CASCADE SOIL SURVEY

1981-02-03

Province of
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Ministry of
Environment

Province of British Columbia
Ministry of Environment
ASSESSMENT AND PLANNING DIVISION

CASCADE SOIL SURVEY

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WORKING REPORT

by

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PREFACE

The purpose of the survey is to provide resource planners and managers with needed resource data for land allocation and management decisions. This report contains information on the soils and associated vegetation of the Cascade study area located northwest of Manning Provincial Park. The report describes each soil type delineated on the accompanying 1:100 000 scale soil maps. Soil interpretations for engineering, forestry, agriculture and grazing, wildlife, recreation and visual concerns are provided to assist resource managers involved in the area.

The report is not intended to be read cover to cover, but to be used as a manual for field and office use. Most readers will be interested only in certain sections of the report. A quick review of the Table of Contents will direct you to those appropriate sections which are most relevant.

Don Howes and Norm Sprout, Ministry of Environment; Karel Klinka and Bob Mitchell, Ministry of Forests; and Peter Walton, Ministry of Municipal Affairs (formerly with E.L.U.C. Secretariat) are gratefully acknowledged for their review comments.

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CHAPTER ONE
GENERAL DESCRIPTION OF STUDY AREA

1.1 INTRODUCTION

The Cascade study area (Fig. 1) was established by British Columbia's Environment and Land Use Committee (ELUC) in order to study resource conflicts and make recommendations for their resolution. A two-year moratorium on logging and mining activity was initiated in May, 1980 to provide for government study by the ELUC. The Okanagan-Similkameen Parks Society is proposing that the area be preserved as a park for its wilderness and historic trail values. A number of historic trails, including the Dewdney, Whatcom, Hope, and Hudson's Bay Company Brigade trail are maintained within the area (Harris and Hatfield, 1977). Forest, grazing, and mineral values, however, do exist and are in partial conflict with the proposed park status for the area.

The purpose of this survey is to describe and evaluate resources of the Cascade study area which are necessary to consider for land allocation and management decisions. This report provides a description of the soils, surficial geology, and associated landscape and vegetation features; the distribution of each soil type is presented on a 1:100 000 scale map located in the back pocket. Soil interpretations are provided in Chapter Three for a variety of land uses including forestry, agriculture (grazing), engineering, wildlife, recreation and visual resources. These interpretations can provide input into the upcoming study for the area and for future planning and management decisions in years to come.

Soil is an important resource for several reasons. All renewable resources are in some way dependent upon soil, which is basically a non-renewable resource due to the very slow rate at which it develops. This fact necessitates conservation of this basic resource in order to maintain optimum yields of timber, wildlife, water, recreation, forage and agricultural crops. Soils are also useful in predicting the natural productivity of these renewable resources, and their response to management.

Although soil refers to the material immediately below the earth's surface, it directly influences the kinds of plants that grow on a site, and the rate at which these plants grow. Thus, the identification of relatively homogeneous soil types provide a framework for the identification of vegetation and ecosystem types, habitats for wildlife, and for the growth characteristics (productivity) of commercial forests.

The engineering properties of soils and surficial materials are another important feature of the survey. The survey depicts limitations for roads, sources of aggregate (sand and gravel), and indicates the potential susceptibility of soils to surface erosion. This information is useful since considerable financial savings can result if the most appropriate route and soil materials are utilized for road construction.

1.2 STUDY AREA LOCATION

The Cascade Wilderness study area is a proposed extension to Manning Provincial Park and lies adjacent to the northwest portion of the park. The area's western boundary lies 18 km southeast of Hope; its eastern boundary lies approximately 30 km southwest of Princeton. The study area includes 400 km^2 bounded roughly by the heights of land between the peaks of Outram, Tulameen, Granite, Skaist and Snass Mountains. It is covered by NTS maps 92H (1:250 000) and portions of 92H/2,3,6 and 7 (1:50 000).

1.3 PHYSIOGRAPHY

The study area lies entirely within the Hozameen Range of the Cascade Mountains, a region of moderate relief consisting of strongly folded and metamorphosed sedimentary and volcanic rocks (Holland, 1976), with some zones of igneous bedrock. The topography has generally resulted from the varying resistance to erosion of the underlying bedrock. The present surface and rather uniform height of peaks suggest that the relief has resulted from fluvial and glacial dissection of a late Tertiary erosion surface.

Notable peaks on the border of or within the area include Mount Dewdney (2220 m), Mount Outram (2440 m), Snass Mt. (2320 m) and Tulameen Mt. (2280 m). These and other prominent peaks were probably above the ice during Pleistocene glaciation, but have been subject to alpine glaciation: cirque basins are especially evident on north and northeast facing slopes. The area is presently free of glacial ice; nivation processes are limited in extent. The predominance of rubbly colluvium on many valley slopes suggests that physical weathering and mass-wasting are major processes in the area.

Following the retreat to the northeast of the Thomson Plateau ice sheet (which covered the area during the last glaciation), meandering streams were left flowing through alluvium and glacial drift in relatively broad valleys of the Similkameen system to the north - Podunk Creek, Holding Creek and Paradise Valley. Conversely the Skagit system streams to the south - Snass, Skaist and Twenty Mile Creeks - experienced a smaller degree of glaciation. This, along with higher precipitation, has resulted in more vigorous, steep streams within deeply incised, steep-sided valleys.

1.4 BEDROCK GEOLOGY

Source materials for information on the bedrock geology of the area include Geological Survey of Canada Map 737A (Cairnes et al, 1942), Map 888A (Rice, 1946) and Bulletin 238 (Coates, 1974).

Four basic groupings can be identified in the area according to lithology: intrusive igneous rocks of the Lightning Creek and Coast Intrusion groups (granite, granodiorite and quartz diorite); extrusive igneous and pyroclastic rocks of the Hozameen, Nicola and Kingsvale groups (chert, greenstone, tuff); medium to coarse grained sedimentary rock of the Ladner, Dewdney Creek and Pasayten groups (shale, sandstone and greywacke); and fine to medium grained non-foliated metamorphics (argillite and serpentinite).

According to age, the area is represented by the Hozameen Group of possibly Carboniferous age, through the Coast intrusions, Ladner Group and Dewdney Creek groups of Late to Upper Jurassic age respectively, to the younger Pasayten and Kingsvale groups of probably lower Cretaceous origin. These groups are described below.

Hozameen Group

The Hozameen Group (map unit 1) dominates the western border of the study area (Fig. 2) and is described as an association of metamorphosed greenstone (altered basalt), chert and limestone of Late Paleozoic age (Coates, 1974). Deformed by folds throughout, the group is exposed along Manson Ridge and underlies the western slope of the Sowaqua Creek valley.

Dewdney Creek Group

Dominating the largest, central portion of the study area is the Dewdney Creek Group (map unit 9) of Upper Jurassic age. Generally poorly exposed and complicated by faulting, surface contacts exist around Mount Dewdney and at isolated outcrops in the area. The lithology is characterized by fine grained, well sorted sandstone with lesser amounts of interbedded sandy argillite (Coates, 1974).

Pasayten Group

The Pasayten Group (map unit 11), in the southeast portion of the area, trends northwest like all the local groups and lies adjacent to and in faulted contact with the Dewdney Creek group. It consists mainly of fine to coarse grained, moderately sorted sandstone and lesser amounts of siltstone and shale, of about Lower Cretaceous age. Its deposition appears to be of similar age as the dominantly volcanic rocks of the Kingsvale Group to the northwest (map unit 13) - chiefly basalts, volcanic breccia and andesite.

Throughout the group within the study area are isolated dykes and outcrops identified as the Lightning Creek intrusions (map unit 15) on valley sides and peaks such as Warburton Peak. These comprise some of the few exposed igneous intrusives in the study area, in this case, grey quartz diorite of Upper Cretaceous age.

Coast Intrusions

The easternmost northwest-trending belt of rocks is the Coast Intrusions, exposed as a series of unroofed batholiths in Skaist Mt., Kettle Mountain and Granite Mountain on the margin of the area and characteristic of much Coast and Cascade Range topography (map unit 5). This group consists of grey, slightly gneissic granodiorite, quartz diorite and some granite, of late Jurassic age.

Correlated with this group in terms of both age and lithology are unnamed but similar intrusives (map unit 25) which occur as small isolated bands especially in the western half of the study area.

Ladner Group

Generally overlain by the Dewdney Creek group, the Ladner Group is exposed in the fluvially-eroded valley of Sowaqua Creek and is found along the Creek's length in the northwest portion of the study area. Probably Late Jurassic in age, the rocks are dominantly slate with lesser amounts of interbedded greywacke and conglomerate.

This group borders a very thin ribbon of similarily resistant but slightly older metamorphics identified as chiefly serpentinite (map unit 23).

Figure 2

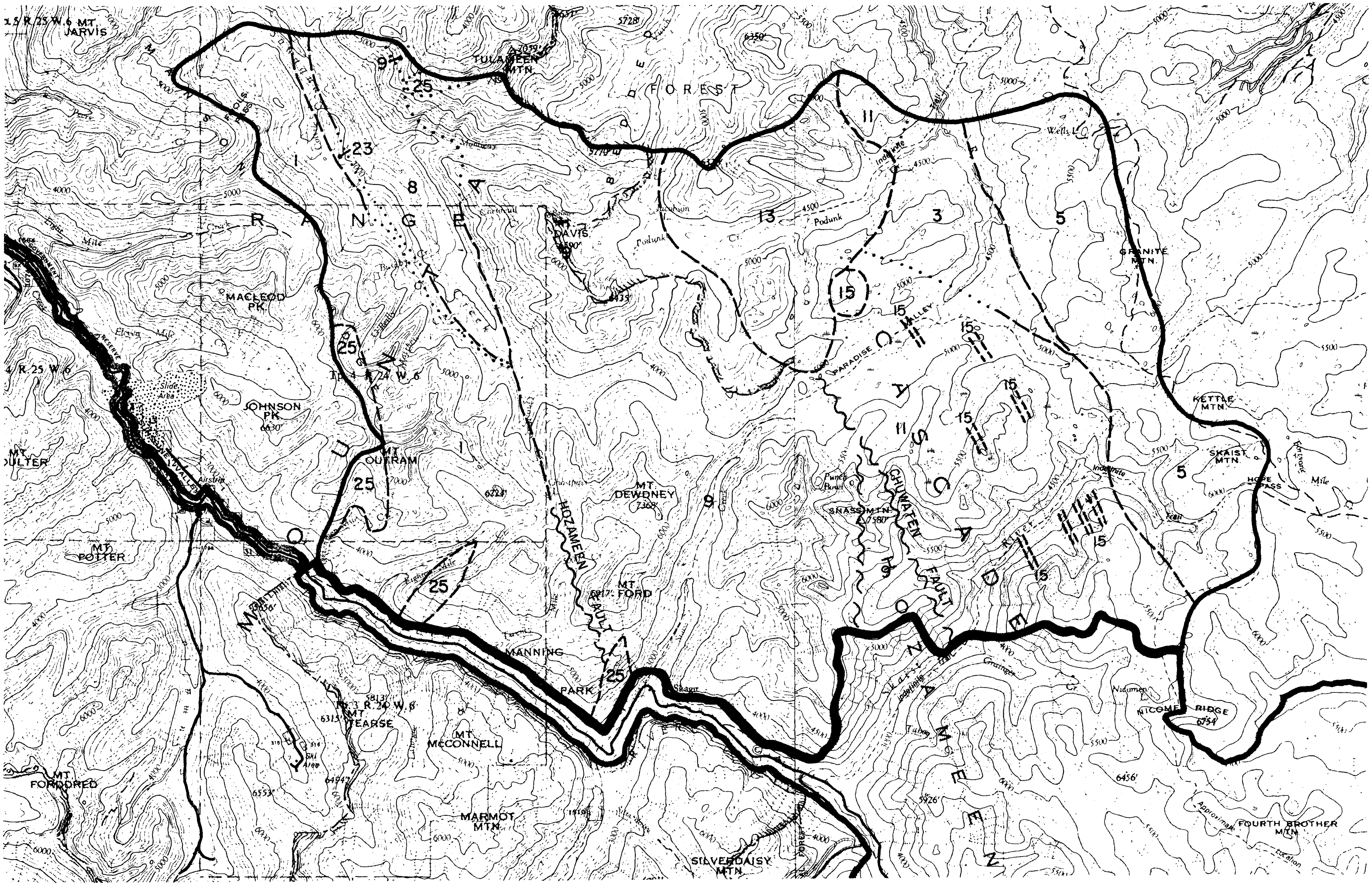
BEDROCK GEOLOGY *

AGE	GROUP	ROCK TYPES
1 Carboniferous	Hozameen	chert, greenstone, limestone intercalated volcanics
3 Upper Triassic	Nicola	varicoloured lava, argillite, tuff
5 Jurassic	Coast Intrusions	granite and gneissic granodiorite
8 Upper Jurassic or Lower Cretaceous	Ladner	chiefly slate, greywacke, schist grit, conglomerate
9 Upper Jurassic	Dewdney Creek	tuff, argillite, volcanic breccia sandstone
11 Lower Cretaceous	Pasayten	grit and shale
13 Eocene or Lower Cretaceous	Kingsvale	basalts, volcanic breccia, andesite
15 Upper Cretaceous	Lightning Creek	grey quartz diorite
23 Jurassic and later		chiefly serpentinite
25 Jurassic	Coast Intrusions	granite

Geological boundary (defined, approximate, assumed) ——— — — — · · · ·

Fault (defined, approximate, assumed) ∿∿∿∿ ∿∿ ∿ ∿

** This Map was derived from Cairnes et. al. 1942, Rice 1946, and Coates 1974*


MT. JARVIS
TULAMEEN MTN.
FOREST
MT. DAVIS
MACLEOD PK.
JOHNSON PK.
Slide Area
MT. OUTRAM
Airstrip
MT. POTTER
MT. DEWDNEY 7368'
HOZAMEEN FAULT
MT. FORD
MANNING PARK
MT. TEARSE
MT. McCONNELL
MARMOT MTN.
SILVERDAISY MTN.
Ski Area
Podunk Cr.
Wells L.
PARADISE VALLEY
SNASS MTN.
CHUWANTEN FAULT
GRANITE MTN.
KETTLE MTN.
SKAIST MTN.
HOPE PASS
NICOMEN RIDGE
FOURTH BROTHER MTN.
Approximate Location

1.5 CLIMATE

Although no climate stations occur within the study area itself, data from Hope Slide station to the west and from Allison Pass to the southeast give an indication of existing climatic conditions and are shown on Table 1.

Table 1

MONTHLY AND ANNUAL MEAN TEMPERATURE AND TOTAL PRECIPITATION DATA FOR HOPE SLIDE AND ALLISON PASS[1]

	Jan	Feb	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
HOPE SLIDE													
Elev. 701 m													
Mean Temp. (°C)	-5.8	-1.0	1.3	4.2	9.8	12.3	14.1	14.0	10.1	5.5	1.0	-3.2	5.1
Total Prec.[2] (mm)	213	127	109	81	38	61	28	25	81	112	109	203	1234
Total Snow (water equiv, mm)	138	65	47	34	--	--	--	--	--	4	26	117	469
ALLISON PASS													
Elev. 1340 m													
Mean Temp. (°C)	-7.3	-4.5	-3.4	1.1	3.9	8.4	12.3	11.8	7.8	3.4	-3.4	-6.2	2.2
Total Prec.[2] (mm)	254	164	126	95	67	61	34	48	70	113	193	227	1452
Total Snow (water equiv. mm)	227	141	115	74	24	3	--	--	2	34	147	200	965

1 Figures are 6 to 7 year averages for Hope Slide and 8 to 9 year averages for Allison Pass.
2 Total precipitation is snowfall plus rainfall. Rainfall totals can be achieved by subtracting snow water equivalent from total precipitation.

SOURCE: Environment Canada (1973).

In general the climate can be described as Humid Continental dominated by mild, moist Pacific air most of the year. The region is characterized by cool to cold winters with high precipitation, and warm, drier summers. Because of the considerable variation in altitude (elevation range from 600 to 2400 m within the area) and because the Hozameen Range divide runs central through the area, large local variations in climate can be expected.

Mean annual temperatures within the area range from about 5°C to 2°C or lower at high altitudes. It is estimated that the entire area experiences fewer than 100 days frost-free; between altitudes 1000 and 1150 m, 60 to 75 frost-free days exist; from 1150-1650 m, only 30 to 50 frost-free days are expected (Green, 1971).

Mean annual precipitation ranges from 1200 to 1400 mm, increasing westward and with elevation. The zone of maximum precipitation occurs just west of the divide whose axis trends northward through the area; precipitation will drop sharply eastward as one enters the interior 'rain shadow'. Due to the high frequency of frontal systems in winter and their orographic enhancement, nearly 75% of total annual precipitation occurs in October through March, and due to the high altitude of the area, about 80% of this falls as snow. Snowpacks vary greatly in depth from year to year however, and in all years most snow has melted by early July.

Microclimatic features such as mountain-valley local circulations and the pooling of cold air in valley bottoms can be expected at local sites, a consequence of several north-south trending valleys.

1.6 WILDLIFE

General assessments of big-game abundance in the Cascade study area are presented below on the basis of 1:2 000 000 scale wildlife distribution maps prepared by the B.C. Fish and Wildlife Branch (Blower, 1978). Eleven maps exist, one for each big-game species. The terms "few, "moderate" and "plentiful" used below are defined by a range of numbers of animals per unit area on the wildlife distribution maps. Broad estimates of present abundance are provided below to give an impression of big-game numbers in the study area.

Few mule deer are found throughout the area, with numbers ranging from 25-75 animals. Few elk and moose are found, except in the Sowaqua drainage where they are not present. Present abundance of these animals in the study area is estimated to be less than 20 animals each. Few mountain goat exist, except in the rolling subalpine forests in the northwest of study area where they are not present. Numbers of goat appear to be less than 10. No white-tailed deer, mountain sheep, or caribou are found in the study area.

Black bear are of moderate abundance, except in the Sowaqua and Skaist drainages where their presence was mapped as plentiful. Estimated numbers of bear are 25-55 for the study area. Grizzly bear and cougar are believed to occur in the study area, but their present populations are estimated to be less than 3 animals each. Wolves are not known to occur in the study area.

Most of the study area has no capability for waterfowl; the wet subalpine meadows in the Paradise Valley area have a very low capability indicating very limited waterfowl use (Taylor and Carreiro, 1969).

1.7 VEGETATION

The vegetation of the Cascade study area reflects the transition between coastal and interior climates. Four biogeoclimatic zones and six subzones recognized by Klinka (1977) were identified and are described below (Fig. 3). Table 2 illustrates the dynamic status of the trees in the study area by generalized ecosystem unit. Correlation with Daubenmire and Daubenmire's (1968) habitat types is also shown. More detailed information on the relative presence of species per generalized ecosystem unit are given in Appendix 1. Soil-vegetation relationships are discussed in section 2.4.

Table 2

DYNAMIC STATUS OF TREES AND CORRELATION WITH HABITAT TYPES

Generalized Ecosystem Unit \ Species	Abies amabilis	Abies lasiocarpa	Pinus albicaulis	Pinus contorta	Pinus monticola	Picea engelmannii	Pseudotsuga menziesii	Populus balsamifera	Thuja plicata	Tsuga heterophylla	Tsuga mertensiana	Species \ Habitat* Type
CWHya - mesic sites							S		c	C		Tsuga heterophylla - Paxistima
CWHyb - mesic sites	C				s		S		c	C		(Abies amabilis - Paxistima)
CWHy - dry sites	c			s	s		S		c	C		Tsuga heterophylla - Paxistima
CWHy - wet sites	C						s	s	C	C		Thuja plicata - Athyrium
MHya - mesic sites	C	c				s					C	Tsuga mertensiana - Menziesia
ESSFya - mesic sites	c	C		s	s	C					c	Abies lasiocarpa - Menziesia
ESSFya - dry sites	c	C		s	s	C	s		c		c	Abies lasiocarpa - Paxistima
ESSFya - wet sites	c	C		s		C					c	Abies lasiocarpa - Vaccinium
ESSFyb - mesic sites	c	C	s			C					c	(Abies lasiocarpa - Phyllodoce)

CWHy = Transitional coastal western hemlock zone
MHy = Transitional mountain hemlock zone
ESSFy = Transitional Engelmann spruce - subalpine fir zone
a = dry subzone
b = wet subzone

C = major climax species
c = minor climax species
S = major seral species
s = minor seral species

A "major" species is commonly found, a "minor" species is uncommonly found.

* According to Daubenmire and Daubenmire (1968).

Types in parenthesis were added by authors.

At lower elevations below 900 m, the transitional (subcontinental) western hemlock drier subzone (CWHya)* exists. Most stands consists of Pseudotsuga menziesii with Tsuga heterophylla and Thuja plicata in the lower canopy. Common** shrubs on mesic sites include Paxistima myrsinites, Berberis nervosa, and Vaccinium membranaceum. Acer glabrum, Acer circinatum, Alnus sinuata, Menziesia ferruginea and Taxus brevifolia are also occasionally** found. Common herbs include Clintonia uniflora, Chimaphila umbellata, and Pyrola spp; Cornus canadensis, Goodyera oblongifolia, and Smilacina stellata occasionally occur. A common fern is Pteridium aquilinum.

Between 900 and 1200 m elevation, the transitional (subcontinental) western hemlock wetter subzone (CHWyb) is dominant. Most stands consists of Pseudotsuga menziesii with Tsuga heterophylla, Thuja plicata, and Abies amabilis in the lower canopy. On mesic sites, Vaccinium membranaceum is the common shrub; Berberis nervosa, Menziesia ferruginea, and Paxistima myrsinites occasionally occur. Herbs occasionally found include Clintonia uniflora, Goodyera oblongifolia, Tiarella unifoliata, Chimaphila umbellata, and Pyrola spp. Pteridium aquilinum is an occasionally-found fern.

