauge;
  2. level;
  3. no closer to any obstruction than twice the height of the object.
- Wind should be measured with an anemometer exposed as follows:
  1. 10 m above open level ground, if the nearest timber edge is at least 5 times the height of the timber away from the anemometer mast;

2. 10 m above average treetop level in a forest stand, if no clearing is available;
3. if smaller clearings than specified in (i) are used, anemometer masts should be raised above the 10 m standard;
4. if the anemometer site is not on open level ground, correct for irregularities like brush, slash, and hummocks by raising mast height.

Instrumentation Accuracy Standards:

Consult the appropriate agency manual for details of particular instruments, including observing and maintenance practices.

- Thermometers should have an accuracy of ±0.1°C.
- Ventilating fans for wet and dry bulb thermometers should move air with a velocity of at least 3 m/s.
- Thermographs should have an accuracy of ±0.5°C and have a time constant no more than several minutes.
- Hygrographs should be accurate to at least ± 5% RH under steady conditions where the relative humidity is not changing rapidly.
- Rain gauges are not subject to many accuracy limitations, so long as the required measurement precision can be achieved. Gauge collecting surfaces must be rigid and free of dents, and can vary in size from 60 to 300 cm^2. To ensure accurate readings, the correct graduated cylinder or dip stick for the particular instrument must be used. An instrument of large enough capacity to match the heaviest rainfall expected at a given location should be selected. Gauges should not be mounted without a proper windscreen or turbulance will affect accuracy.
- Anemometers of the three-cup type with mechanical counters can provide suitably accurate 10 minute wind speed averages for fire danger indices. Accuracy depends on proper maintenance of cups (round, free of dents or holes, turning freely on shaft), counters, and power supply.

WIND SPEED ADJUSTMENT FOR MAST HEIGHTS OTHER THAN 10 m

For temporary or other auxiliary stations, it may not be practical to mount the anemometer on a 10 m mast.

Provided that the exposure is adequate (i.e., the clearing is large enough), the following adjustment can be applied to the measured wind speed to give a good estimate of the wind at 10 m.

For wind speed measured at a height between:	Multiply by:
< 2.0 m	1.5
2 and 2.9 m	1.48
3 and 3.9 m	1.35
4 and 4.9 m	1.25
5 and 6.9 m	1.15
7 and 8.9 m	1.07
9 and 11.9 m	no correction

Example: A wind speed of 12 km/h is measured at 2 m. The "standard" wind speed at 10 m is estimated by multiplying the measured speed by 1.48, to give 17.8 km/h.

NOTE: The above correction cannot be used with any confidence in a small clearing.

BEAUFORT SCALE FOR ESTIMATION OF WIND SPEEDS

When suitable instruments are lacking or when the instruments are not in operating condition, wind speeds can be estimated with reasonable accuracy by observing common effects of the wind, according to the following guide:

Beaufort Scale of Winds

Speed range km/h	Descriptive term	Observed wind effects
<2	Calm	Smoke rises vertically
2-5	Light Air	Direction of wind shown by smoke drift but not wind vanes
6-11	Light Breeze	Wind felt on face; leaves rustle; vanes moved by wind
12-19	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag
20-29	Moderate Breeze	Raises dust and loose paper; small branches are moved
30-39	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland waters
40-50	Strong Breeze	Large branches in motion; whistling in telephone wires; umbrellas used with difficulty

APPENDIX 4. Adjustments to Fine Fuel Moisture Code (FFMC)

1. FFMC diurnal adjustment.

To determine adjusted FFMC values for times of day not listed, interpolate between adjacent rows in the table below (after Van Wagner 1972). The FFMC for some time other than the afternoon peak fire danger period is determined as follows:

- Find the column heading value in the table closest to the most recent standard daily determination of the FFMC.
- Find the row heading for the desired time of day and the measured or estimated relative humidity (if required).
- Where the column and row intersect, read the desired current FFMC.

Example: Estimate the FFMC for today at 0900 when the relative humidity is 70%, and the standard daily FFMC determined at the basic observation time of 1300 yesterday was 92. Find the FFMC value of 92 across the top of the table. On the left-hand side of the table locate 0900 in the Time "T" column and the appropriate relative humidity class (> 67%) in the next column. Trace along the resulting row to the 92 FFMC column heading. An FFMC value of 80 is shown at the intersection.