In the study area, edaphically drier and wetter sites in the transitional western hemlock zone (CWHy) consist of similar species regardless of subzone. Drier sites are generally dominated by Pseudotsuga menziesii with Tsuga heterophylla commonly present in the understory. Thuja plicata and Pinus monticola occasionally occur. In the CWHyb, Abies amabilis is also commonly present in the understory. Common shrubs include Amelanchier alnifolia, Berberis nervosa, Vaccinium membranaceum, Linnaea borealis, and Paxistima myrsinites. Acer glabrum, Acer circinatum, and Menziesia ferruginea are occasionally found shrubs. The most commonly found herb is Chimaphila umbellata; herbs occasionally found include Clintonia uniflora, Goodyera oblongifolia, and Pyrola spp.

Wetter sites in the CWHy contain stands of Pseudotsuga menziesii, Abies amabilis, Thuja plicata, and Tsuga heterophylla. Shrubs occasionally found are Acer circinatum, Menziesia ferruginea, Vaccinium membranaceum, Sorbus spp., Oplopanax horridus, Rubus pedatus, Rubus parviflorus, and Rubus spectabilis. Commonly occurring herbs include Clintonia uniflora, Tiarella unifoliata, and Asarum caudatum; Actaea rubra, Cornus canadensis, Smilacina stellata, Valeriana sitchensis, and Chimaphila umbellata are occasionally found. The common fern is Athyrium filix-femina; Gymnocarpium dryopteris is occasionally found.

West of the Cascade Divide, between 1200 and 1700 m elevation, the transitional (subcontinental) mountain hemlock forest subzone (MHya) is dominant. Abies amabilis and Tsuga mertensiana are the most common trees. Menziesia ferruginea, Sorbus spp., Rhododendron albiflorum are common shrubs. Valeriana sitchensis, Tiarella unifoliata, Arnica latifolia, and Veratrum viride are typical herbs.

For most of the study area between 1200 and 1700 m elevation, the transitional (subcontinental) Engelmann spruce - subalpine fir forest subzone (ESSFya) is dominant east of the Cascade Divide. On mesic sites, Abies lasiocarpa and Picea engelmannii are the common climax species. Abies amabilis and Pinus contorta are occasionally found climax and seral trees respectively. Commonly occurring shrubs include Ribes lacustre and Vaccinium membranaceum; Rhododendron albiflorum, Rubus pedatus, Vaccinium scoparium, and Sorbus spp. are occasionally found. Common herbs include Valeriana sitchensis and Arnica latifolia; Tiarella unifoliata and Veratrum viride are occasionally found.

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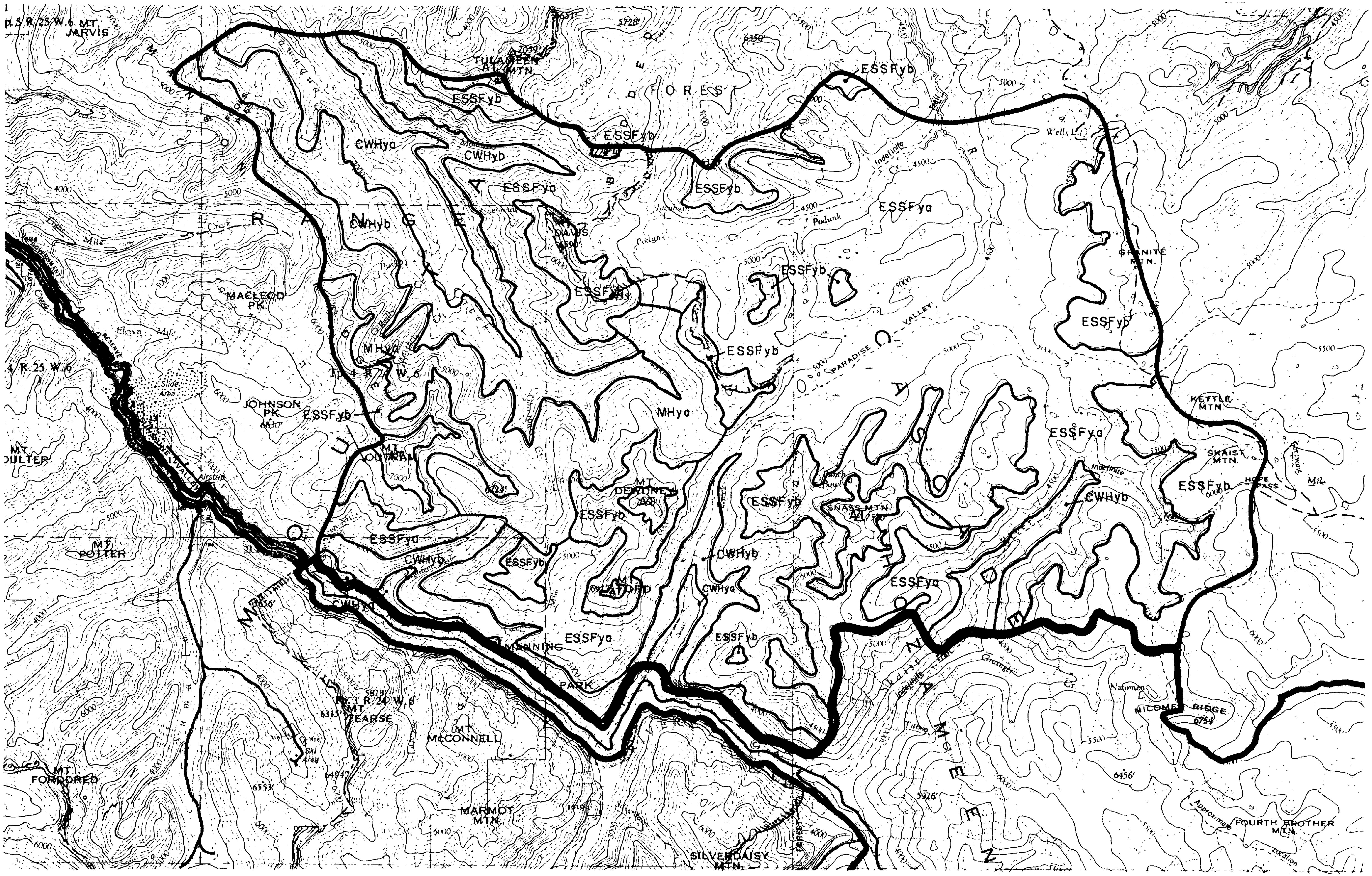
* Correlation with recent B.C. Ministry of Forests subzone symbol changes are indicated in Appendix 1.

** "Common" plants are those found in greater than two-thirds of the sample plots, while "occasionally" occurring plants are those found in one-third to two-thirds of the sample plots.

Figure 3

BIOGEOCLIMATIC SUBZONES

CWHy	-	Transitional Coastal Western Hemlock Zone
MHy	-	Transitional Mountain Hemlock Zone
ESSFy	-	Transitional Engelmann Spruce - Subalpine Fir Zone
AT	-	Alpine Tundra Zone
a	-	Dry (Lower Elevation) Subzone
b	-	Wet (Higher Elevation) Subzone


MT JARVIS
TULAMEEN MTN
FOREST
ESSFyb
CWHya
CWHyb
ESSFya
RANGE
MACLEOD PK
MHya
JOHNSON PK
MT OUTRAM
MT POTTER
MT DEWDNEY
MT DAVIS
PARADISE VALLEY
GRANITE MTN
KETTLE MTN
SKAIST MTN
HOPE PASS
SNASS MTN
MT ATFORD
MANNING PARK
MT FRASER
MT McCONNELL
MARMOT MTN
SILVERDAISY MTN
MT FORDDRED
NICOMEN RIDGE
FOURTH BROTHER MTN
Wells L.
Podunk
Jacobson L.
Slide Area
Airstrip
Eleven Mile
Indefinite
Approximate location

Drier sites in the ESSFya commonly contain Abies lasiocarpa, Picea engelmannii, Abies amabilis, and Pseudotsuga menziesii. Pinus contorta, Pinus monticola, and Thuja plicata are occasionally found tree species. Common shrubs include Paxistima myrsinites and Vaccinium membranaceum; Amelanchier alnifolia occasionally occurs. A common herb is Lupinus spp.; Chimaphila umbellata and Fragaria spp. are occasionally found.

Wetter sites in the ESSFya commonly contain Abies lasiocarpa and Picea engelmannii. Vaccinium membranaceum, Vaccinium scoparium, and Rubus pedatus are commonly occurring shrubs. Common herbs include Valeriana sitchensis and Lupinus spp.; Tiarella unifoliata occasionally occurs.

Between 1700 and 2000 m elevation, the transitional (subcontinental) Engelmann spruce - subalpine fir parkland subzone (ESSFyb) is dominant. Abies lasiocarpa and Picea engelmannii occur in discontinuous clumps in this subzone. The more dominant shrub vegetation commonly consists of Phyllodoce empetriformis, occasionally with Vaccinium membranaceum, V. scoparium, V. caespitosum, Rhododendron albiflorum and Sorbus sitchensis. Anemone occidentalis, Valeriana sitchensis, Phlox diffusa, Arnica latifolia, Lupinus spp., Veratrum viride, and Ranunculus spp. are occasionally occurring herbs.

Above 2000 m, the Alpine tundra (AT) zone occurs. Tree species may occur in krummholz (low shrubby) form, but do not appear in tree form. Abies lasiocarpa, Picea engelmannii, and Pinus albicaulis are occasionally found species. Juniperus communis, Cassiope mertensiana, Phyllodoce empetriformis, P. glanduliflora, and Vaccinium caespitosum are typical low shrubs. Many herbs including Antennaria spp., Potentilla diversifolia, Phlox diffusa, and Silene acaulis are found in this zone.

CHAPTER TWO
SOIL RESOURCES

2.1 SURVEY PROCEDURES

Prior to fieldwork, aerial photographs were analysed to delineate different landforms, slopes, aspects, and vegetation conditions. Recent photographs at an approximate scale of 1:40 000 were used. A preliminary soil legend was prepared on the basis of Green and Lord's (1979) soil report. Their 1:125 000 scale maps provided a valuable aid in the interpretation of aerial photographs.

Field survey by foot and helicopter provided checking of airphoto interpretation. Soils, vegetation, and landscape features were examined according to procedures outlined in Describing Ecosystems in the Field (Walmsley et al, 1980). Soils were classified at the soil family level using The Canadian System of Soil Classification (Canada Soil Survey Committee, 1978). Representative soils were sampled for physical and chemical analyses in the laboratory.

Soil and ecosystem features were inspected and described on 70 sites, for an average inspection density of one field check per 6 km^2. Although few map delineations were inspected on the ground, most were viewed from a helicopter to help assist photo-interpretation.

Following field work, the soils legend and soil mapping were finalized. Map unit boundaries were transferred to 1:50 000 topographic map for compilation. The soils map and legend are located in the back pocket of this report.

Soils in the study area were first differentiated by major surficial deposits (soil parent materials) at the genetic materials level as defined by the Terrain Classification System (Resource Analysis Branch, 1976). The major surficial materials differentiated were: morainal (till), colluvial, and fluvial deposits.

Surficial materials were further differentiated by soil subgroup, particle-size class, mineralogy, depth-to-bedrock, reaction (pH) class, and soil climate including soil temperature and soil moisture, to determine soil families. Soil climate breaks were determined using biogeoclimatic subzones, as described and mapped during the survey. The soil family was used to help finalize the soil legend and in the description of soil types (see Fig. 4).

Soil map unit symbols employed in the survey are described directly on the soil map legend (see back pocket).

2.2 SOIL PARENT MATERIALS (SURFICIAL DEPOSITS)

The soils of the study area have developed on three major types of materials: morainal, colluvial, and fluvial deposits. These parent (surficial) materials and their general soil characteristics are discussed below. Additional information is shown for each soil type in section 2.5 and on the legend which accompanies the soil map located in the back pocket.

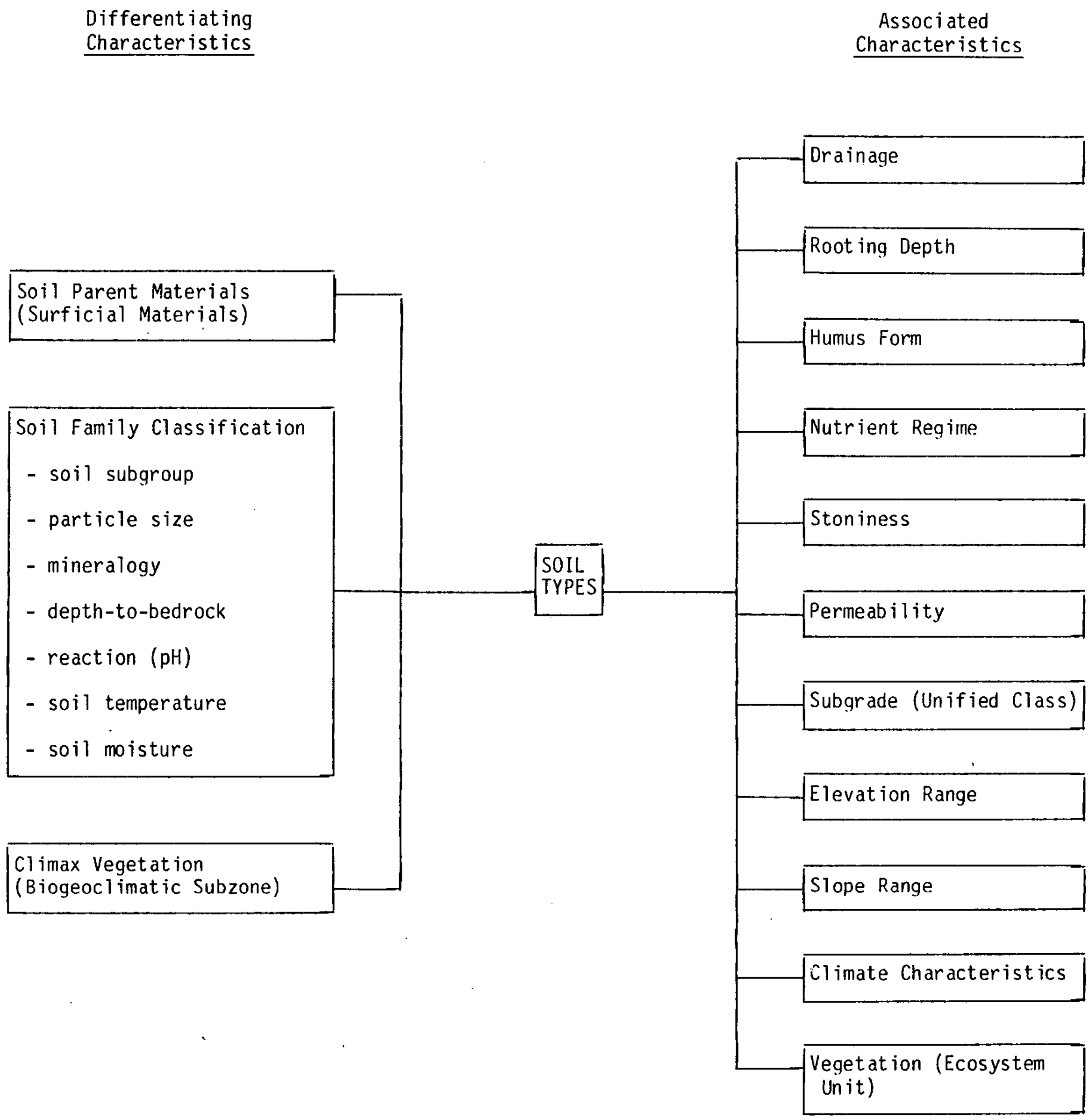


Figure 4. SCHEME FOR DIFFERENTIATING AND DESCRIBING SOIL TYPES

Morainal (till) materials were deposited directly by glaciers. Morainal parent materials are dominant on gentler (0-30%) slopes in the Engelmann spruce - subalpine fir zone (1200-2000 m). Most of the broad valleys in the north and east portions of the area are till-covered; till occurs sporadically elsewhere.

Two types of morainal deposits are identified in the study area: a) coarse-textured till consisting of sandy loam to loamy sand, reflecting the granitic bedrock characteristic of the Skaist/Granite Mountain (eastern) area; and b) medium-textured till consisting of loam to sandy clay loam, reflecting the volcanic and sedimentary bedrock of much of the rest of the study area. Most morainal soils have 20 to 50% coarse fragments.

Soils developed on till are moderately well to well drained. In flat and depressional landscape positions, seepage may result in imperfect drainage conditions. These sites are characterized by the presence of oak fern, lady fern and/or Devil's club.

Colluvial materials are products of mass wastage and have reached their present position by gravity-induced downslope movement. Colluvium is the dominant surficial material on slopes exceeding 45%, and thus is particularly common on the steep valley sides characteristic of the southern half of the study area.

Colluvium occurs mainly as a veneer (depth-to-bedrock less than one metre) on thinly-forested slopes or as a blanket (depth-to-bedrock greater than one metre) on more stable, densely-forested slopes. Common also are colluvial aprons (talus slopes), occurring either as exposed rubbly or blocky slopes or with more stable vegetation. Many colluvial slopes in the area have been affected by avalanches, identifiable where the original coniferous forest has been removed and replaced by dense low deciduous vegetation.

Most colluvial deposits are well to rapidly drained. The loam to sandy loam texture of most colluvium in the study area reflects the medium-grained bedrock types from which it was derived. Most of the colluvial soils have more than 30% coarse fragments.

Fluvial materials are deposits which have been transported and deposited by streams and rivers; they may or may not be subject to flooding. Active fluvial materials are those on floodplains which are subject to periodic flooding. Soils of this origin are of limited distribution in the study area (the level floors of stream valleys), and are characterized by sandy loam to loamy sand textures and imperfect drainage.

Inactive fluvial deposits are more widely distributed; they were deposited adjacent and above the present river channels by former, larger streams (and in some cases, by glacial outwash). These were observed in the valleys of the Podunk, Tulameen, Holding and Hubbard Creeks, often overlying or adjacent to morainal deposits, especially in the 1300-1700 m range. These are primarily of loamy sand to sand texture, 30-60% coarse fragments, and are well to rapidly drained.

The open meadows that have formed in broad, low-gradient valley bottoms in the Paradise Valley area are underlain by poorly drained fluvial deposits with few coarse fragments. Common vegetation include willows and cottongrass.

2.3 SOIL CLIMATE

Soil temperature classes and soil moisture subclasses were estimated for the study area using limited climatic information. These soil climate classes are defined by The Canada Soil Survey Committee (1978).

Soil temperature classes are primarily determined by mean annual soil temperature at 50 cm depth. This can be estimated by adding 1°C to mean annual air temperature (Soil Survey Staff, 1975). Using Allison Pass climate data as a base (see Table 1), and by assuming that air temperatures increase 0.6°C every 100 m increase in elevation (a standard lapse rate used by climatologists), the following relationships emerge:

Elevation	Mean Annual Soil Temperature	Soil Temperature Class	Biogeoclimatic Subzone
700 m	6.8	cool	CWHya
1000 m	5.0	cool	CWHyb
1300 m	3.2	cold	ESSFya or MHya
1700 m	0.8	very cold	ESSFyb
2100 m	-1.0	very cold	AT

Soil moisture subclasses are primarily based on estimates of water deficits. Water deficits are determined by adding soil moisture recharge to estimates of climatic moisture deficit. In the Hope Slide area at 700 m elevation, climatic moisture deficits have been estimated to be 15 cm (Coldigado, pers. comm.). A 7 cm soil moisture recharge can be assumed for loamy soils based on data in southeastern B.C. (Vold and Marsh, 1980). Thus, the water deficit for loamy soils at 700 m is estimated to be 8 cm. This falls within the subhumid class. Wetter soil moisture subclasses can be anticipated with increasing precipitation accompanying rising elevation.

The estimated relationship between soil climate and biogeoclimatic subzone is illustrated on Figure 5. Subzone/soil climate relationships are based on broadly coincident elevation ranges.

2.4 SOIL-VEGETATION RELATIONSHIPS

The relationship between soil subgroup and biogeoclimatic subzone are shown on a horizon and depth basis in Figure 5. The soil subgroup on mesic and dry sites in the CWHya and CWHyb subzones is Orthic Humo-Ferric Podzol. On wetter sites, the soil subgroup varies depending on how wet the site is. Subhygric sites are generally Orthic Humo-Ferric Podzols with the influences of seepage. Hygric sites generally have distinct to prominent mottles and thus have Gleyed Humo-Ferric Podzols, or occur on floodplains with a high seasonal water table and Cumulic Regosol subgroups. On subhydric sites, Gleysolic soils occur.

The dominant soil subgroup in the ESSFya (forest) subzone is also Humo-Ferric Podzol, although some Orthic and Gleyed Ferro-Humic Podzols also occur. In the ESSFyb (parkland) subzone, soil subgroup varies from Orthic Ferro-Humic Podzols to Sombric Ferro-Humic Podzols. The AT zone dominantly has Orthic Sombric Brunisols. The MHya subzone mainly has Orthic Ferro-Humic Podzols.

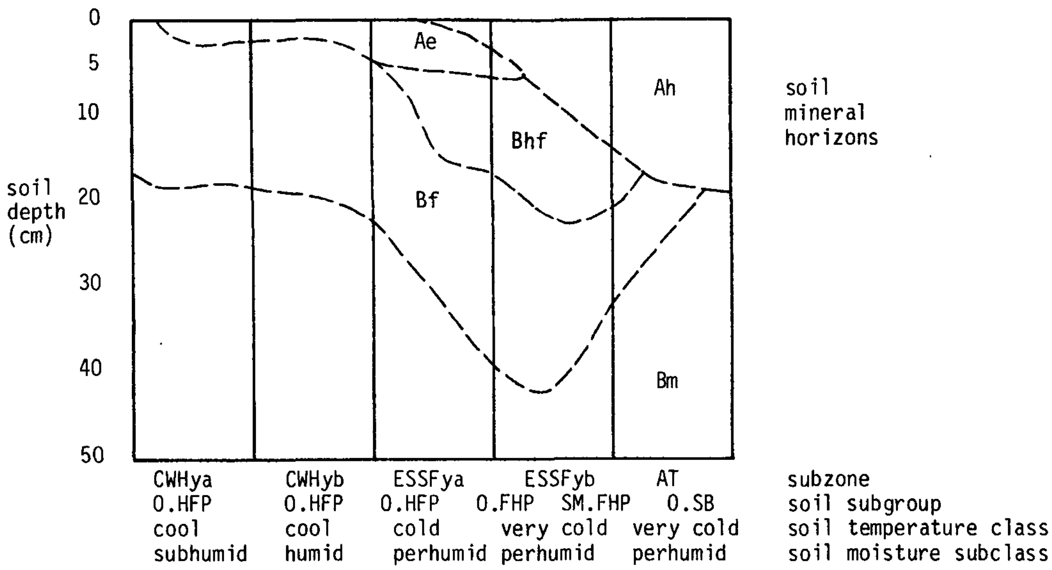


Figure 5. RELATIONSHIP BETWEEN SOIL SUBGROUP, SOIL CLIMATE AND BIOGEOCLIMATIC SUBZONE ON MESIC SITES

2.5 SOIL TYPES

For the purposes of mapping, twenty-two 'soil types' were identified. These are differentiated according to several broad parameters: most importantly parent material and biogeoclimatic subzone (based on climax vegetation), and secondarily soil subgroup and soil texture. Table 3 summarizes the various combinations which occur in the study area and assigns soil type codes for identification on the soil map (back pocket). Hence, location of a particular site or establishment of parent material and biogeoclimatic subzone will yield information regarding the expected soil family, drainage, texture, and climate in general terms. Note that due to the inherent range of soil properties found within each soil type, other soil subgroups and descriptions may be observed in addition to those dominant ones described here.

Following the legend, each soil type is described in greater detail, depicting the range of soil characteristics expected. A schematic profile of the soil is also provided. Where possible, a photograph of the associated landscape and vegetation, and of a representative soil profile, will also appear.

It should be recognized that the reliability of these soil type descriptions will vary. Where a large, important map unit occurs, several field observations have been used in the compilation of the soil type description. However, other soil types identified herein do not benefit from multi-occurrence observation and may be less accurate summaries.

The soils described by Green and Lord (1979) which includes portions of the study area, are related to the soils described in this report as follows: Buckhorn (C5, M7), Coquihalla (C3), Lawless and Nicomen (C4, M4), Pasayten (F4, F5), Pitin (C5, M6, M7), Quinescoe (F3).

Table 3

SOIL LEGEND

SOIL* TYPE	PARENT MATERIAL	TEXTURE (< 2 mm)	COARSE FRAGMENTS (> 2 mm)	SOIL DRAINAGE	DOMINANT** SOIL SUBGROUP	EST'D SOIL TEMP. CLASS	EST'D SOIL MOISTURE SUBCLASS	GENERALIZED*** ECOSYSTEM UNIT
C1	colluvium	loam to sandy loam	30 - 70%	well drained	O.HFP	cool	subhumid	CWHya (m-d)
C2	colluvium	loam to sandy loam	30 - 70%	well drained	O.HFP	cool	humid	CWHyb (m-d)
C3	colluvium	silt loam to loam	30 - 70%	well drained	O.FHP	cold	perhumid	MHya (m-d)
C4	colluvium	loam to sandy loam	30 - 70%	well drained	O.HFP	cold	perhumid	ESSFya (m-d)
C5	colluvium	loam to sandy loam	30 - 70%	well drained	SM.FHP	very cold	perhumid	ESSFyb (m-d)
C6	colluvium	silt loam to sandy loam	30 - 70%	well drained	O.SB	very cold	perhumid	At (m-d)
C7	colluvium (avalanched)	loam to sandy loam	50 - 70%	well drained	SM.FHP	variable	humid to perhumid	variable
C8	colluvium (talus)	--	> 90%	rapidly drained	O.R	variable	variable	variable
F1	fluvial (floodplain)	sandy loam, loamy sand	0 - 60%	moderately well to imperfectly drained	CU.R,GL.R	cool	perhumid to subaquic	CWHy (w)
F2	fluvial (floodplain)	sandy loam, loamy sand	0 - 60%	moderately well to imperfectly drained	CU.R,GL.R	cold	perhumid to subaquic	ESSFy (w)
F3	fluvial (meadows)	sandy loam	0 - 35%	poorly to very poorly drained	FE.HG	cold	aquic to peraquic	ESSFy (w)
F4	fluvial	sandy loam, loamy sand	30 - 70%	well to rapidly drained	O.HFP	cool	subhumid	CWHya (d-m)
F5	fluvial	loamy sand, sand	30 - 70%	well to rapidly drained	O.HFP	cool	humid	CWHyb (d-m)
F6	fluvial	loamy sand	30 - 70%	well to rapidly drained	O.HFP	cold	perhumid	ESSFya (d-m)
M1	morainal	loam to sandy clay loam	20 - 40%	moderately well drained	O.HFP	cool	subhumid	CWHya (m)
M2	morainal	loam to sandy clay loam	20 - 40%	moderately well drained	O.HFP	cool	humid	CWHyb (m)
M3	morainal	sandy loam, sandy clay loam	20 - 40%	moderately well drained	O.FHP	cold	perhumid	MHya (m)
M4	morainal	loam to sandy clay loam	20 - 40%	moderately well drained	O.HFP	cold	perhumid	ESSFya (m)
M5	morainal	sandy loam, loamy sand	25 - 50%	well drained	O.FHP	cold	perhumid	ESSFya (m)
M6	morainal	loam to sandy clay loam	25 - 40%	moderately well drained	SM.FHP	very cold	perhumid	ESSFyb (m)
M7	morainal	sandy loam, loamy sand	25 - 50%	moderately well to well drained	SM.FHP	very cold	perhumid	ESSFyb (m)
R	bedrock							

* Soil types with a "v" on the soil map indicate that some areas are shallow (less than 1 m) to bedrock.
Soil types with a "x" on the soil map indicate that some areas are imperfectly to poorly drained.
Where more than one soil type occurs per parent material, the numbers occur together, e.g. M45.

** O.HFP - Orthic Humo-Ferric Podzol
O.FHP - Orthic Ferro-Humic Podzol
SM.FHP - Sombric Ferro-Humic Podzol
O.R - Orthic Regosol
CU.R - Cumulic Regosol
GL.R - Gleyed Regosol
FE.HG - Fera Humic Gleysol
O.SB - Orthic Sombric Brunisol

*** CWHy - Transitional coastal western hemlock zone
MHy - Transitional mountain hemlock zone
ESSFy - Transitional Engelmann spruce - subalpine fir zone
AT - Alpine tundra zone

a = dry (lower elevation) subzone
b = wet (higher elevation) subzone

d = dry (xeric) sites
m = mesic sites
w = wet (hygric) sites

SOIL TYPE: C1

PARENT MATERIAL: Colluvium

SOIL FAMILY: Orthic Humo-Ferric Podzol, Loamy Skeletal, Mixed, Cool, Subhumid

SLOPE: 30-75%

ELEVATION: 700-900 m

MOISTURE REGIME: Mesic to Subxeric

NUTRIENT REGIME: Mesotrophic to Submesotrophic

HUMUS FORM CLASS: Humi-fibrimor

ROOTING DEPTH: 50-70 cm

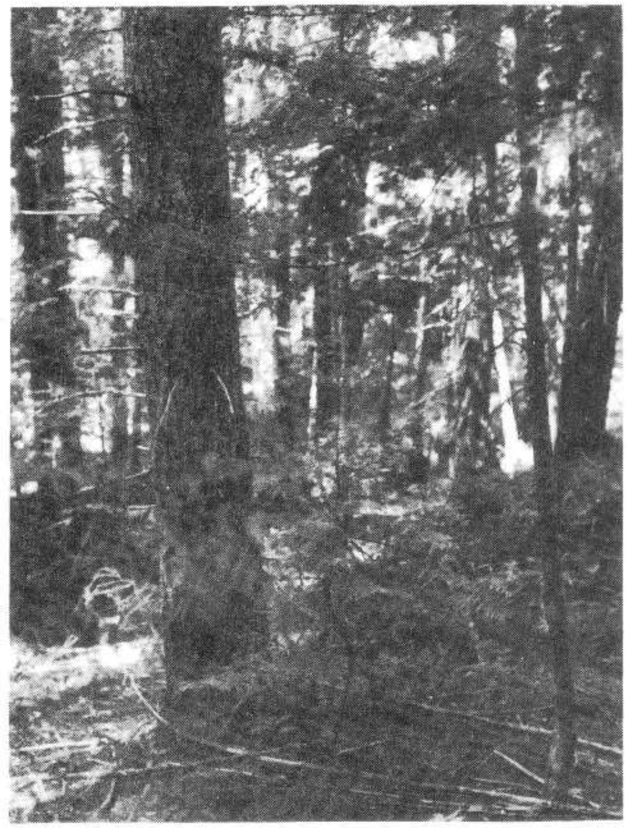
DRAINAGE: Well Drained

COARSE FRAGMENTS: 30-70%, Angular

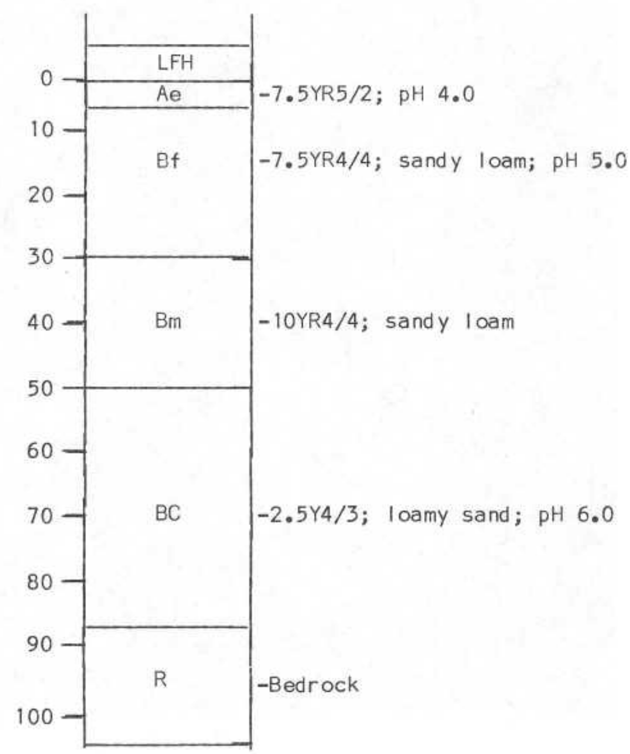
TEXTURE: Loam to Sandy Loam

SOLUM THICKNESS: 50-70 cm

NOTES/DISCUSSION: Transitional western hemlock dry subzone, Douglas-fir stands dominant.



SOIL PROFILE



SOIL TYPE: C2

PARENT MATERIAL: Colluvium

SOIL FAMILY: Orthic Humo-Ferric Podzol, Loamy Skeletal, Mixed, Cool, Humid

SLOPE: 30-75%

ELEVATION: 900-1200 m

MOISTURE REGIME: Mesic to Subxeric

NUTRIENT REGIME: Mesotrophic to Submesotrophic

HUMUS FORM CLASS: Humi-fibrimor

ROOTING DEPTH: 60-75 cm

DRAINAGE: Well Drained

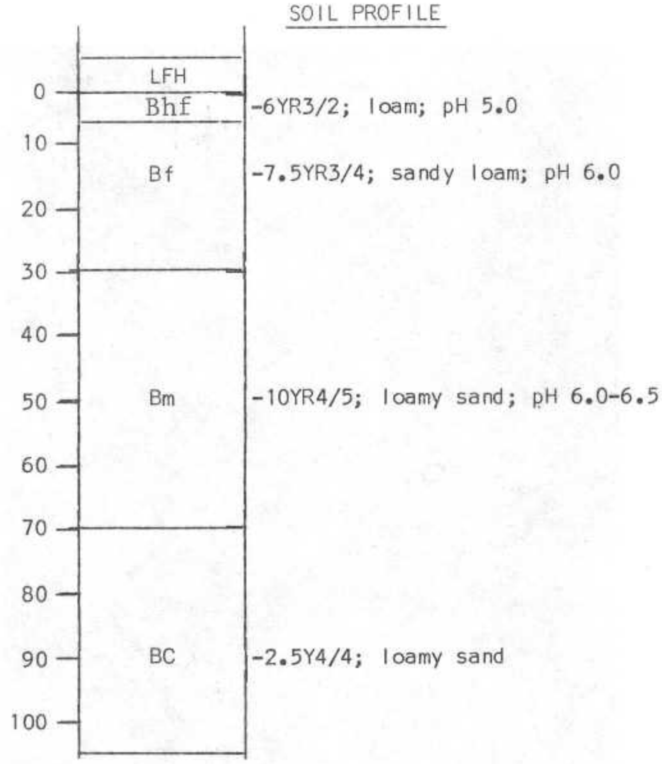
COARSE FRAGMENTS: 30-70%, Angular

TEXTURE: Loam to Sandy Loam

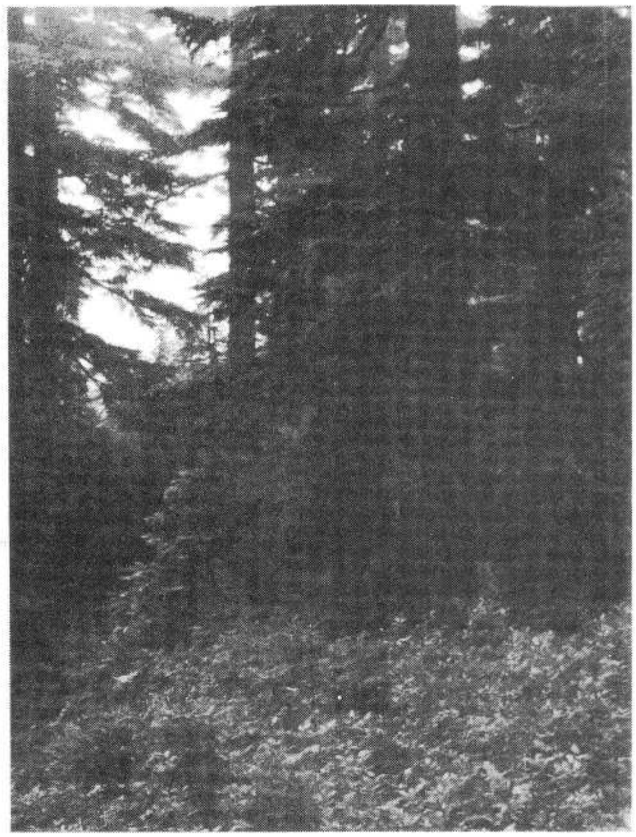
SOLUM THICKNESS: 60-75 cm

NOTES/DISCUSSION: Transitional western hemlock wet subzone, Douglas-fir stands with amabilis fir common

SOIL PROFILE



SOIL TYPE: C3



PARENT MATERIAL: Colluvium

SOIL FAMILY: Orthic Ferro-Humic Podzol, Loamy Skeletal, Mixed, Cold, Perhumid

SLOPE: 30-75%

ELEVATION: 1200-1700 m

MOISTURE REGIME: Mesic to Subxeric

NUTRIENT REGIME: Submesotrophic

HUMUS FORM CLASS: Fibri-humimor

ROOTING DEPTH: 40-60 cm

DRAINAGE: Well Drained

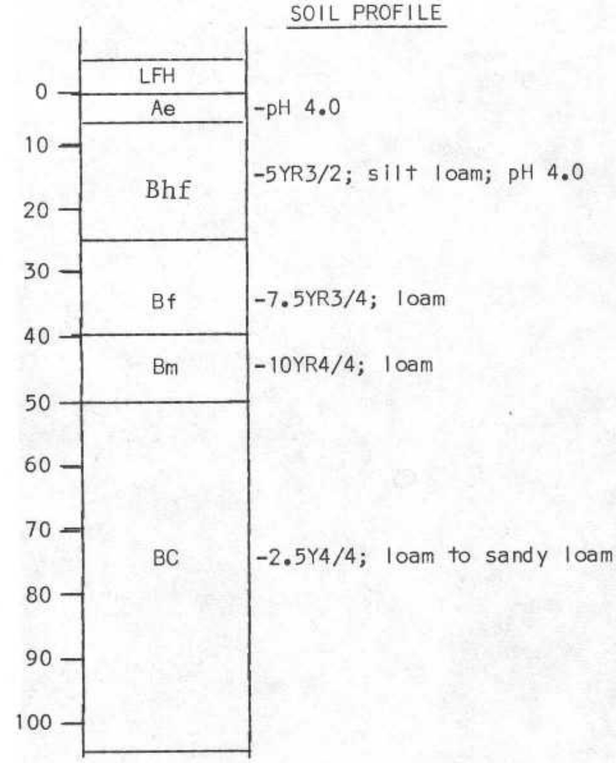
COARSE FRAGMENTS: 30-70%, Angular

TEXTURE: Silt Loam to Sandy Loam

SOLUM THICKNESS: 40-60 cm

NOTES/DISCUSSION: Transitional mountain hemlock forest subzone. Mainly occurs on north and east facing slopes in western half of study area.

SOIL PROFILE



SOIL TYPE: C4

PARENT MATERIAL: Colluvium

SOIL FAMILY: Orthic Humo-Ferric Podzol, Loamy Skeletal, Mixed, Cold, Perhumid

SLOPE: 30-75%

ELEVATION: 1200-1700 m

MOISTURE REGIME: Mesic to Xeric

NUTRIENT REGIME: Mesic to Oligotrophic

HUMUS FORM CLASS: Humi-fibrimor

ROOTING DEPTH: 50-80 cm

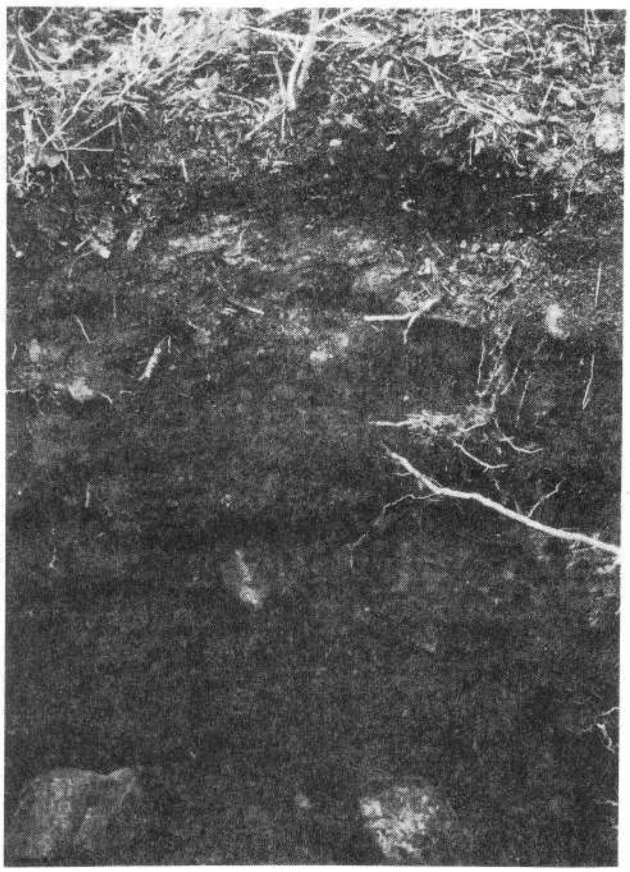
DRAINAGE: Well Drained

COARSE FRAGMENTS: 30-70%, Angular

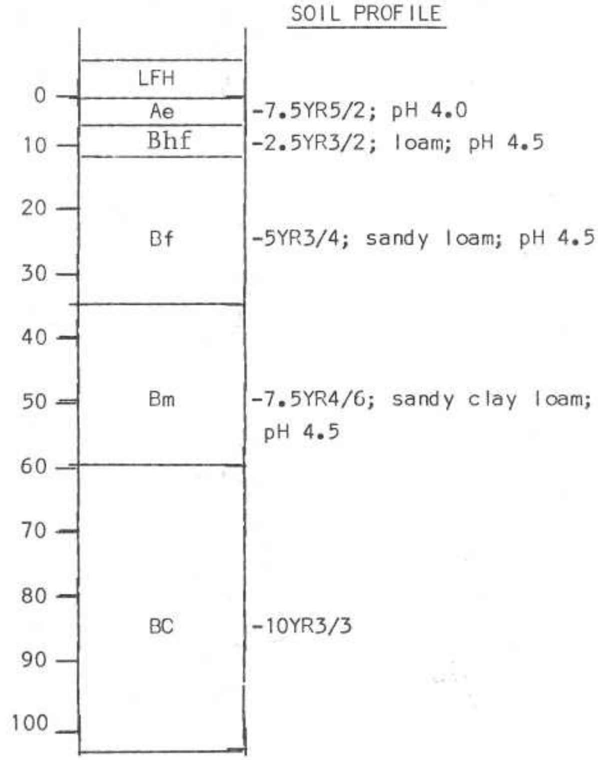
TEXTURE: Sandy Loam to Loam

SOLUM THICKNESS: 50-80 cm

NOTES/DISCUSSION: Transitional Engelmann spruce-subalpine fir forest subzone. Ae horizon thin or absent.