Time[1] "T" (h)	Relative humidity at time "T" (%)	Standard daily FFMC[2]																								
		FFMC at time "T"																								
0700	<68	58	59	60	61	62	65	67	69	70	71	72	72	73	74	75	76	78	80	81	82	83	84	85	87	88	90	92
	68-87	51	52	54	56	59	63	64	66	67	68	69	70	70	71	72	73	75	76	77	79	80	81	82	83	84	85	87
	>87	45	47	49	52	55	59	61	63	64	65	66	67	68	69	70	71	72	74	75	76	77	79	80	81	82	83	85
0900	<48	63	64	65	66	68	71	72	74	74	75	76	76	77	78	79	80	82	83	84	85	86	87	88	89	90	92	93
	48-67	53	55	57	59	62	66	68	70	71	72	73	74	75	76	77	78	79	80	82	83	84	85	86	87	88	89	91
	>67	47	48	50	53	56	60	63	66	67	68	69	70	71	72	73	74	76	77	79	80	81	82	83	84	85	87	89
1100	<38	73	74	74	75	76	79	80	82	82	82	83	84	84	85	85	86	87	88	89	90	91	92	92	93	94	95	96
	38-57	65	67	69	71	73	75	76	78	79	80	80	81	82	82	83	84	85	86	87	88	89	90	91	92	92	93	94
	>57	60	62	64	66	68	70	72	74	74	75	76	77	77	78	79	80	81	82	83	84	84	85	86	87	88	89	90
1300	*	42	46	50	53	56	63	66	69	70	72	74	76	79	81	83	85	87	88	89	90	91	92	93	94	95	96	97
1500	*	46	50	54	59	64	70	74	76	77	79	81	82	83	84	85	86	88	89	90	91	92	93	94	95	96	97	98
1700	*	50	55	60	65	70	75	78	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
1900	*	52	58	63	67	71	75	78	80	81	82	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
2100	*	54	59	63	67	70	74	76	78	79	80	81	82	82	83	84	85	86	87	88	89	90	91	92	92	93	94	95

[1] Daylight saving time. Subtract one hour for local standard time. Daylight saving time is in effect for six months from the last Sunday in April to the last Sunday in October.

[2] Value determined at last basic observation time (1300).

* Relative humidity measurement or estimate not required.

(From Alexander, 1982)

2. FFMC Slope and aspect adjustment

To adjust the Fine Fuel Moisture Code (FFMC) for slope and aspect differences between weather observation point and fire behavior prediction point, use the table below. Values given apply only to FFMC calculated for times between 1200 and 2000 h (LST), on clear days in March, April, August, September, or October, and for elevation differences of less than 300 m between points. The table applies only to "Slash" and "Open" fuel type groups.

To use the table, determine which column best describes slope and aspect of weather observation point. Find FFMC at time "T" in that column and then move horizontally to the column best describing prediction point and read **Adjusted FFMC.**

For example, a weather station on a 15% slope/east aspect provided an FFMC at time "T" of 92. For predicting fire behavior on a 50% slope/south aspect, the table would give an **Adjusted FFMC** of 95.

	Ground Slope and Aspect															
	1 to 15%				16 to 30%				31 to 45%				46 to 60%			
Level	N	E	S	W	N	E	S	W	N	E	S	W	N	E	S	W
	FFMC															
80	78	79	82	80	77	78	82	80	74	77	83	81	72	76	84	81
82	80	81	84	82	79	80	84	82	76	79	85	83	74	78	85	83
84	83	83	85	84	81	82	86	84	79	81	87	84	76	80	88	84
86	85	85	87	86	83	84	88	86	81	83	89	86	78	82	90	86
87	86	86	88	87	84	85	89	87	82	84	90	87	80	83	90	87
88	87	87	89	88	85	87	90	88	83	86	91	88	82	85	91	88
89	88	88	90	89	87	88	91	89	85	87	91	89	83	86	92	89
90	89	89	91	90	88	89	92	90	86	88	92	90	84	87	93	90
91	90	90	92	91	89	90	92	91	87	89	93	91	86	88	93	91
92	91	91	93	92	90	91	93	92	88	90	94	92	87	89	94	92
93	92	92	94	93	91	92	94	93	89	91	95	93	88	90	95	93
94	93	93	95	94	92	93	95	94	91	92	96	94	90	92	96	94

(From Alexander et al., 1984)

3. Equivalent FFMC using Fuel Moisture Sticks (F.M.S.)

   1. Using 1600 h fuel moisture stick weight, the table below shows seasonal adjustments of stick weight. Adjust by adding the value as shown for the elapsed number of weather exposure days.