SOIL PROFILE



SOIL TYPE: C5

PARENT MATERIAL: Colluvium

SOIL FAMILY: Sombric Ferro-Humic Podzol, Loamy Skeletal, Mixed, Very Cold, Perhumid

SLOPE: 20-75%

ELEVATION: 1700-2000 m

MOISTURE REGIME: Mesic to Subxeric

NUTRIENT REGIME: Mesotrophic to Submesotrophic

HUMUS FORM CLASS: Rhizomull

ROOTING DEPTH: 30-50 cm

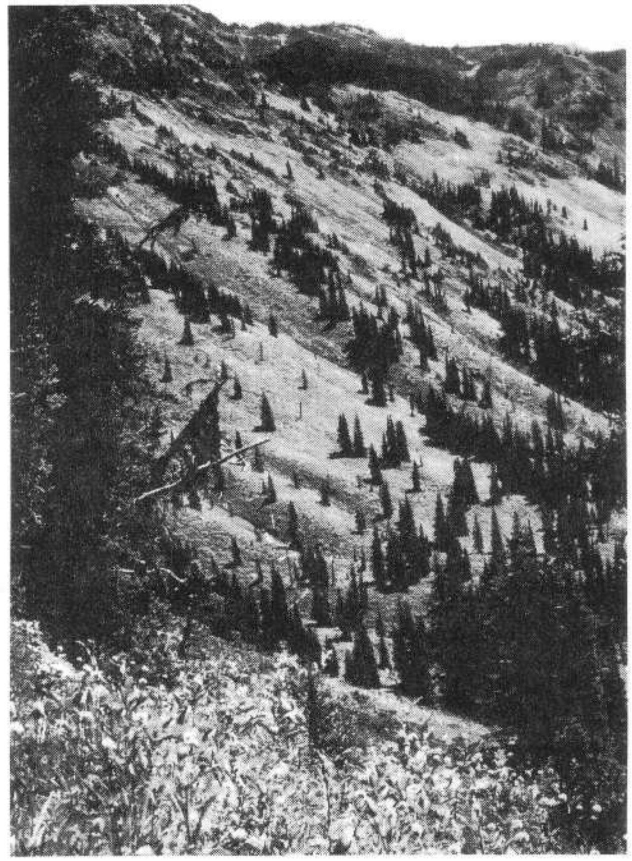
DRAINAGE: Well Drained

COARSE FRAGMENTS: 30-70%, Angular

TEXTURE: Loam to Sandy Loam

SOLUM THICKNESS: 30-60 cm

NOTES/DISCUSSION: Transitional Engelmann spruce-subalpine fir parkland subzone. Open forest conditions. Some soils have thinner Ah horizons and are Orthic Ferro-Humic Podzols.



SOIL PROFILE

Depth (cm)	Horizon	Description
0–20	Ah	7.5YR4/2; loam; pH 4.5
20–50	Bhf	7.5YR3/2; loam; pH 4.5
50–80	Bf	7.5YR3/3; loam pH 4.5
80–100	BC	10YR3/3

SOIL TYPE: C6

PARENT MATERIAL: Colluvium

SOIL FAMILY: Orthic Sombric Brunisol, Loamy Skeletal, Mixed, Very Cold, Perhumid

SLOPE: 20-75%

ELEVATION: > 2000 m

MOISTURE REGIME: Xeric to Mesic

NUTRIENT REGIME: Submesotrophic

HUMUS FORM CLASS: Rhizomull

ROOTING DEPTH: 20-40 cm

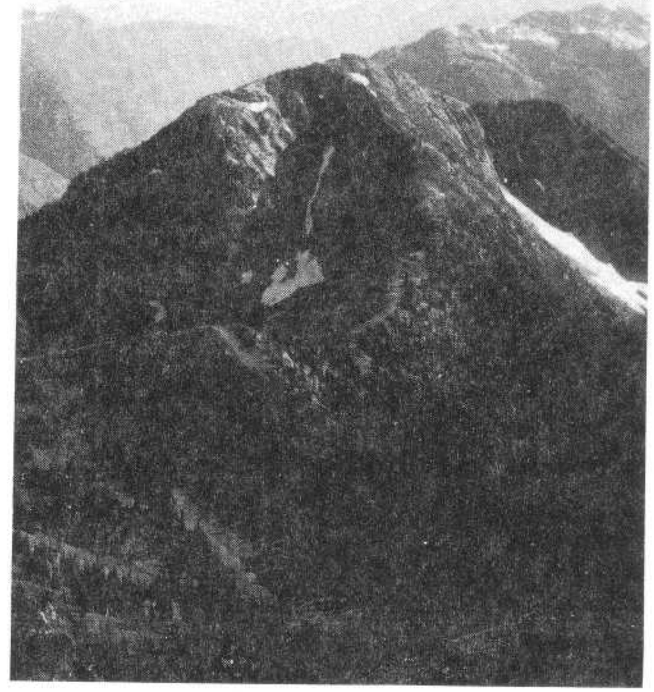
DRAINAGE: Well Drained

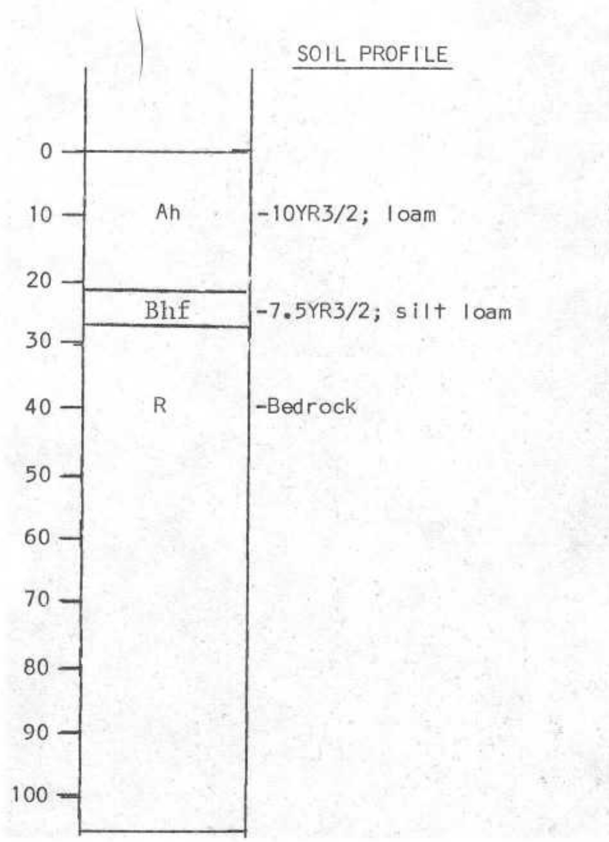
COARSE FRAGMENTS: 30-70%, Angular

TEXTURE: Silt Loam to Sandy Loam

SOLUM THICKNESS: 30-40 cm

NOTES/DISCUSSION: Alpine tundra zone. Thick turfy Ah horizon, with no LFH. Some soils have a thick Bfh and are Sombric Ferro-Humic Podzols.





SOIL TYPE: C7

PARENT MATERIAL: Colluvium

SOIL FAMILY: Sombric Humo-Ferric Podzol, Loamy Skeletal, Mixed, Cool to Cold, Humid to Perhumid

SLOPE: 30-75%

ELEVATION: 900-1700 m

MOISTURE REGIME: Subhygric to Mesic

NUTRIENT REGIME: Mesotrophic

HUMUS FORM CLASS: Typical Moder

ROOTING DEPTH: 50-70 cm

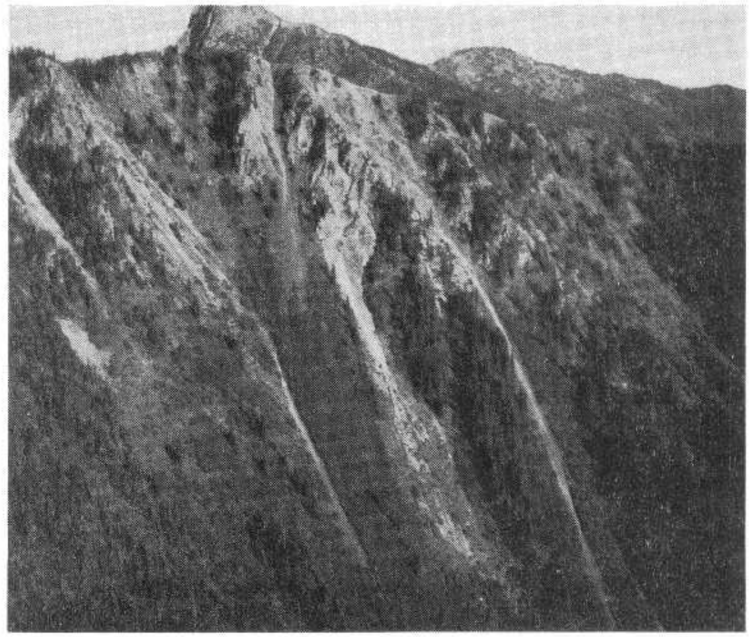
DRAINAGE: Well Drained

COARSE FRAGMENTS: 50-70%, Angular

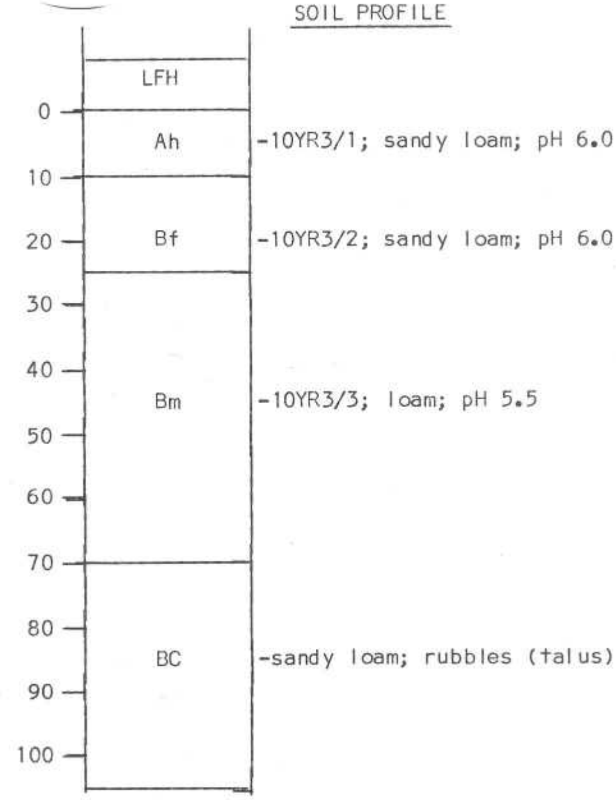
TEXTURE: Loam to Sandy Loam

SOLUM THICKNESS: 70-90 cm

NOTES/DISCUSSION: Refers specifically to snow avalanched areas, occurring especially on steep valley sides on middle to lower slopes. Vegetation is shrubby with few trees.



SOIL PROFILE



SOIL TYPE: C8

PARENT MATERIAL: Colluvium (Talus)

SOIL FAMILY: Orthic Regosol, Fragmental, Mixed, (Variable Soil Climate)

SLOPE: 60-75%

ELEVATION: 900-2500 m

MOISTURE REGIME: Very Xeric to Subxeric

NUTRIENT REGIME: Oligotrophic

HUMUS FORM CLASS: None

ROOTING DEPTH: 10 cm

DRAINAGE: Rapid

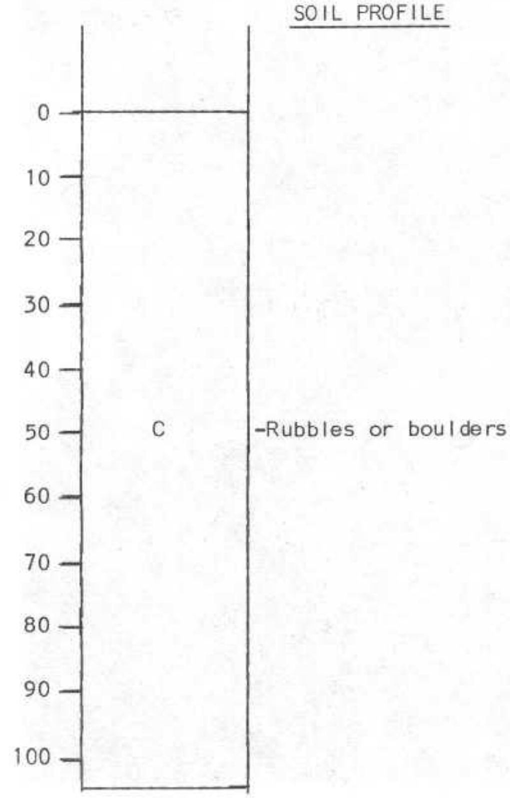
COARSE FRAGMENTS: > 90%, Angular

TEXTURE: None

SOLUM THICKNESS: 0

NOTES/DISCUSSION: Talus aprons and fans.

SOIL PROFILE



SOIL TYPE: F1

PARENT MATERIAL: Fluvial (Floodplain)

SOIL FAMILY: Cumulic Regosol or Gleyed Regosol, Sandy Skeletal or Sandy, Mixed, Cool, Perhumid or Subaquic

SLOPE: 0-10%

ELEVATION: 700-1200 m

MOISTURE REGIME: Hygric to Subhydric

NUTRIENT REGIME: Eutrophic

HUMUS FORM CLASS: Fibrimor

ROOTING DEPTH: 30-60 cm

DRAINAGE: Moderately Well or Imperfectly Drained

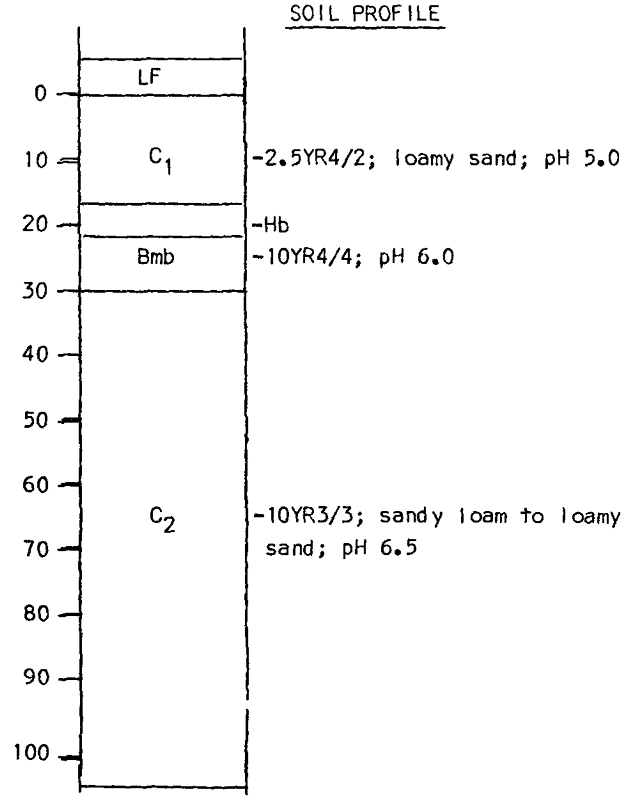
COARSE FRAGMENTS: 0-60%, Rounded

TEXTURE: Sandy Loam to Loamy Sand

SOLUM THICKNESS: 0

NOTES/DISCUSSION: Floodplains in transitional western hemlock zone; weakly developed soils due to recent flooding and sedimentation.

SOIL PROFILE



SOIL TYPE: F2

PARENT MATERIAL: Fluvial (Floodplain)

SOIL FAMILY: Cumulic Regosol or Gleyed Regosol, Sandy Skeletal or Sandy, Mixed, Cold, Perhumid or Subaquic

SLOPE: 0-10%

ELEVATION: 1200-1700 m

MOISTURE REGIME: Hygric to Subhydric

NUTRIENT REGIME: Eutrophic

HUMUS FORM CLASS: Fibrimor

ROOTING DEPTH: 30-60 cm

DRAINAGE: Moderately Well or Imperfectly Drained

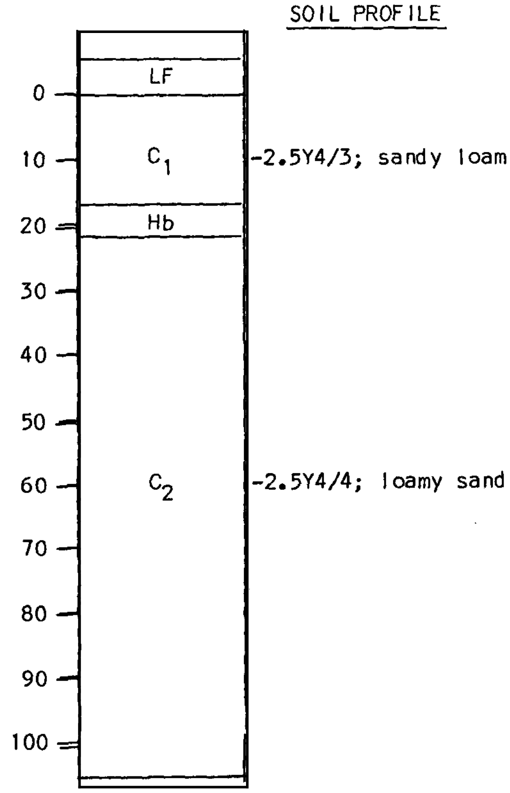
COARSE FRAGMENTS: 0-60%, Rounded

TEXTURE: Sandy Loam to Loamy Sand

SOLUM THICKNESS: 0

NOTES/DISCUSSION: Floodplains in transitional Engelmann spruce-subalpine fir zone; weakly developed due to recent flooding and sedimentation.

SOIL PROFILE



SOIL TYPE: F3

PARENT MATERIAL: Fluvial

SOIL FAMILY: Fera Humic Gleysol, Loamy, Mixed, Cold, Aquic to Peraquic

SLOPE: 0-10%

ELEVATION: 1200-1700 m

MOISTURE REGIME: Subhydric to Hydric

NUTRIENT REGIME: Mesotrophic to Submesotrophic

HUMUS FORM CLASS: Mesic Peaty Mor

ROOTING DEPTH: 20-40 cm

DRAINAGE: Poorly to Very Poorly Drained

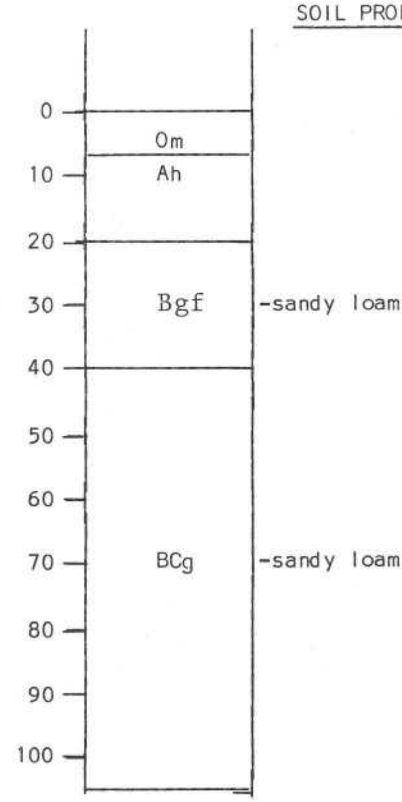
COARSE FRAGMENTS: 0-35%, Rounded

TEXTURE: Sandy Loam

SOLUM THICKNESS: 50-60 cm

NOTES/DISCUSSION: Open (non-forested), wet meadows in transitional Engelmann spruce-subalpine fir zone. Common vegetation includes willows and cottongrass.

SOIL PROFILE



SOIL TYPE: F4

PARENT MATERIAL: Fluvial

SOIL FAMILY: Orthic Humo-Ferric Podzol, Sandy Skeletal, Mixed, Cool, Subhumid

SLOPE: 0-20%

ELEVATION: 700-900 m

MOISTURE REGIME: Submesic to Xeric

NUTRIENT REGIME: Submesotrophic

HUMUS FORM CLASS: Humi-fibrimor or Fibrimor

ROOTING DEPTH: 40-60 cm

DRAINAGE: Well to Rapidly Drained

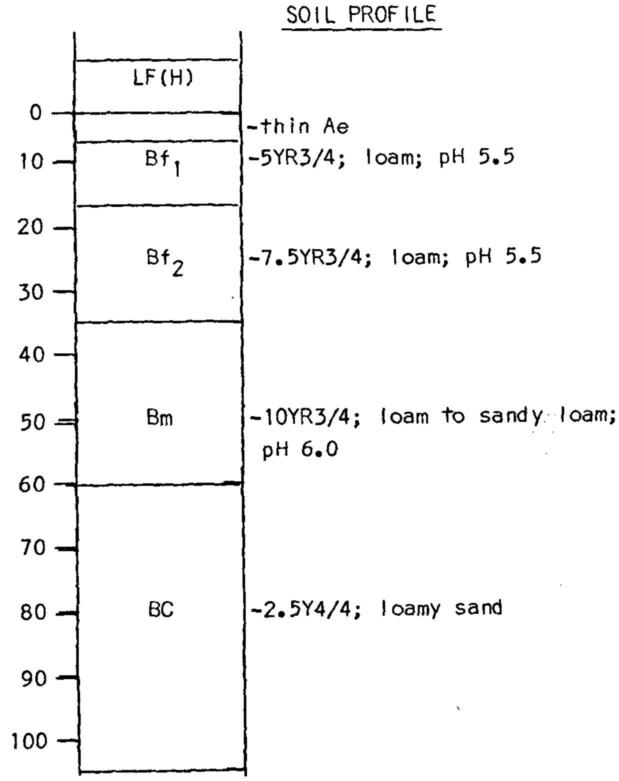
COARSE FRAGMENTS: 30-70%, Rounded

TEXTURE: Sandy Loam to Loamy Sand

SOLUM THICKNESS: 40-60 cm

NOTES/DISCUSSION: Transitional western hemlock dry subzone. Douglas-fir stands common. Loam capping with few coarse fragments.

SOIL PROFILE



SOIL TYPE: F5

PARENT MATERIAL: Fluvial

SOIL FAMILY: Orthic Humo-Ferric Podzol, Sandy Skeletal, Mixed, Cool, Humid

SLOPE: 0-20%

ELEVATION: 900-1200 m

MOISTURE REGIME: Mesic to Xeric

NUTRIENT REGIME: Mesotrophic to Oligotrophic

HUMUS FORM CLASS: Humi-fibrimor or Fibrimor

ROOTING DEPTH: 40-60 cm

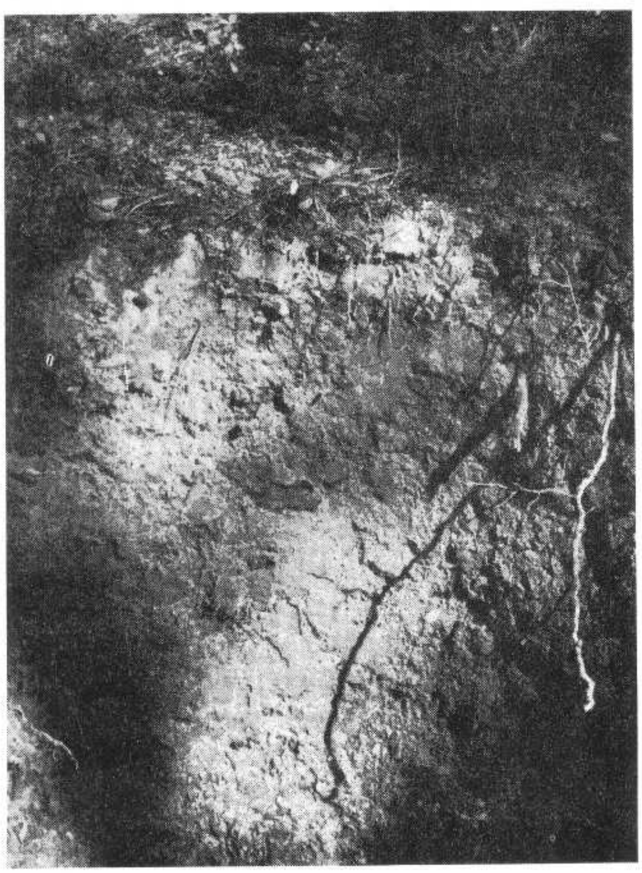
DRAINAGE: Well to Rapidly Drained

COARSE FRAGMENTS: 30-70%, Rounded

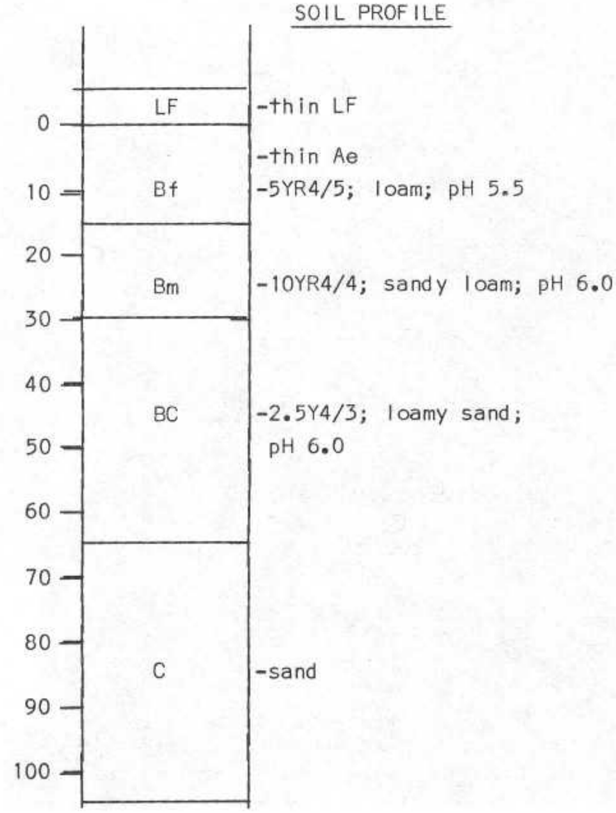
TEXTURE: Loamy Sand

SOLUM THICKNESS: 40-60 cm

NOTES/DISCUSSION: Transitional western hemlock wet subzone. Douglas-fir stands with amabilis fir. Loam capping with few coarse fragments.



SOIL PROFILE



SOIL TYPE: F6

PARENT MATERIAL: Fluvial

SOIL FAMILY: Orthic Humo-Ferric Podzol, Sandy Skeletal, Mixed, Cold, Perhumid

SLOPE: 0-20%

ELEVATION: 1200-1700 m

MOISTURE REGIME: Submesic to Subxeric

NUTRIENT REGIME: Submesotrophic

HUMUS FORM CLASS: Humi-fibrimor or Fibrimor

ROOTING DEPTH: 40-60 cm

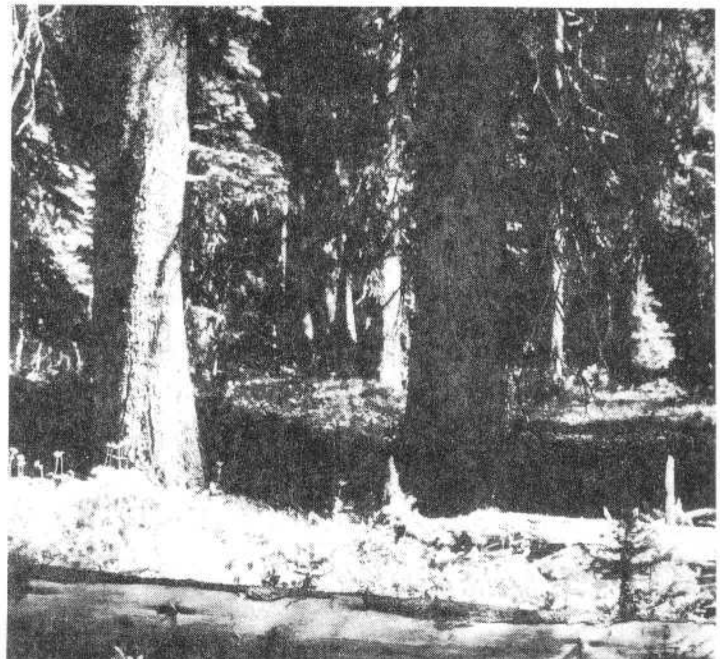
DRAINAGE: Well to Rapidly Drained

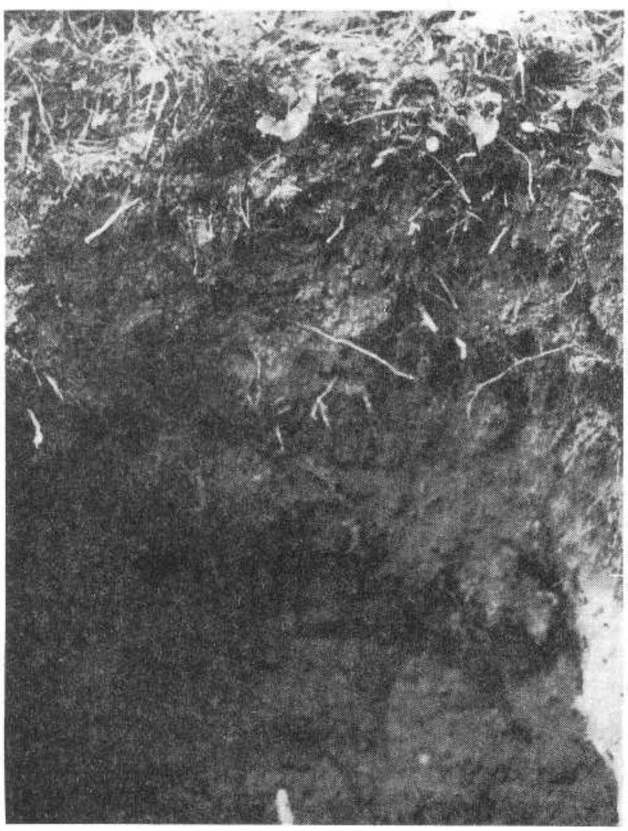
COARSE FRAGMENTS: 30-70%, Rounded

TEXTURE: Loamy Sand

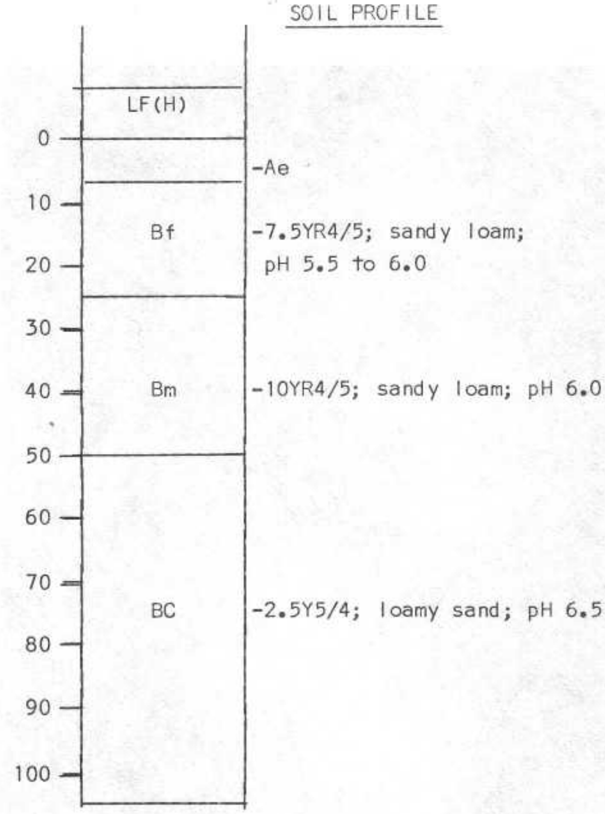
SOLUM THICKNESS: 40-60 cm

NOTES/DISCUSSION: Transitional Engelmann spruce-subalpine fir zone; seral stands with lodgepole pine.





SOIL PROFILE



SOIL TYPE: M1

PARENT MATERIAL: Morainal (Till)

SOIL FAMILY: Orthic Humo-Ferric Podzol, Loamy Skeletal, Mixed, Cool, Subhumid

SLOPE: 9-45%

ELEVATION: 700-900 m

MOISTURE REGIME: Mesic

NUTRIENT REGIME: Mesotrophic

HUMUS FORM CLASS: Humi-fibrimor or Fibrimor

ROOTING DEPTH: 40-60 cm

DRAINAGE: Moderately Well Drained

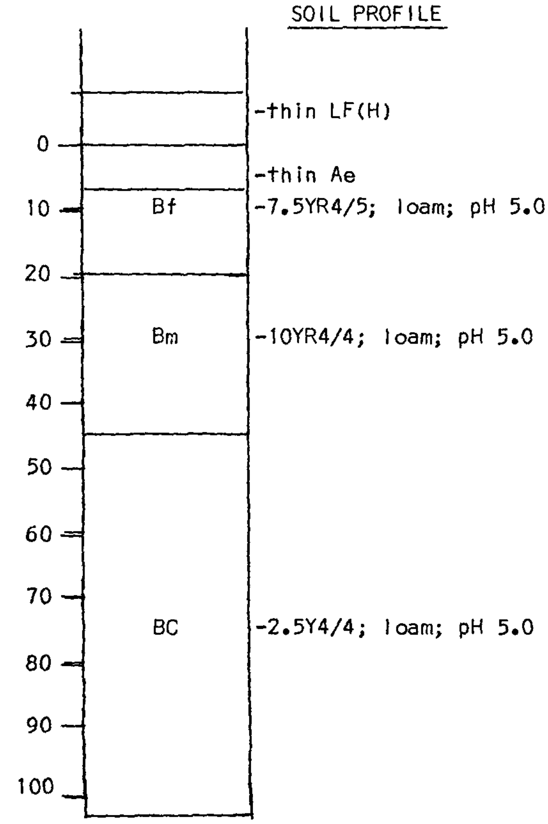
COARSE FRAGMENTS: 20-40%, Subrounded

TEXTURE: Loam to Sandy Clay Loam

SOLUM THICKNESS: 40-60 cm

NOTES/DISCUSSION: Transitional western hemlock dry subzone with Douglas-fir stands. Mainly in lower Sowaqua Valley.

SOIL PROFILE



SOIL TYPE: M2

PARENT MATERIAL: Morainal (Till)

SOIL FAMILY: Orthic Humo-Ferric Podzol, Loamy Skeletal, Mixed, Cool, Humid

SLOPE: 9-45%

ELEVATION: 900-1200 m

MOISTURE REGIME: Subhygric to Submesic

NUTRIENT REGIME: Mesotrophic to Permesotrophic

HUMUS FORM CLASS: Humi-fibrimor

ROOTING DEPTH: 30-60 cm

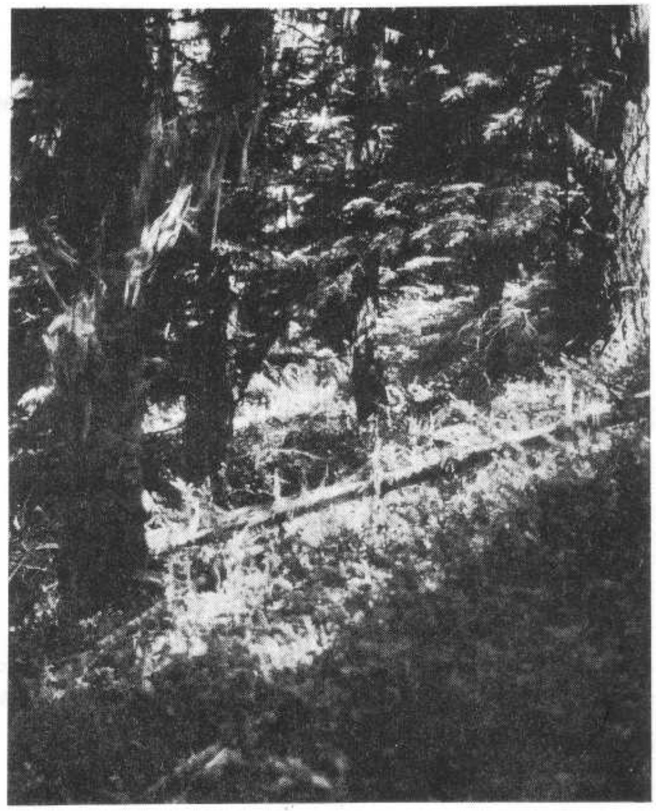
DRAINAGE: Moderately Well Drained

COARSE FRAGMENTS: 20-40%, Subrounded

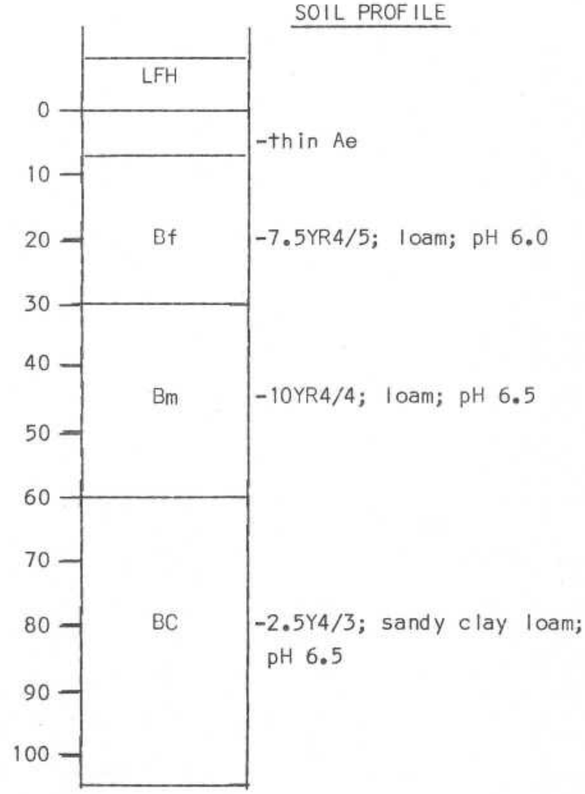
TEXTURE: Loam to Sandy Clay Loam

SOLUM THICKNESS: 50-70 cm

NOTES/DISCUSSION: Transitional western hemlock wet subzone with Douglas-fir and amabilis fir.



SOIL PROFILE



SOIL TYPE: M3

PARENT MATERIAL: Morainal (Till)

SOIL FAMILY: Orthic Ferro-Humic Podzol, Loamy Skeletal, Mixed, Cold, Perhumid

SLOPE: 9-45%

ELEVATION: 1200-1700 m

MOISTURE REGIME: Mesic to Subhygric

NUTRIENT REGIME: Mesotrophic

HUMUS FORM CLASS: Fibri-humimor

ROOTING DEPTH: 40-50 cm

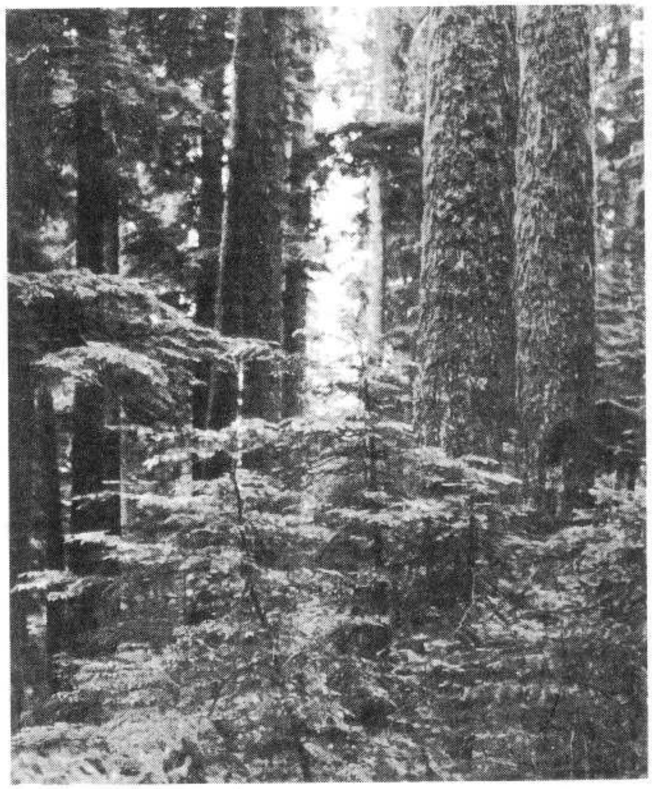
DRAINAGE: Moderately Well Drained

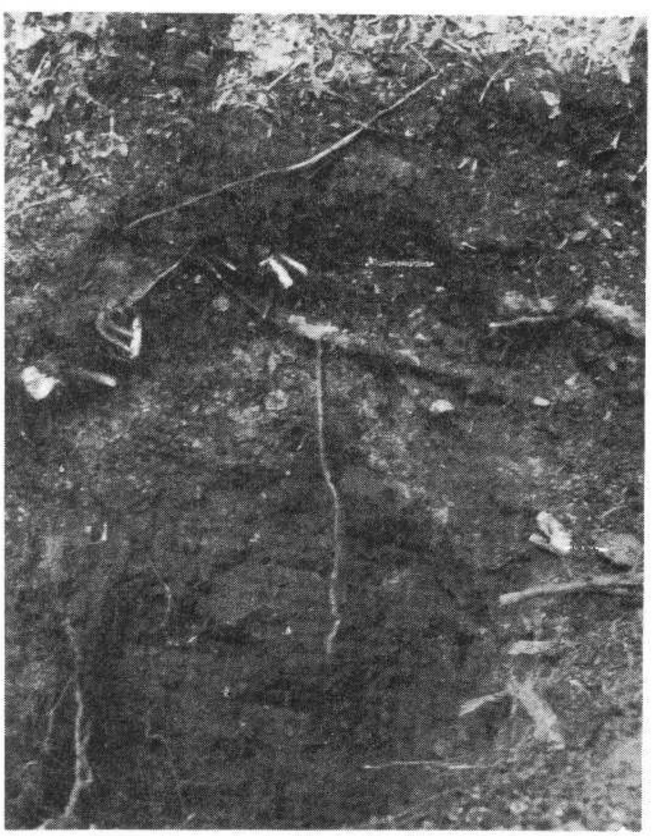
COARSE FRAGMENTS: 20-40%, Subrounded

TEXTURE: Sandy Loam to Sandy Clay Loam

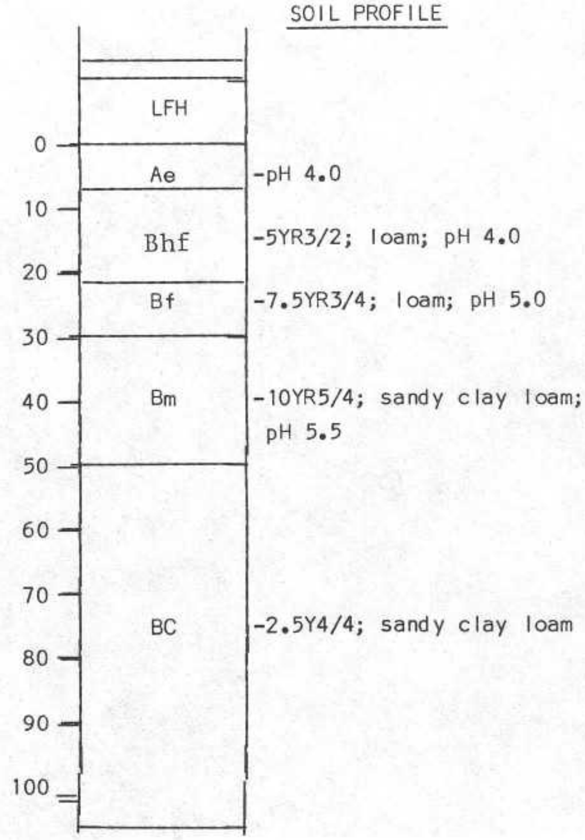
SOLUM THICKNESS: 40-50 cm

NOTES/DISCUSSION: Transitional mountain hemlock zone in western portions of study area.