Number of elapsed days of weather exposure	Moisture content adjustment value to add to actual
0-15	0.08
16-30	0.17
31-45	0.28
46-60	0.35
61-75	0.45
76-90	0.54
91-105	0.63
106-120	0.72
121-135	0.81
136-150	0.91
151-165	1.00
166-180	1.09
181-195	1.18
196-210	1.27
211-225	1.36
226-240	1.48
241-255	1.55
256-270	1.64
271-285	1.73
286-300	1.82
301-315	1.91
316-330	2.01
331-345	2.10
346-360	2.19

(Adapted from Grimaldi, 1985)

2. Using the seasonally adjusted 1600 h fuel moisture stick weight with this table establish the equivalent fine fuel moisture code.

1600 Hour F.M.S. Value Units	Decimals 0	.25	.50	.75
3	95	95	94	94
4	94	94	93	93
5	92	92	91	91
6	91	91	90	90
7	90	90	89	89
8	88	87	86	85
9	85	84	84	83
10	82	81	80	79
11	78	77	76	75
12	74	73	72	71
13	70	70	69	68
14	67	66	66	65
15	64	64	63	62
16	61	60	59	59
17	58	58	57	56
18	56	55	57	56
19	54	53	53	52
20	51	51	50	49

From: Bell (1980)

APPENDIX 5. Biogeoclimatic units of British Columbia[1]

ZONE	SUBZONE and VARIANT (if applicable)
Alpine Tundra (AT)	
ATa	Coastal Alpine Tundra
ATb	Subcontinental Alpine Tundra
ATc	Very Dry Southern Alpine Tundra
ATd	Dry Southern Alpine Tundra
ATe	Moist Interior Alpine Tundra
ATf	Dry Southern Cordilleran Alpine Tundra
ATg	Wet Interior Alpine Tundra
ATh	Wet Central Interior Alpine Tundra
ATi	Dry Central Interior Alpine Tundra
ATj	Dry Central Subcontinental Alpine Tundra
ATk	Oceanic Alpine Tundra
AT1	North Coastal Alpine Tundra
ATm	Central Continental Alpine Tundra
ATn	Northern Continental Alpine Tundra
ATo	Dry Rocky Mountain Alpine Tundra
ATp	Moist Rocky Mountain Alpine Tundra
Boreal White and Black Spruce (BWBS)	
BWBSa	Northern Boreal White and Black Spruce
BWBSa1	Fort Nelson Lowland Northern Boreal White and Black Spruce
BWBSa2	Liard Plain Northern Boreal White and Black Spruce
BWBSb	Montane Boreal White and Black Spruce
BWBSc	Moist Cool Southern Boreal White and Black Spruce
BWBSd	Moist Cold Southern Boreal White and Black Spruce
BWBSe	Cordilleran Boreal White and Black Spruce
Coastal Douglas-fir (CDF)	
CDFa	Drier Coastal Douglas-fir
CDFb	Wetter Coastal Douglas-fir

[1]Biogeoclimatic units of British Columbia as of January 1986.

Coastal Western Hemlock (CWH)

CWHa	Drier Maritime Coastal Western Hemlock
CWHa1	Vancouver Island Drier Maritime Coastal Western Hemlock
CWHa2	Pacific Ranges Drier Maritime Coastal Western Hemlock
CWHb	Wetter Coastal Western Hemlock
CWHb1	Windward Submontane Maritime Wetter Coastal Western Hemlock
CWHb2	Windward Montane Maritime Wetter Coastal Western Hemlock
CWHb3	Leeward Submontane Maritime Wetter Coastal Western Hemlock
CWHb4	Leeward Montane Maritime Wetter Coastal Western Hemlock
CWHb5	Southern Submaritime Wetter Coastal Western Hemlock
CWHb6	Central Submaritime Lower Wetter Coastal Western Hemlock
CWHb7	Central Submaritime Upper Wetter Coastal Western Hemlock
CWHc	Drier Submaritime Coastal Western Hemlock
CWHc1	Southern Drier Submaritime Coastal Western Hemlock
CWHc2	Central Drier Submaritime Coastal Western Hemlock
CWHd	Hypermaritime Coastal Western Hemlock
CWHd1	Southern Hypermaritime Coastal Western Hemlock
CWHd2	Outer Central Coast Hypermaritime Coastal Western Hemlock
CWHd3	Inner Central Coast Western Hemlock
CWHf	Northern Drier Maritime Coastal Western Hemlock
CWHf1	Low Elevation Northern Drier Maritime Coastal Western Hemlock
CWHf2	High Elevation Northern Drier Maritime Coastal Western Hemlock
CWHg	Queen Charlotte Islands Coastal Western Hemlock
CWHg1	Lower Elevation Queen Charlotte Islands Coastal Western Hemlock
CWHg2	High Elevation Queen Charlotte Islands Coastal Western Hemlock
CWHh	Mid-Coast Drier Transitional Coastal Western Hemlock
CWHh1	(wetter)
CWHh2	(drier)
CWHh3	(transitional)
CWHi	Central Wetter Maritime Coastal Western Hemlock
CWHi1	Western Low Elevation Central Wetter Maritime Coastal Western Hemlock
CWHi2	Western High Elevation Central Wetter Maritime Coastal Western Hemlock
CWHi3	Eastern Transitional Central Wetter Maritime Coastal Western Hemlock
CWHj	Northern Wetter Maritime Coastal Western Hemlock