SOIL PROFILE



SOIL TYPE: M4

PARENT MATERIAL: Morainal (Till)

SOIL FAMILY: Orthic Humo-Ferric Podzol, Loamy Skeletal, Mixed, Cold, Perhumid

SLOPE: 9-45%

ELEVATION: 1200-1700 m

MOISTURE REGIME: Mesic to Subhygric

NUTRIENT REGIME: Mesotrophic

HUMUS FORM CLASS: Humi-fibrimor

ROOTING DEPTH: 40-60 cm

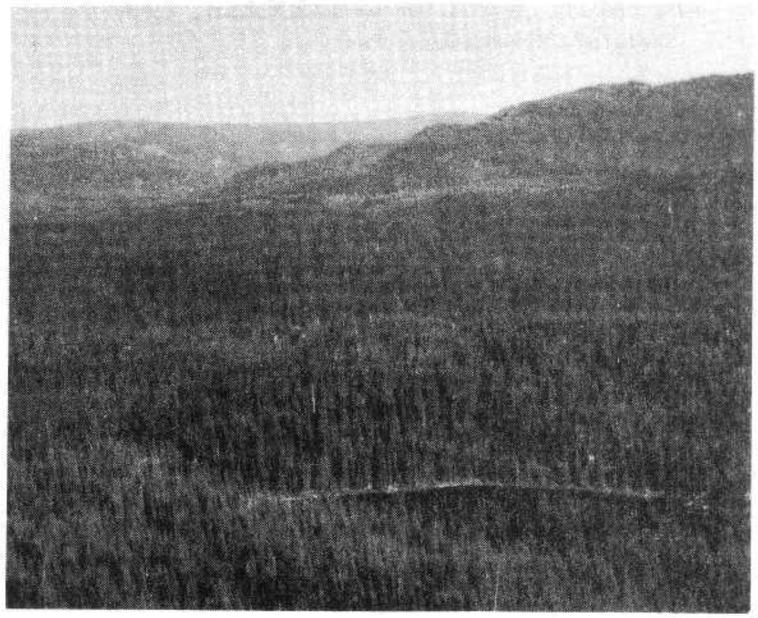
DRAINAGE: Moderately Well Drained

COARSE FRAGMENTS: 20-40%, Subrounded

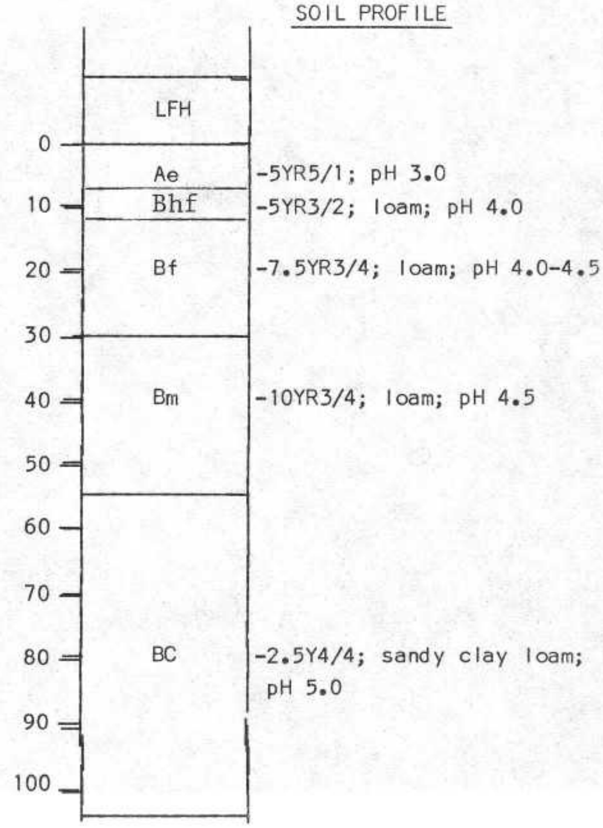
TEXTURE: Loam to Sandy Clay Loam

SOLUM THICKNESS: 40-60 cm

NOTES/DISCUSSION: Medium-textured till in transitional Engelmann spruce-subalpine fir forest subzone. Orthic Ferro-Humic Podzols also occur.



SOIL PROFILE



SOIL TYPE: M5

PARENT MATERIAL: Morainal (Till)

SOIL FAMILY: Orthic Ferro-Humic Podzol, Sandy Skeletal, Mixed, Cold, Perhumid

SLOPE: 9-45%

ELEVATION: 1500-1700 m

MOISTURE REGIME: Mesic

NUTRIENT REGIME: Mesotrophic or Permesotrophic

HUMUS FORM CLASS: Humi-fibrimor

ROOTING DEPTH: 40-60 cm

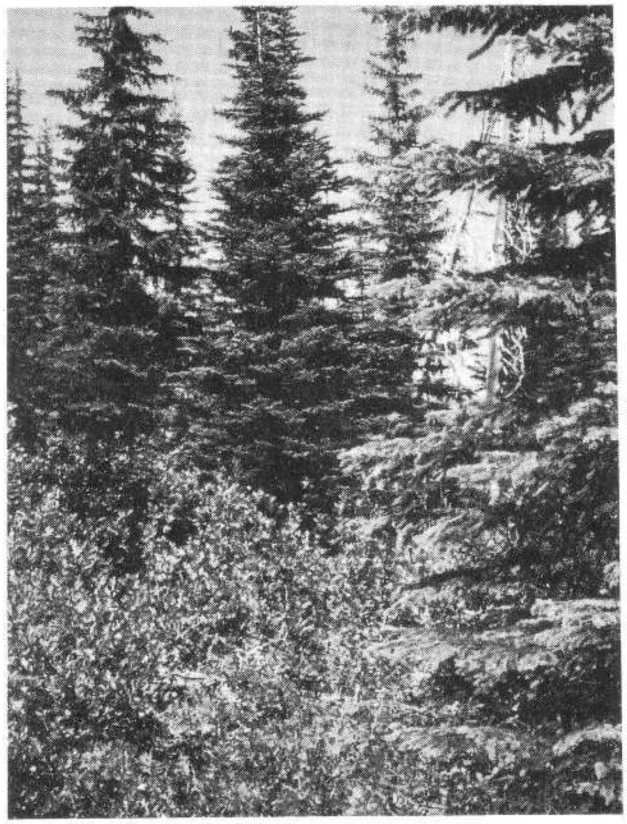
DRAINAGE: Well Drained

COARSE FRAGMENTS: 25-50%, Subrounded

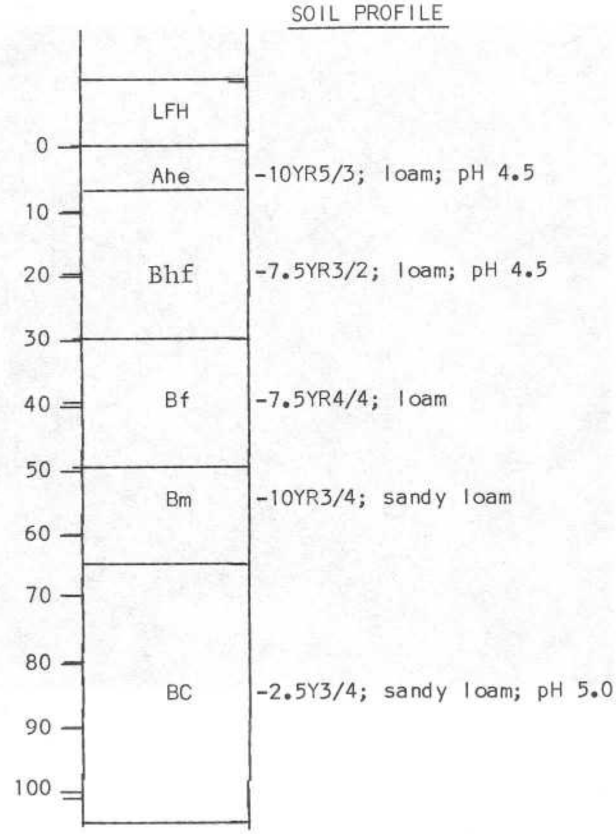
TEXTURE: Sandy Loam to Loamy Sand

SOLUM THICKNESS: 40-60 cm

NOTES/DISCUSSION: Coarse-textured till in transitional Engelmann spruce-subalpine fir forest subzone. Restricted to Skaist/Granite Mtn. area where granitic bedrock types are found.



SOIL PROFILE



SOIL TYPE: M6

PARENT MATERIAL: Morainal (Till)

SOIL FAMILY: Sombric Ferro-Humic Podzol, Loamy Skeletal, Mixed, Very Cold, Perhumid

SLOPE: 9-45%

ELEVATION: 1700-2000 m

MOISTURE REGIME: Mesic to Submesic

NUTRIENT REGIME: Mesotrophic

HUMUS FORM CLASS: Rhizomull

ROOTING DEPTH: 30-50 cm

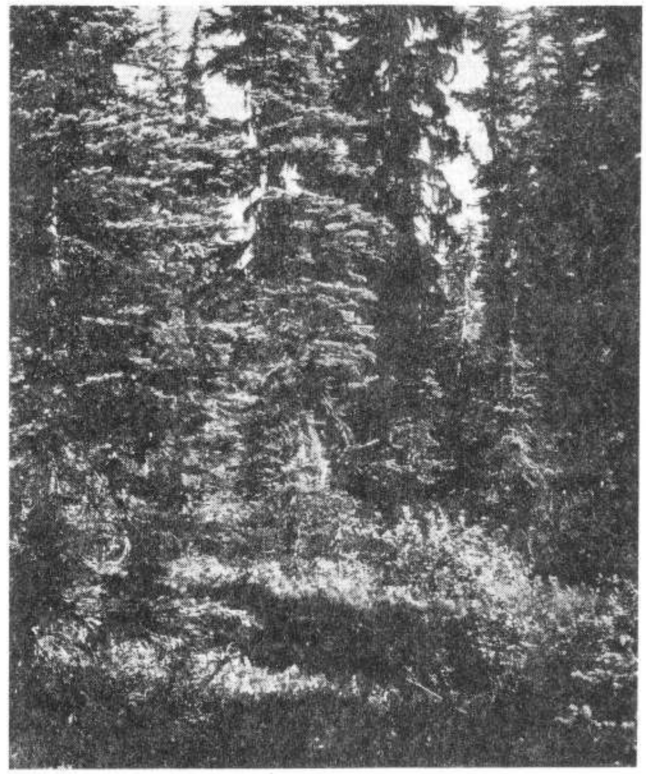
DRAINAGE: Moderately Well Drained

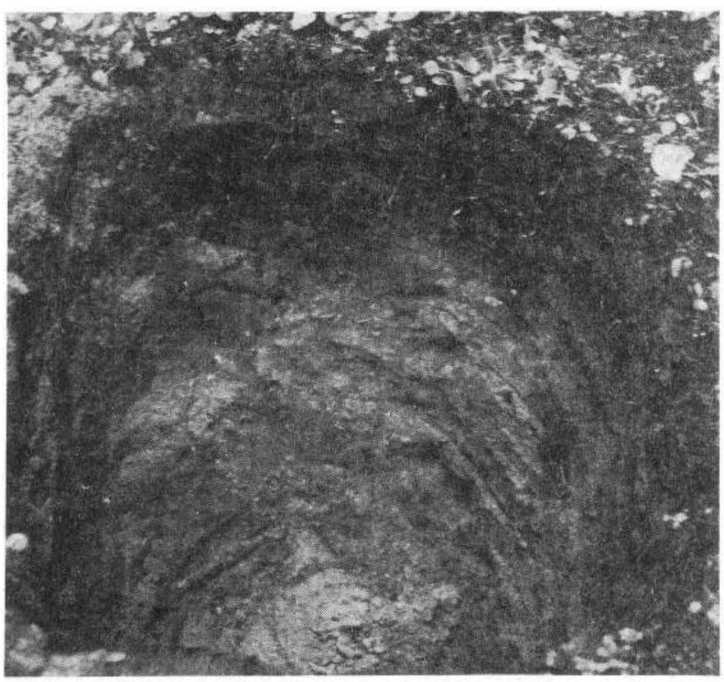
COARSE FRAGMENTS: 25-40%, Subrounded

TEXTURE: Loam to Sandy Clay Loam

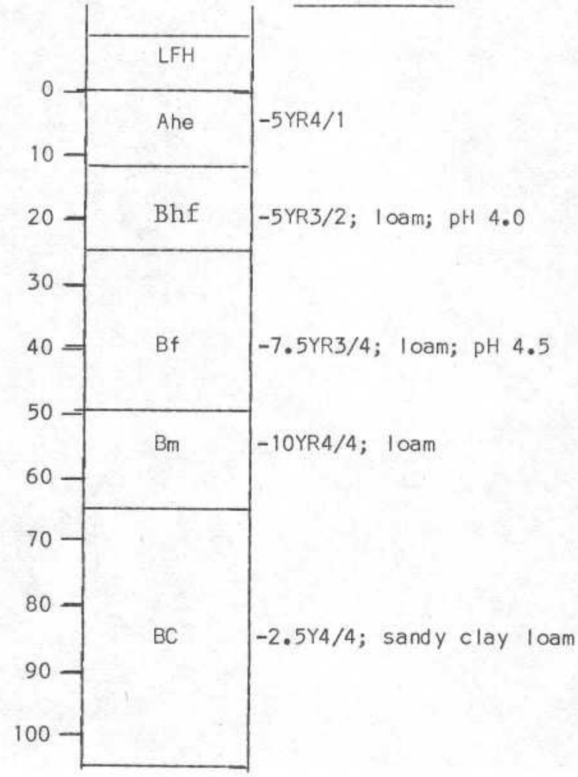
SOLUM THICKNESS: 40-60 cm

NOTES/DISCUSSION: Medium-textured till in transitional Engelmann spruce-subalpine fir parkland subzone. Some soils have thinner Ah horizons and are Orthic Ferro-Humic Podzols.





SOIL PROFILE



SOIL TYPE: M7

PARENT MATERIAL: Morainal (Till)

SOIL FAMILY: Sombric Ferro-Humic Podzol, Sandy Skeletal, Mixed, Very Cold, Perhumid

SLOPE: 9-45%

ELEVATION: 1700-2000 m

MOISTURE REGIME: Mesic

NUTRIENT REGIME: Mesotrophic

HUMUS FORM CLASS: Rhizomull

ROOTING DEPTH: 40-50 cm

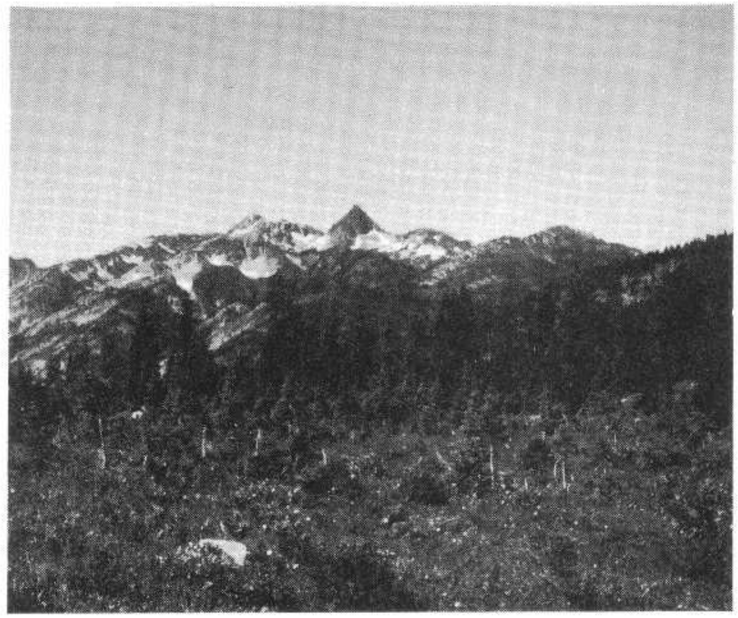
DRAINAGE: Moderately Well to Well Drained

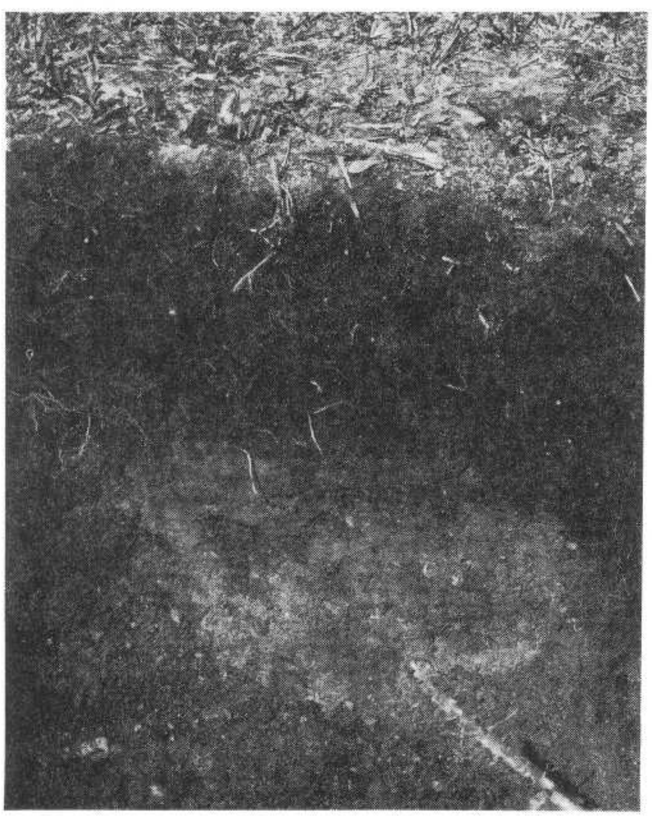
COARSE FRAGMENTS: 25-50%, Subrounded

TEXTURE: Sandy Loam to Loamy Sand

SOLUM THICKNESS: 50-80 cm

NOTES/DISCUSSION: Coarse-textured till in Engelmann spruce-subalpine fir parkland subzone. Restricted to Skaist/Granite Mtn. area. Some soils have thinner Ah horizons and are Orthic Ferro-Humic Podzols.





SOIL PROFILE

Depth (cm)	Horizon	Description
0-12	Ah	7.5YR3/1; loam
12-27	Bhf	5YR3/2; loam; pH 4.5
27-40	Bf	7.5YR4/5; loam; pH 5.0
40-60	Bm	10YR4/5; loam
60-100+	BC	2.5Y4/4; sandy loam; pH 6.0

CHAPTER THREE
SOIL INTERPRETATIONS FOR LAND USE

3.1 INTRODUCTION

Soil types are interpreted for a variety of land uses in this chapter. Soil capability ratings for agriculture and forestry, and soil limitation ratings for recreation sites and engineering uses such as roads are provided. Ratings are given in the engineering section for soil erosion potential. Assessments of each soil type as habitat for wildlife are also provided.

Soil interpretations of this kind are value judgements based on soil characteristics observed in the field and on soil samples tested in the laboratory. Soil interpretations are intended to serve as input into the planning process and are not intended as recommendations for land use. The predictive value of soil interpretations depends on a number of factors including the methods used to develop the interpretive ratings. Users are encouraged to modify or change the interpretive methods used in this report when further experience warrants it. Guide sheets used to develop most interpretations are given in Appendix 2.

The reliability of soil interpretations also depends on the homogeneity of the soils delineated within the map unit. Some landscapes are naturally more complex than others. Also, some areas received more intensive field checking which generally improves map reliability. From experience in other survey areas (Vold et al., 1980), it is believed that at least 75% of the area delineated by a map unit is represented by the labelled soils. Thus, up to 25% of a map unit area may contain different soil types too small to be shown at the scale of mapping. These inclusions of soils not represented by a map unit symbol can be as large as 25 ha (62 acres). Therefore, the interpretations provided in this chapter are intended for broad resource planning and are not intended for site-specific management. When specific soils information is needed for operations or design purposes, additional on-site investigation will be required.

Soil interpretations are usually expressed in terms of the nature and degree of soil limitations or suitability for the intended use. Soil suitability ratings are simply expressd as high,moderate, and low, or good, fair, poor, or unsuited. Ratings of slight, moderate, and severe are used to designate the degree of soil limitations:

slight limitations: recognized in soils that have properties favourable for the rated use. Soil limitations are minor and can easily be overcome. Good performance and low maintenance can be expected on these soils.

moderate limitations: recognized in soils that have properties with some significant limitations for the specified use. Limitations can be overcome or modified with special planning, design, or maintenance. Soils with this rating may require treatment to modify limiting features.

severe limitations: recognized in soils that are poorly suited for the rated use because of one or more unfavourable soil properties. Limitations are difficult and costly to overcome, requiring special design, major soil reclamation, or intense maintenance. 'Severe' soil ratings do not necessarily imply that a site cannot be changed to remove, correct, or modify existing soil limitations. The use of soils rated 'severe' depends on the kind of limitations, whether or not the soil limitations can be altered successfully and economically, and the scarcity of good sites.