Engelmann Spruce - Subalpine fir (ESSF)

ESSFa	Dry Southern Cordilleran Forested Engelmann Spruce - Subalpine Fir
ESSFap	Dry Southern Cordilleran Parkland Engelmann Spruce - Subalpine Fir
ESSFb	Wet Forested Engelmann Spruce - Subalpine Fir
ESSFbp	Wet Parkland Engelmann Spruce - Subalpine Fir
ESSFc	Moist Southern Forested Engelmann Spruce - Subalpine Fir
ESSFcp	Moist Southern Parkland Engelmann Spruce - Subalpine Fir
ESSFd	Very Dry Southern Forested Engelmann Spruce - Subalpine Fir
ESSFd1	(unnamed)
ESSFd2	(unnamed)
ESSFd3	(unnamed; similar to ESSFe2)
ESSFd4	(unnamed)
ESSFdp	Very Dry Southern Parkland Engelmann Spruce - Subalpine Fir
ESSFe	Dry Southern Forested Engelmann Spruce - Subalpine Fir
ESSFe1	Thompson Plateau Dry Southern Forested Engelmann Spruce - Subalpine Fir
ESSFe2	Okanagan Highlands Dry Southern Forested Engelmann Spruce - Subalpine Fir
ESSFep	Dry Southern Parkland Engelmann Spruce - Subalpine Fir
ESSFf	Subcontinental Forested Engelmann Spruce - Subalpine Fir
ESSFfp	Subcontinental Parkland Engelmann Spruce - Subalpine Fir
ESSFg	Very Dry Central Forested Engelmann Spruce - Subalpine Fir
ESSFgp	Very Dry Central Parkland Engelmann Spruce - Subalpine Fir
ESSFh	Wet Cold Central Forested Engelmann Spruce - Subalpine Fir
ESSFh1	Lower Cariboo Mountains Wet Cold Central Forested Engelmann Spruce - Subalpine Fir
ESSFh2	Upper Cariboo Mountains Wet Cold Central Forested Engelmann Spruce - Subalpine Fir
ESSFh3	Rocky Mountains Wet Cold Central Forested Engelmann Spruce - Subalpine Fir
ESSFhp	Wet Cold Central Parkland Engelmann Spruce - Subalpine Fir
ESSFi	Northwestern Transitional Forested Engelmann Spruce - Subalpine Fir
ESSFip	Northwestern Transitional Parkland Engelmann Spruce - Subalpine Fir
ESSFk	Northern Continental Forested Engelmann Spruce - Subalpine Fir
ESSFkp	Northern Continental Parkland Engelmann Spruce - Subalpine Fir
ESSF1	West Central Transitional Forested Engelmann Spruce - Subalpine Fir
ESSF1p	West Central Transitional Parkland Engelmann Spruce - Subalpine Fir

ESSFm	Moist Central Forested Engelmann Spruce - Subalpine Fir
ESSFm1	Shuswap Highlands Moist Central Engelmann Spruce - Subalpine Fir
ESSFm2	Cariboo-Monashee Mountains Moist Central Engelmann Spruce - Subalpine Fir
ESSFn	Wet Rocky Mountain Forested Engelmann Spruce - Subalpine Fir
ESSFnp	Wet Rocky Mountain Parkland Engelmann Spruce - Subalpine Fir
ESSFo	Moist Rocky Mountain Forested Engelmann Spruce - Subalpine Fir
ESSFop	Moist Rocky Mountain Parkland Engelmann Spruce - Subalpine Fir
ESSFu	Wet Central Upper Forested Engelmann Spruce - Subalpine Fir
ESSFw	Wet Central Forested Engelmann Spruce - Subalpine Fir