Soil capability ratings for agriculture, forestry, and wildlife employ the seven class system defined by the Canada Land Inventory (1970).

3.2 RECREATION INTERPRETATIONS

Three related interpretations regarding potential recreational use are derived from the soil properties data: a) soil limitations for campgrounds and picnic sites; b) soil limitations for trails and paths; and c) recreational carrying capacity. The soil characteristics considered, in terms of their relative limitations for recreational use, are presented in Appendix 2 for each interpretation. Note that these interpretations are based on soil properties which may limit recreational use. Recreational features which may attract use are not considered.

Each interpretation considers the following soil properties: drainage, flood hazard, slope, texture, coarse fragment content, and depth to bedrock. The impact of these variables is similar for each intepretation; they will be generalized here.

Soil drainage estimates the rate and extent of water removal from soils in relation to water addition. Poorly and very poorly drained soils represent severe limitations to recreation, as compacted, wet soils suffer reduced infiltration and percolation, markedly increasing surface runoff and erosion. Trails become muddy by trampling and are widened by user detours; campsites are similarly unpleasant once the soil is disturbed.

Flooding hazard is considered severe when overbank flow is sufficiently frequent to disturb seasonal use, or in cases where expensive structures are required to maintain user corridors. Floodplain sites and active fluvial fans may represent a danger to recreationists under adverse weather conditions and in seasons of maximum discharge.

Slope is perhaps the most important determinant of recreational suitability. Steep slopes are physically unsuited for campground or picnic site placement. Intensive use or modification of steep slopes results in rapid surface erosion; it is estimated that erosion rates double for each 10% increase in slope where the vegetation and litter cover of the soil is less than 50% (Meeuwig, 1971). Trails can be built traversing steep slopes but are relatively more costly to construct and maintain.

Soil texture helps to determine both compaction rates (and hence soil surface erosion) and vegetation growth. Loamy soils have only slight limitations since they are relatively cohesive and are optimum for plant growth. Fine-textured (silty and clayey) soils are less permeable and more erosion-susceptible; very sandy soils become loose and unstable.

Coarse fragment content refers to the percentage of stones and boulders in the soil. Excessive stoniness presents obstacles to campground placement unless expensive removal is undertaken. Stoniness similarly influences the difficulty of trail construction. Finally, exposures of bedrock may necessitate trail re-routing and complicate campground placement. Steep bedrock outcrops may also pose a safety hazard to recreationists.

The relative impacts and importance of each of these properties were considered in evaluating soil limitations (see Appendix 2). For campgrounds and trails a rating of slight, moderate or severe was assigned (Montgomery and Edminister, 1966). For recreational carrying capacity, a rating was chosen from 5 classes, according to Block and Hignett (1976):

Table 4

SOIL INTERPRETATIONS FOR RECREATION

SOIL TYPE	DEGREE AND KIND OF LIMITATION FOR...		RECREATION CARRYING CAPACITY*
	CAMPGROUNDS AND PICNIC SITES	TRAILS AND PATHS	
C1 to C4	severe: slope, CF**	moderate: slope	Ts4-5 3-4 Sb2
C5	severe: slope, depth	moderate to severe: slope, depth	Ts4-5 4 Sb2 Lp
C6	severe: slope, depth	moderate to severe: slope, depth	Lp 4-5 Ts4-5
C7	severe: slope, CF	severe: slope, CF	La 5 Ts5
C8	severe: slope, CF	severe: CF, slope	Ts5 5 Sb3
F1, F2	moderate: drainage, flooding	moderate: drainage, flooding	Sw2 3-4 Hi2-3
F3	severe: drainage	severe: drainage, texture	Sw3 4-5 So2
F4 to F6	slight: CF	slight: CF	Sb2 1-2 Sc2
M1 to M4	moderate to severe: slope	slight to moderate: slope	Ts3-4 2-3
M5	moderate to severe: slope, texture	moderate: slope, texture	Ts3-4 2-3 Sc2
M6	moderate to severe: slope	slight to moderate: slope	Ts3-4 3-4 Lp
M7	moderate to severe: slope, texture	moderate: slope, texture	Ts3-4 3-4 Lp Sc2
R	severe: rock	severe: rock	Ts5 5 Sr3

* Soil types with a "v" on the soil map indicate additional Sk2 limitations.
CF** Coarse fragment (stoniness) limitations.

CLASS 1: soils with the highest physical carrying capacity, suitable for intensive recreational use.

CLASS 2: soils with few limitations.

CLASS 3: soils with limitations which restrict most forms of intensive recreational activity, for instance, developed campgrounds.

CLASS 4: major soil limitations restricting both intensive and extensive recreational use.

CLASS 5: soils with the lowest carrying capacity with severe limitations affecting most forms of use.

Soil limitations for recreational use are summarized in Table 4. The inactive fluvial terraces and blankets (F4, F5, F6) present slight limitations to both campgrounds and trails and have a high carrying capacity; the only possible limitation is a textural one: soils may be loose and sandy at depth. Floodplains (F1, F2) have moderate limitations to use due to flood hazard and drainage problems.

All the colluvial soils have severe limitations to campgrounds and moderate limitations to trails because of very steep slopes. Thin soil depths and high coarse fragment content also add to the soil limitations. Avalanche hazards are noted as a severe limitation for soil type C7.

Morainal soils (M1 to M5) in forested environments have high to moderate carrying capacities depending on steepness of slope. Parkland and alpine soils (C5, C6, M6, M7) have low to moderate carrying capacities because of factors related to the fragility of high-altitude sites: frost action, steep slopes, and exposed bedrock.

3.3 ENGINEERING INTERPRETATIONS

The soil types differentiated in the study area can be classified according to two textural classification systems for engineering purposes. The Unified system, adopted by most engineers, classes soils according to four parameters: particle-size distribution, plasticity, liquid limit and organic matter. Therein fifteen soil classes are recognized under three headings: gravelly materials, sandy materials and fine grained soils. From this soil classification many engineering characteristics can be inferred: value as subgrade, shear strength, compressibility, and susceptibility to frost action are examples. These relationships are summarized in Table 5.

The AASHO system is used in classifying soils according to those properties that determine use in road construction and maintenance. Seven basic groups (A-1 to A-7) are derived from examination of grain-size distribution, liquid limit and plasticity index. A-1 represents a gravelly soil, very suitable for subgrade, while A-7 represents clayey soils unsuitable for subgrade. For more information on both the Unified and AASHO systems, refer to U.S.D.A. Soil Conservation Service (1971) and Asphalt Institute (1969).

These textural classifications are given for each soil type in Table 6. This and other previously tabulated data yield several interpretations for each soil for engineering purposes: sand and gravel sources, potential frost action susceptibility, value as subgrade, limitations for logging roads, and potential soil erosion hazard. Appendix 2 contains the guide sheets used for each interpretation.

Table 5

ENGINEERING CHARACTERISTICS OF UNIFIED SOIL CLASSES[1]

Unified Soil Class	Value as Subgrade	Shear Strength	Compressibility and Expansion	Compaction Characteristics	Frost Action Potential
GW	Excellent	High	Almost none	Good	None to very slight
GP	Good to excellent	High	Almost none	Good	None to very slight
GM	Good to excellent	High to medium	Very slight to slight	Good	Slight to medium
GC	Good	Medium	Slight	Fair	Slight to medium
SW	Good	High	Almost none	Good	None to very slight
SP	Good to fair	Medium	Almost none	Good to fair	None to very slight
SM	Good to fair	Medium	Very slight to medium	Good to fair	Slight to high
SC	Fair to good	Medium to low	Slight to medium	Fair	Slight to high
ML	Fair to poor	Medium to low	Slight to medium	Fair to poor	Medium to very high
CL	Fair to poor	Medium to low	Medium	Fair to good	Medium to high
MH	Poor	Low	High	Poor to very poor	Medium to very high
CH	Poor	Low	High	Fair to poor	Medium
OL	Poor	Low	Medium to high	Fair to poor	Medium
OH	Poor to very poor	Low	High	Poor to very poor	Medium
Pt	Unsuitable	Very low	Very high	Fair to poor	Slight

[1] This chart is adapted from similar tables presented by the USDA Soil Conservation Service (1971), the USDI Bureau of Land Management, and the Asphalt Institute (1969).

Table 6

SOIL ENGINEERING INTERPRETATIONS

Soil Type	Surficial Materials	Textural Classification			Slope Range	Sand and Gravel Suitability	Potential Frost Action	Value as Subgrade	Limitations* for Logging Roads	Soil* Erosion Hazard
		CDA	Unified	AASHO						
C1	colluvium	loam, sandy loam	GM, GC	A-2	30-75%	poor	low	good to excellent	moderate: slope	moderate: slope, depth
C2	colluvium	loam, sandy loam	GM, GC	A-2	30-75%	poor	low	good to excellent	moderate: slope	moderate: slope, depth
C3	colluvium	silt loam, loam	SM, SC	A-4	30-75%	poor	moderate	fair to good	moderate: slope	moderate: slope, soil
C4	colluvium	sandy loam	GM, GC	A-2	30-75%	poor	moderate	good to excellent	moderate: slope	moderate: slope
C5	colluvium	loam	SM, SC	A-4	20-75%	poor	high	fair to good	moderate to severe: slope, frost	moderate to high: slope, litter
C6	colluvium	silt loam, loam	SM, SC	A-4	20-75%	poor	high	fair to good	severe: slope, frost	high: slope, litter, frost
C7	colluvium (avalanched slopes)	loam	GM	A-1-b	30-75%	poor	moderate to low	good	severe: slope, avalanching	high: slope, avalanching
C8	colluvium (talus aprons)	rubbly or blocky	GW	A-1-a	60-75%	poor to unsuited	low	excellent	moderate to severe: slope, rockfall	high: slope, litter, rockfall
F1	fluvial (floodplain)	sandy loam, loamy sand	SM, SC	A-2-4	0-10%	unsuited**	low	good to fair	moderate: flooding	low to moderate: drainage, channeling
F2	fluvial (floodplain)	sandy loam, loamy sand	SM, SC	A-2-4	0-10%	unsuited**	low	good to fair	moderate: flooding	low to moderate: drainage, channeling
F3	fluvial (meadows)	sandy loam	SC	A-4-5	0-10%	unsuited	moderate	fair to poor	severe: drainage	moderate: drainage
F4	fluvial (terraces, blankets)	sandy loam, loamy sand	GM, GC	A-1-b	0-20%	good	low to moderate	good to excellent	slight	low
F5	fluvial (terraces, blankets)	loamy sand, sand	SP (GM. GC)	A-3	0-20%	good	low to moderate	good	slight	low
F6	fluvial (terraces, blankets)	loamy sand	SP (GM, GC)	A-3	0-20%	good	low to moderate	good	slight	low
M1	morainal (till)	loam, sandy clay loam	GM, GC (SM, SC)	A-2	9-45%	poor	low to moderate	good	slight to moderate: slope	moderate: slope
M2	morainal (till)	loam, sandy clay loam	GM, GC (SM, SC)	A-2	9-45%	poor	moderate	good	slight to moderate: slope	moderate: slope
M3	morainal (till)	sandy loam, sandy clay loam	GM, GC (SM, SC)	A-2	9-45%	poor	moderate	good	slight to moderate: slope	moderate: slope
M4	morainal (till)	loam, sandy clay loam	GM, GC (SM, SC)	A-2	9-45%	poor	moderate to high	good	slight to moderate: frost, slope	moderate: slope
M5	morainal (till)	sandy loam, loamy sand	SW-SM	A-1-b	9-45%	fair	moderate	good	slight to moderate: frost, slope	low to moderate: slope
M6	morainal (till)	loam, sandy clay loam	GM, GC (SM, SC)	A-2	9-45%	poor	moderate to high	good	moderate: frost, slope	moderate: litter, slope
M7	morainal (till)	sandy loam, loamy sand	SW-SM	A-1-b	9-45%	fair	moderate	good	moderate: frost, slope	moderate: litter, slope

* A "v" at the end of a soil type, e.g. C1v, imposes additional depth to bedrock limitations on logging roads and can increase soil erosion hazards by increasing surface runoffs (due to impeded bedrock layer).

** Floodplain soils (F1, F2) are rated unsuitable for sand and gravel due to potential damage to streams and fisheries.

Sand and Gravel Suitability

Designed to indicate probable sources of sand and gravel, these ratings are based on the Unified soil classification, boulder content, depth to bedrock, flooding hazard and drainage. Fair to good soils are relatively thick depositions of well drained, coarser-grained materials. Poor or unsuited soils are medium to fine-grained materials, those that are shallow to bedrock, or those that are poorly drained. In the study area, an 'unsuited' rating is given to riverbed and active floodplain material due to potential stream damage by extraction of sand and gravel. Soil factors considered in determining suitability ratings are summarized in Appendix 2, which was modified from one prepared by the U.S.D.A. Soil Conservation Service (1971).

Potential Frost Action

Soil susceptibility to frost action (heaving) is determined by the Unified soil classification or soil texture, along with soil temperature class. Soils in a 'very cold' climate regime or fine-grained (silt loam to loam) soils are very prone to frost heaving and are rated 'high'. Conversely, highly-permeable, coarser-grained soils in warmer regimes are not frost-susceptible and are rated 'low'. Factors considered in determining the ratings are presented in Appendix 2, and was based on one by the U.S.D.A. Soil Conservation Service (1971).

Value as Subgrade

The general suitability of different soils for use as road subgrade is based solely on the material's Unified soil classification (Table 5). Soils are rated from unsuited to excellent. Characteristics such as slope, drainage and bedrock are not considered in this rating.

Limitations for Logging Roads

Soil limitation ratings indicate the relative cost and difficulty in constructing and maintaining unpaved logging roads. Soils are rated from 'slight' to 'severe'; a 'severe'-rated soil will present strong limitations to logging road construction; a 'slight'-rated soil will present few difficulties.

It is important to consider many influencing factors and to rate the soil according to their impact in combination. Soil factors considered include soil drainage, subgrade properties, slope, flooding hazard, bedrock presence, susceptibility to frost action, and presence/absence of geologic hazards. These are summarized in an Appendix 2 guide sheet, which was adapted from one prepared by Craul (1975).

Note that the presence of 'severe' limitations does not imply that logging roads cannot or should not be constructed, but does suggest that construction and maintenance costs are likely to be high, and hence alternative routes should be considered.

Colluvial soils at lower elevations (C1 to C4) present moderate limitations to logging roads simply because of steep topography (slopes often exceeding 70%). At higher elevations, colluvial soils (C5, C6) present even greater difficulties due to slope, thin soil depth, and frost action.

The avalanched slopes (C7) and the talus aprons (C8) are given 'severe' ratings because of slope and geologic hazards.

Present fluvial floodplains (F1, F2) have moderate limitations due to flooding hazards. Meadows and bogs (F3) are unsuited to road placement because of poor drainage.

Fluvial terraces and blankets (F4, F5, F6) afford the best opportunity for road construction: gentle slopes, good subgrade material and rapid drainage offer only slight limitations.

Finally, morainal soils have moderate limitations for logging roads. At lower elevations, moderate slopes pose the only problems; the till in the study area is generally well-drained and suitable as subgrade material. At higher elevations, potential problems with slope and frost action require consideration.

Soil Erosion Hazard

This final interpretation indicates the susceptibility of soils to erosional processes should the soil surface be disturbed. The degree of hazard is rated from low to high depending on the local properties of drainage, soil class, permeability, depth, forest floor thickness, landscape slope, and presence/absence of erosional processes. Appendix 2 provides the criteria for the assessment, based on concepts summarized by Utzig (1978).

3.4 FOREST CAPABILITY

Land capability for forestry ratings for each soil type are presented on Table 7. The Canada Land Inventory (McCormack, 1972) classification framework was used. No forest capability growth plots were measured in the study area; thus the ratings are based on the nature and severity of soil and climatic limitations. Fifty-eight Forest Service productivity plots (Klinka and Mitchell, pers. comm.) on similar soils types in and near the Cascade area, and Romaine and Lacate's (1969) forest capability map covering eastern portions of the study area were referred to in developing the capability ratings.

A given capability class is a grouping of soils that have a similar inherent ability to grow commercial timber. The classes are defined in terms of the inherent limitations to the growth of commercial forests and in terms of productivity. The best lands for commercial tree growth will be found in Class 1 and, at the other extreme, those in Class 7 cannot be expected to yield timber in commercial quantities. Subclass ratings indicate the nature of the limitations. Location of soil, access, distance to markets, and ownership are not considered in the capability ratings.

Associated with each capability class is a productivity range based on the mean annual increment. Productivity classes are expressed in gross merchantable cubic metre volume to a minimum diameter of ten centimeters. Thinnings, bark and branch wood are not included. The productivity as expressed is that of "normal" (i.e. fully-stocked) stands. It may be assumed that only good management would have produced stands of this nature.

The classes are based on the natural state of the land without improvements such as fertilization, drainage or amelioration practices. It is realized that with improved forest management, productivity may improve to the extent that the limitations shown in the symbol may be altered, and class changes may also take place. However, significant changes will only be achieved through costly and continuing practices.

A complex pattern of forest capability occurs in this mountainous area because of the interaction of highly variable climatic, edaphic, and topographic factors. At lower elevations, in the transitional coastal western hemlock zone, few climate-related limitations exist. Consequently, deep, medium-textured soils (M1, M2, C1, C2) found on morainal and some colluvial parent materials have high capabilities for forestry, with Pseudotsuga menziesii best suited for most sites. Floodplains (F1) in this zone can have very high capabilities due to high seasonal water tables which enrich the soils with water and nutrients. Very shallow soils (C1v, C2v) and excessively stony soils (C8, F4, F5) have moderate to low capabilities.

Low temperatures which result in short, cool growing seasons are the main limitation for forest capability in subalpine forests. Here, deep, medium-textured soils (M3, M4, M5, C3, C4, F6) have moderate to low capabilities. Areas of exposed bedrock (R) and talus (C8), poorly drained meadow areas (F3), and avalanched areas (C7) cannot grow commercial forest stands. Enriched soils such as floodplains (F2) and unmapped seepage sites have moderate capabilities.

Soils in parkland environments (C5, M6, M7) have very low capabilities for forestry, and alpine soils (C6) cannot grow trees at all due to adverse weather conditions.

3.5 AGRICULTURAL CAPABILITY

Soil Capability for agriculture ratings are presented on Table 8 for each soil type. The Canada Land Inventory (1972) and Runka's (1973) manuals, and Green's (1971) agriculture capability map for eastern portions of the study area were consulted in developing the capability ratings.

In this classification, mineral soils are grouped into seven classes. Soils in classes 1, 2, 3, and 4 are considered capable of sustained use for cultivated field crops, those in classes 5 and 6 only for perennial forage crops, and those in class 7 for neither. Capability classes are based on inherent edaphic, topographic, and climatic limitations. The following are not considered: distances to market, kind of roads, location, size of farms, type of ownership, cultural patterns, skill or resources of individual operators, and hazard of crop damage by storms.

No capability for cultivated field crops appears to exist in the Cascade area due to adverse climate. Limited areas of Class 5 and 6 soils exist, with some potential for summer grazing. Adverse climate throughout the area limits the duration of the grazing season. Fluvial soils are best suited for grazing as they occur on relatively gentle toography. They are rated Class 5 or 6 depending on the nature of the soil limitations. Existing grazing in the Paradise Valley area are on these soil types.

Morainal and some colluvial soils in parkland and alpine environments have some grazing potential as well. The open forests allow considerable herbaceous cover which is usable in the summer months. Existing grazing permits in the Skaist-Granite area are on these soil types.

Table 7

LAND CAPABILITY FOR FORESTRY

Soil Type*	Dominant Capability Classes	Dominant Capability Subclasses	Tree Species Indicators**
C1	2-3	M, P	Fd
C2	3-4	M, P	Fd
C3	4-5	H, P	Ba, Hm
C4	4-5	H, P	Se, Bl, (Pl, Pw)
C5	6	H	Se, Bl
C6	7	H	--
C7	7	E	--
C8	6-7	E, P	--
F1	1-2	I	Cw, Ba, (Hw, Ac)
F2	3-4	I	Se
F3	7	W	--
F4	3-5	P, M	Fd
F5	3-5	P, M	Fd
F6	4-5	H, P	Pl, Se, Bl
M1	1-2	C	Fd
M2	2-3	C	Fd, Hw, Ba
M3	4-5	H	Ba, Hm
M4	4-5	H	Se, Bl
M5	6	H	Se, Bl
M6	6	H	Se, Bl
M7	6	H	Se, Bl
R	7	R	--

* A "v" at the end of the soil type, e.g. Clv, lowers the capability rating by one or two due to subclass R limitations.

** Tree Species indicators are those which can be expected to yield the most volume for each soil type. Only indigenous species adapted to the region are shown. Species in parenthesis are not suitable for the entire soil type. Symbols shown are as follows:

- Ac - Populus balsamifera, poplar
- Ba - Abies amabilis, amabilis fir
- Bl - Abies lasiocarpa, alpine fir
- Cw - Thuja plicata, western red cedar
- Fd - Pseudotsuga menziesii, Douglas-fir
- Hw - Tsuga heterophylla, western hemlock
- Hm - Tsuga mertensiana, mountain hemlock
- Pl - Pinus contorta, lodgepole pine
- Pw - Pinus monticola, western white pine
- Se - Picea engelmannii, Engelmann spruce

LEGEND FOR TABLE 7

The capability classes used for the Cascade area are described below. Forest productivity estimates are based on a rotation age of 100 years.

Class 1: Lands having no important limitations to the growth of commercial forests. Soils are deep, permeable, of medium texture, moderately well drained to imperfectly drained, have good water-holding capacity and are naturally high in fertility. Their topographic position is such that they frequently receive seepage and nutrients from adjacent areas. They are not subject to extremes of temperature or evapotranspiration. Productivity will usually be greater than 7.7 cubic metres per hectare per year.