Interior Cedar - Hemlock (ICH)

ICHa	Moist Southern Interior Cedar - Hemlock
ICHa1	Lower Columbia - Kootenay Moist Southern Interior Cedar - Hemlock
ICHa2	Upper Columbia - Kootenay Moist Southern Interior Cedar - Hemlock
ICHb	Wet Interior Cedar - Hemlock
ICHc	Moist Cool Southern Interior Cedar - Hemlock
ICHc1	Elk River Moist Cool Southern Interior Cedar - Hemlock
ICHc2	West Kootenay - Kickinghorse Moist Cool Southern Interior Cedar - Hemlock
ICHd	Moist Warm Southern Interior Cedar - Hemlock
ICHe	Cool Semi-moist Interior Cedar - Hemlock
ICHe1	Shuswap Highland Cool Semi-moist Cedar - Hemlock
ICHe2	Fraser Plateau Cool Semi-moist Interior Cedar - Hemlock
ICHe3	Canim Lake Cool Semi-moist Interior Cedar - Hemlock
ICHf	Very Wet Northern Interior Cedar - Hemlock
ICHg	Northwestern Transitional Interior Cedar - Hemlock
ICHg1	Upper Nass Basin Northwestern Transitional Interior Cedar - Hemlock
ICHg2	Lower Nass Basin Northwestern Transitional Interior Cedar - Hemlock
ICHg3	Hazelton Northwestern Transitional Interior Cedar - Hemlock
ICHg4	Meziadin - Bell-Irving Northwestern Transitional Interior Cedar - Hemlock
ICHg5	Iskut - Stikine Northwestern Transitional Interior Cedar - Hemlock
ICHh	Wet Central Interior Cedar - Hemlock
ICHh1	Quesnel Lake Wet Central Interior Cedar - Hemlock
ICHh2	Cariboo River Wet Central Interior Cedar - Hemlock

ICHj	Moist Northern Interior Cedar - Hemlock
ICHk	Wet Northern Interior Cedar - Hemlock
ICHm	Moist Central Interior Cedar - Hemlock
ICHm1	Thompson River Moist Interior Cedar - Hemlock
ICHm2	Shuswap River Moist Interior Cedar - Hemlock
ICHv	Western Wet Montane Interior Cedar - Hemlock
ICHw	Western Wet Submontane Interior Cedar - Hemlock

Interior Douglas-fir (IDF)

IDFa	Very Dry Submontane Interior Douglas-fir
IDFa1	Thompson Plateau Very Dry Submontane Interior Douglas-fir
IDFa2	Bonaparte River Very Dry Submontane Interior Douglas-fir
IDFa3	Okanagan Very Dry Submontane Interior Douglas-fir
IDFa4	Fraser River Very Dry Submontane Interior Douglas-fir
IDFb	Very Dry Montane Interior Douglas-fir
IDFb1	Thompson Plateau Very Dry Montane Interior Douglas-fir
IDFb2	East Fraser Plateau Very Dry Montane Interior Douglas-fir
IDFb3	Okanagan Very Dry Montane Interior Douglas-fir
IDFb4	(Unnamed)
IDFb5	Chilcotin Very Dry Montane Interior Douglas-fir
IDFc	Dry Submontane Interior Douglas-fir
IDFc1	Thompson Plateau Dry Submontane Interior Douglas-fir
IDFd	Dry Montane Interior Douglas-fir
IDFd1	Thompson Plateau Dry Montane Interior Douglas-fir
IDFd2	Okanagan Dry Montane Interior Douglas-fir
IDFe	Subcontinental Interior Douglas-fir
IDFe1	Southern Subcontinental Interior Douglas-fir
IDFe2	Central Subcontinental Interior Douglas-fir
IDFf	Dry Southern Montane Interior Douglas-fir
IDFg	Dry Cordilleran Interior Douglas-fir
IDFg1	Windermere Lake Dry Cordilleran Interior Douglas-fir
IDFg2	Southern Rocky Mountain Trench Dry Cordilleran Interior Douglas-fir
IDFg3	Kootenay - Columbia Dry Cordilleran Interior Douglas-fir
IDFi	(Unnamed)
IDFj	Semi-moist Interior Douglas-fir
IDFj1	Shuswap Highlands Semi-moist Interior Douglas-fir
IDFj2	Okanagan Semi-moist Interior Douglas-fir

Montane Spruce (MS)

MSa	Dry Southern Cordilleran Montane Spruce
MSb	Dry Montane Spruce
MSb1	Thompson Plateau Dry Montane Spruce
MSb2	Okanagan Highlands Dry Montane Spruce
MSb3	North Okanagan Dry Montane Spruce
MSb4	(Unnamed)
MSc	Very Dry Southern Montane Spruce
MSd	Very Dry Central Montane Spruce

Mountain Hemlock (MH)

MHa	Maritime Forested Mountain Hemlock
MHap	Maritime Parkland Mountain Hemlock
MHb	Submaritime Forested Mountain Hemlock
MHbp	Submaritime Parkland Mountain Hemlock
MHc	Oceanic Forested Mountain Hemlock
MHcp	Oceanic Parkland Mountain Hemlock
MHd	Coastal Forested Mountain Hemlock
MHdp	Coastal Parkland Mountain Hemlock
MHe	Transitional Forested Mountain Hemlock
MHep	Transitional Parkland Mountain Hemlock

Ponderosa Pine - Bunchgrass (PPBG)

PPBGa	Very Dry Northern Shrub Steppe Ponderosa Pine - Bunchgrass
PPBGa1	Kamloops Very Dry Northern Shrub Steppe Ponderosa Pine - Bunchgrass
PPBGa2	Douglas Lake Very Dry Northern Shrub Steppe Ponderosa Pine - Bunchgrass
PPBGa3	Osoyoos Very Dry Northern Shrub Steppe Ponderosa Pine - Bunchgrass
PPBGb	Very Dry Southern Shrub Steppe Ponderosa Pine - Bunchgrass
PPBGc	Dry Southern Montane Savannah Ponderosa Pine - Bunchgrass
PPBGd	Very Dry Forested Ponderosa Pine - Bunchgrass
PPBGd1	Very Dry Northern Forested Ponderosa Pine - Bunchgrass
PPBGd2	Very Dry Southern Forested Ponderosa Pine - Bunchgrass
PPBGe	Plateau Grasslands Ponderosa Pine - Bunchgrass
PPBGf	Princeton Very Dry Forested Ponderosa Pine - Bunchgrass
PPBGg	Very Dry Cool Northern Shrub Steppe Ponderosa Pine - Bunchgrass

Sub-Boreal Spruce (SBS)

SBSa	Very Dry Southern Sub-Boreal Spruce
SBSa1	Fraser Plateau Very Dry Southern Sub-Boreal Spruce
SBSa2	Entiako River Very Dry Southern Sub-Boreal Spruce
SBSb	Dry Cool Southern Sub-Boreal Spruce
SBSc	Moist Central Sub-Boreal Spruce
SBSd	Dry Cool Central Sub-Boreal Spruce
SBSe	Moist Cool Central Sub-Boreal Spruce
SBSe1	Babine Lake Moist Cool Central Sub-Boreal Spruce
SBSe2	Fraser Basin Moist Cool Central Sub-Boreal Spruce
SBSf	Very Wet Rocky Mountain Sub-Boreal Spruce
SBSg	Moist Rocky Mountain Sub-Boreal Spruce
SBSh	Dry Rocky Mountain Sub-Boreal Spruce
SBSi	Moist Cold Central Sub-Boreal Spruce
SBSj	Wet Cool Central Sub-Boreal Spruce
SBSj1	Willow River Wet Cool Central Sub-Boreal Spruce
SBSj2	Williston Lake Wet Cool Central Sub-Boreal Spruce
SBSk	Dry Warm Southern Sub-Boreal Spruce
SBSk1	Fraser Plateau Dry Warm Southern Sub-Boreal Spruce
SBSk2	Southern Fraser Basin Dry Warm Southern Sub-Boreal Spruce
SBSk3	Northern Fraser Basin Dry Warm Southern Sub-Boreal Spruce
SBSl	Dry Warm Central Valley Sub-Boreal Spruce
SBSm	Moist Sub-Boreal Spruce
SBSn	Moist Cold Northern Sub-Boreal Spruce
SBSo	Dry Cold Northern Sub-Boreal Spruce

Spruce - Willow - Birch (SWB)

SWBa	Southern Drier Forested Spruce - Willow - Birch
SWBas	Southern Drier Scrub Spruce - Willow - Birch
SWBb	Southern Moister Forested Spruce - Willow - Birch
SWBbs	Southern Moister Scrub Spruce - Willow - Birch