Class 2: Lands having slight limitations to the growth of commercial forests. Soils are deep, well drained to moderately well drained, and have good water-holding capacity. The most common limitations are adverse climate and the cumulative effects of several minor adverse soil characteristics. Productivity will usually be from 6.4 to 7.7 cubic metres per hectare per year.

Class 3: Lands having moderate limitations to the growth of commercial forests. Soils may be deep to somewhat shallow, well to moderately well drained with moderate to good water-holding capacity. They may be slightly low in fertility or suffer from periodic moisture imbalances. Productivity will usually be from 5.0 to 6.3 cubic metres per hectare per year.

Class 4: Lands having moderately severe limitations to the growth of commercial forests. Soil characteristics vary considerably. The most common limitations are moisture deficiency and adverse climate. Productivity will usually be from 3.6 to 4.9 cubic metres per hectare per year.

Class 5: Lands having severe limitations to the growth of commercial forests. Soils are frequently shallow to bedrock, stony and well to rapidly drained. The most common limitations (often in combination) are moisture deficiency, shallowness to bedrock, and adverse climate. Productivity will usually be from 2.2 to 3.5 cubic metres per hectare per year.

Class 6: Lands having very severe limitations to the growth of commercial forests. Soils are frequently shallow, s tony and rapid to well drained. A large percentage of the land in this class is composed of open, parkland forests in high elevations. The most common limitations (frequently in combination) are shallowness to bedrock, deficiency of soil moisture, and adverse climate. Productivity will usually be from 0.8 to 2.1 cubic metres per hectare per year.

Class 7: Lands having severe limitations which preclude the growth of commercial forests. Soils are usually extremely shallow to bedrock; actively eroding or extremely wet soils are also placed in this class. Bedrock areas are also included. The most common limitations are shallowness to bedrock, excessive soil moisture and extremes of climate or exposure. Productivity will usually be less than 0.8 cubic metres per hectare per year.

The capability subclasses express the kinds of limitations that affect the forest capability rating. The subclasses used for the Cascade area are:

Subclass C - a combination of more than one minor climatic factor which adversely affects forest growth.

Subclass E - actively eroding soils (e.g. talus slopes, snow avalanched areas).

Subclass H - low temperatures which result in a short, cool growing season.

Subclass I - soils periodically inundated by streams.

Subclass M - soil moisture deficiency attributable to soil characteristics such as low water-holding capacity and rapid drainage.

Subclass P - excessive stoniness which affects forest density or growth.

Subclass R - restriction of rooting zone by bedrock. Soils are shallow and generally coarse-textured.

Subclass W - soil moisture excess used for poorly drained soils (meadows).

Table 8

SOIL CAPABILITY FOR AGRICULTURE

Soil Type	Dominant Capability Classes	Dominant Subclasses
C1	7	T, C, P
C2	7	T, C, P
C3	7	C, T, P
C4	7	C, T, P
C5	6-7	T, C, P
C6	6-7	T, C, P
C7	6-7	T, C, P
C8	7	P, T
F1	5	C
F2	5	C, P
F3	5-6	C, W
F4	6	P, C, M
F5	6	P, C, M
F6	6-7	P, C, M
M1	6-7	C, T
M2	7-6	C, T
M3	7	C
M4	7	C
M5	7	C
M6	6	C, T
M7	6	C, T
R	7	T, R

The capability classes used for the Cascade area are as follows. Class 1 to 4 soils do not exist in the study area.

Class 1: Soils in this class have no significant limitations in use for crops.

Class 2: Soils in this class have moderate limitations that restrict the range of crops.

Class 3: Soils in this class have moderately severe limitations that restrict the range of crops.

Class 4: Soils in this class have severe limitations that restrict the range of crops or require special conservation practices or both.

Class 5: Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. The limitations are so severe that the soils are not capable of use for sustained production of annual field crops. The soils are capable of producing native or tame species of perennial forage plants, and may be improved by use of farm machinery. The improvement practices may include clearing of bush, cultivation, seeding, fertilizing or water control.

Class 6: Soils in this class are capable only of producing perennial forage crops, and improvement practices are not feasible. The soils provide some sustained grazing for farm animals, but the limitations are so severe that improvement by use of farm machinery is impractical. The terrain may be unsuitable for use of farm machinery, or the soils may not respond to improvement, or the grazing season may be very short.

Class 7: Soils in this class have no capability for arable culture or permanent pasture. This class also includes rockland, other non-soil areas, and bodies of water too small to show on the maps.

The capability subclasses express the kinds of limitations that affect the agricultural use of land. The subclasses used for the Cascade area are:

Subclass C: adverse climate - The main limitation is low temperature.

Subclass M: moisture - A low moisture holding capacity caused by adverse inherent soil characteristics limits crop growth (not to be confused with climatic drought).

Subclass P: stoniness - Stones interfere with tillage, planting, and harvesting.

Subclass R: shallowness to solid bedrock - Solid bedrock is less than one metre from the surface.

Subclass T: adverse topography - Either steepness or the pattern of slopes limits agricultural use.

3.6 WILDLIFE INTERPRETATIONS

Habitat information useful for wildlife management and land capability ratings for ungulates are presented in Table 9 for each soil type. For a discussion of present big-game abundance in the study area, refer to section 1.6. The Canada Land Inventory manuals (Perret, 1969; Blower, 1973) and Hazelwood's (1971) ungulate capability map for the study area were consulted in developing the capability ratings.

The classes are defined in terms of the inherent limitations to the production of suitable habitat for ungulates. Habitat characteristics such as vegetation, elevation, climate, and relief associated with each soil type are assessed in the rating. The classification system is based on two important considerations:

- capability ratings are established on the basis of the optimum vegetational stage (successional stage) that can be maintained with good wildlife management practices.
- capability ratings assigned do not reflect present land use, ownership, lack of access, distance from cities, or amount of hunting pressure.

The study area is primarily rated Class 4 to 6 for mule deer, although Rocky Mountain elk, moose, and mountain goat also occur. No ungulate winter range areas or Class 1 to 3 areas appear to exist in the Cascade area. The main limitation affecting ungulate production is winter snow depths. The abundance of forage species affects whether the soil type is rated Class 4, 5, or 6, as shown on Table 9.

3.7 VISUAL ABSORPTION CAPABILITY

Visual absorption capability (VAC) is defined as the biophysical capability of land to maintain visual integrity while supporting management activities (Anderson, 1976). The aim in rating soil types according to their VAC is to determine the inherent ability of land to absorb modification and retain visual quality. In the Cascade study area, this information may be helpful in resolving conflicts between alternative or coexistent uses, such as historic trails and logging activity.

Four factors are used to determine the VAC of a given soil type. First, slope is inversely related to VAC. The rationale is simply that as slope increases, we see increasingly more of the slope surface; flatter slopes feature screening by overlapping objects when viewed from the surface.

Second, as revegetation potential increases, VAC increases. Revegetation potential affects a landscape's ability to recover following disturbance, with the duration of impact greater on soils with a low revegetation potential. Forest capability ratings (Table 7) were used to determine revegetation potential.

Third, soil erosion hazard is inversely related to VAC, as soil erodibility affects the susceptibility of a landscape to visual change. Soils with a high erosion potential can be significantly disturbed following modification, thus exposing soil colours in sharp contrast to adjacent vegetation. Erosional patterns can also result in lines and shapes that are in sharp contrast to natural landscape conditions. Soil erosion hazard ratings are taken from Table 3.

Last, vegetation diversity is directly related to VAC. Briefly, a landscape which manifests a large variety of landscape colours and textures through vegetation will offer features which may be borrowed when modifying an area. Hence modification of a biotically-diverse area will be simpler and less obtruse; modification of biotically-homogeneous areas will be more obvious and therefore difficult to manage visually.

Table 9

SOIL INTERPRETATIONS FOR WILDLIFE

Soil Type	Generalized Ecosystem Unit	Biomass Productivity	Tree Cover	Shrub Cover	Herb Cover	Presence of Forage Species	Dominant Capability Class	Dominant Capability Subclass	Ungulate Indicator Species	Comments
C1	CWHya (m-d)	H	H	M	L	H	4	Q	D	Mainly Douglas-fir canopy on steep slopes
C2	CWHyb (m-d)	H-M	H	M	L	H-M	4-5	Q	D	Mainly Douglas-fir canopy on steep slopes
C3	MHya (m-d)	M-L	H	L-M	L	L	6	Q, V	D, G	Mainly hemlock-fir canopy
C4	ESSFya (m-d)	M-L	H-M	L-M	L	L	6	Q, V	D, E, M	Subalpine forests on steep slopes
C5	ESSFyb (m-d)	L	L	L-M	H	M	4-6	Q	D, E, M	Parkland environments on steep slopes
C6	AT	L	L	L	H	M	4-6	Q	D, G	Alpine environments
C7	Variable	L	L	H	H	H	4-5	Q	D	Avalanche chutes
C8	Variable	L	L	L	L	L	6-7	N	D, G	Talus aprons
F1	CWHyab (w)	H	H	M-H	M-H	H	4	Q	D	Floodplains below 1200 m
F2	ESSFya (w)	M	H	M	M	M-L	5-4	Q	D, E, M	Subalpine floodplains above 1200 m
F3	ESSFya (w)	L	L	L	H	H	4	Q	D, E, M	Wet subalpine meadows
F4	CWHya (d)	M	H-M	L-M	L	H-M	4	Q, N	D	Dry, fluvial soils below 900 m
F5	CWHyb (d)	M	H-M	L-M	L	H-M	4	Q, N	D	Dry, fluvial soils between 900-1200 m
F6	ESSFya (d)	M-L	H	L	L	L	6	Q, V, N	D, E, M	Subalpine forest, seral pine stands common
M1	CWHya (m)	H	H	M	L	H	4	Q	D	Mainly Douglas-fir canopy
M2	CWHyb (m)	H-M	H	M	L	H-M	4-5	Q	D	Mainly Douglas-fir canopy
M3	MHya (m)	M-L	H	L-M	L	L	6	Q, V	D, G	Mainly hemlock-fir canopy
M4	ESSFya (m)	M-L	H-M	L-M	L	L	5-6	Q, V	D, E, M	Subalpine forest
M5	ESSFya (m)	M-L	H-M	L-M	L	L	5-6	Q, V	D, E, M	Subalpine forest in Skaist/Granite area
M6	ESSFyb (m)	L	L	L-M	H	M-H	4	Q	D, E, M	Parkland environments
M7	ESSFyb (m)	L	L	L-M	H	M-H	4	Q	D, E, M	Parkland environments in Skaist/Granite area
R	Variable	L	L	L	L	L	6-7	T, R	G	Bedrock

LEGEND FOR TABLE 9

Generalized Ecosystem Unit

CWHy - transitional coastal western hemlock zone
MHy - transitional mountain hemlock zone
ESSFy - transitional Engelmann spruce-subalpine fir zone
AT - alpine-tundra zone

a - dry subzone (lower elevation)
b - wet subzone (higher elevation)

d - dry (xeric) vegetation types
m - mesic vegetation types
w - wet (hygric) vegetation types

Biomass Productivity

L - Low (forest capability classes 5-7)
M - Moderate (forest capability classes 3-4)
H - High (forest capability classes 1-2)

Tree, Shrub, and Herb Cover

L - Low (less than 20% cover)
M - Moderate (20-50% cover)
H - High (greater than 50% cover)

Presence of Forage Species

L - Low presence
M - Moderate presence
H - High presence

Forage species evaluated (in herb and low shrub layers):
Thuja plicata
Amelanchier alnifolia
Berberis nervosa
Pseudotsuga menziesii
Salix spp.
Paxistima myrsinites
Grasses

Land Capability for Ungulates

The capability classes used are as follows. Class 1 to 3 do not exist in the Cascade area.

Class 1: Lands in this class have no significant limitations to the production of ungulates.

Class 2: Lands in this class have very slight limitations to the production of ungulates.

Class 3: Lands in this class have slight limitations to the production of ungulates.

Class 4: Lands in this class have moderate limitations to the production of ungulates. Capability on these lands is moderate. Limitations are mainly climatic factors (winter snow depths) that limit the mobility of ungulates.

Class 5: Lands in this class have moderately severe limitations to the production of ungulates. Capability on these lands is moderately low. Limitations are climatic factors (winter snow depths) that limit mobility of ungulates, and habitat characteristics that affect availability of food and cover.

Class 6: Lands in this class have severe limitations to the production of ungulates. Capability on these lands is very low. Limitations are similar to those in Class 5, but the degree is greater.

Class 7: Lands in this class have limitations so severe that there is no ungulate production. Non-vegetated talus aprons and exposed bedrock areas are included here.

The capability subclasses express the kinds of limitations that affect ungulate production.

Subclass Q: snow depth - excessive snow depth that reduces the mobility of ungulates and availability of food plants.

Subclass N: adverse soil characteristics - used in Cascade area for rubbly talus aprons or gravelly fluvial soils.

Subclass T: adverse topography - used in Cascade area for steep bedrock areas.

Subclass V: adverse habitat - used in Cascade area for subalpine forests with few forage species.

Species of ungulates for which capability ratings are assigned are shown by the following symbols:

D - Mule Deer
E - Elk
G - Mountain Goat
M - Moose

Parkland areas, which includes krummholz trees, were considered 'high' in vegetation diversity due to the large variety of forest/herb cover over short distances. In the study area, the small wetland and alpine areas were rated 'high' since wetlands are set in a forested landscape and alpine environments contain numerous bedrock outcrops. Conversely, mature subalpine fir/Engelmann spruce forests were rated 'low'. 'Moderate' rated areas were in the coastal western hemlock zone where seral stands of climax species were mixed with other species to lend vegetative diversity.

To calculate the VAC of each soil type, numerical ratings were assigned according to the following table:

Numerical Rating	Slope	Revegetation Potential	Soil Erosion Hazard	Vegetation Diversity
1	> 60%	Low	High	Low
2	30-60%	Moderate	Moderate	Moderate
3	< 30%	High	Low	High

A simple formula was used to determine numerical VAC scores for each soil type:
VAC = slope X (Revegetation Potential + Soil Erosion Hazard + Vegetation Diversity). Numerical VAC scores were subjectively rated as follows:

VAC rating	VAC numerical score
High	21-27
Moderate	11-20
Low	3-10

Results are summarized in Table 10. Where the slope range of a soil type exceeds one rating unit, the VAC rating is given as a range to allow for site variations.

Twelve of the 22 soil types attain a 'low' or 'low to moderate' rating under this classification. This is most striking with the colluvial soils, where a combination of very steep slopes and moderate to high soil erosion hazard results in low VAC ratings. Most of the stream valley sides and mountain slopes in the south half of the study area will fall into this category.

Five soil types have a 'high' VAC. These include the gently-sloped active fluvial floodplains and inactive fluvial terraces, which feature a high to moderate revegetation potential and a moderate vegetative diversity (due to deciduous forest presence along rivers). As well, morainal soils in the coastal western hemlock zone attains a high VAC; this applies especially to the Sowaqua valley bottom. The remaining soil types have a moderate VAC rating.

Table 10

VISUAL ABSORPTION CAPABILITY

Soil Type	Slope (Numerical Rating)	Revegetation Potential (rating)	Soil Erosion Hazard (rating)	Vegetation Diversity (rating)	VAC Numerical Score	VAC Rating
C1	30-75% (1-2)	H (3)	M (2)	M (2)	7-14	low - moderate
C2	30-75% (1-2)	H (3)	M (2)	M (2)	7-14	low - moderate
C3	30-75% (1-2)	M (2)	M (2)	L (1)	5-10	low
C4	30-75% (1-2)	M (2)	M (2)	L (1)	5-10	low
C5	20-75% (1-2)	L (1)	H (1)	H (3)	5-10	low
C6	20-75% (1-2)	L (1)	H (1)	H (3)	5-10	low
C7	30-75% (1-2)	L (1)	H (1)	H (3)	5-10	low
C8	60-75% (1)	L (1)	H (1)	H (3)	5	low
F1	0-10% (3)	H (3)	L (3)	M (2)	24	high
F2	0-10% (3)	M (2)	L (3)	M (2)	21	high
F3	0-10% (3)	L (1)	M (2)	H (3)	18	moderate
F4	0-20% (3)	M (2)	L (3)	M (2)	21	high
F5	0-20% (3)	M (2)	L (3)	M (2)	21	high
F6	0-20% (3)	M (2)	L (3)	L (1)	18	moderate
M1	9-45% (2-3)	H (3)	M (2)	M (2)	14-21	high - moderate
M2	9-45% (2-3)	H (3)	M (2)	M (2)	14-21	high - moderate
M3	9-45% (2-3)	M (2)	M (2)	L (1)	10-15	moderate - low
M4	9-45% (2-3)	M (2)	M (2)	L (1)	10-15	moderate - low
M5	9-45% (2-3)	M (2)	M (2)	L (1)	10-15	moderate - low
M6	9-45% (2-3)	L (1)	M (2)	H (3)	12-18	moderate
M7	9-45% (2-3)	L (1)	M (2)	H (3)	12-18	moderate

* A range in numerical score occurs to allow for variation in slope within a soil type. For specific areas, the map should be consulted to indicate slope values.

3.8 SUMMARY

Generalized land use interpretations for each soil type are shown on Table 11. This summary table allows for some degree of comparison of resource capabilities and resource sensitivities. Refer to Tables 4 to 10 and the previous sections of this chapter for additional information on how interpretations were derived, limitations in their application, and supporting interpretive data.

Table 11 compares and evaluates resources for which interpretations have been made. For a more complete comparison, other resource data must be evaluated, and this should be done before preparing a comprehensive land use plan and considering resource trade-offs. For example, non-soil related information on recreation features such as historic trails, mature stands of commercial timber, and fisheries values must be addressed. Also, comparison of resource values requires analysis of socio-economic considerations. Before these kinds of land suitability evaluations can be undertaken, however, an understanding of land capabilities is required.

It is possible to prepare generalized interpretive maps based on information provided on Table 11. Figure 6 showing generalized land capability for forestry, and Figure 7 showing erosion potential and engineering suitability are but examples. More specific interpretive maps can be prepared by colouring soil types on the soil map according to interpretations prepared on Tables 4 to 10.

Also, by reviewing Table 11 and supportive interpretive information on Tables 4 to 10 in conjunction with the soil maps, much information can be obtained for locations of interest within the Cascade study area. Soil type F4 is evaluated below as an example of what can be done for each soil type by using this report.

Table 11 indicates that soil type F4 has good properties for most engineering and has a high recreation carrying capacity (e.g. these soils can be developed easily). Moderate capabilities exist for forestry and ungulates, and low capabilities for agricuture indicate limited grazing opportunities exist.

Supportive data on soil type F4 provided elsewhere in the report indicate that they are gravelly fluvial soils on dry (xeric), gently sloping sites in the transitional coastal western hemlock dry subzone (below 900 m elevation). Vegetation on most sites consists of Douglas-fir stands with western hemlock in the understory. Western white pine, lodgepole pine, and western red cedar can also occur. Common forage shrubs include Amelanchier alnifolia, Berberis nervosa, and Paxistima myrsinites.

Soil type F4 is physically well suited for most kinds of development. These soils have only slight limitations for trails and campgrounds. They are good to excellent sources of sand and gravel, and subgrade material; they have slight limitations only for logging roads, and have low potential for soil erosion. Also, these soils have a high visual absorption capability which means that the visual impact of development can be readily minimized with proper planning.

Table 11

GENERALIZED LAND USE INTERPRETATIONS

Soil Type	CAPABILITY FOR: Agriculture*	Forestry*	Ungulates*	Engineering** Suitability	Recreation Carrying Capacity	Visual Absorption Capability	Soil Erosion Hazard
C1	N	H-M	M	M	M-L	L-M	M
C2	N	M	M-L	M	M-L	L-M	M
C3	N	M-L	L	M	M-L	L	M
C4	N	M-L	L	M	M-L	L	M
C5	L-N	L	M-L	M-L	L	L	M-H
C6	L-N	N	M-L	L	L	L	H
C7	L-N	N	M-L	L	L	L	H
C8	N	L-N	L-N	M-L	L	L	H
F1	L	H	M	M	M-L	H	L-M
F2	L	M	M-L	M	M-L	H	L-M
F3	L	N	M	L	L	M	M
F4	L	M-L	M	H	H	H	L
F5	L	M-L	M	H	H	H	L
F6	L-N	M-L	L	H	H	M	L
M1	L-N	H	M	H-M	H-M	H	M
M2	L-N	H-M	M-L	H-M	H-M	M	M
M3	N	M-L	L	H-M	H-M	L-M	M
M4	N	M-L	M-L	M	H-M	L-M	M
M5	N	M-L	M-L	M	H-M	L-M	L-M
M6	L	L	M	M	M-L	L-M	M
M7	L	L	M	M	M-L	M	M
R	N	N	L	L	L	L	L-H

* H high = C.L.I. Classes 1-2
M moderate = C.L.I. Classes 3-4
L low = C.L.I. Classes 5-6
N nil = C.L.I. Class 7

**assessed according to logging road limitations, where:
H high = slight limitations
M moderate = moderate limitations
L low = severe limitations

Soil type F4 is rated C.L.I. Class 3-4 for forestry, with excessive stoniness and soil moisture deficiency being the main limitations to forest growth. Douglas-fir appears to be the most suitable species for reforestation. Agriculture capability is C.L.I. Class 6 with similar kinds of limitations. Thus, these soils are only capable of supporting limited, seasonal grazing.

F4 soils have C.L.I. Class 4 rating for mule deer use. They are limited by snow depths in the winter months. The stony, relatively infertile conditions of the soil also limit forage quantity and quality.

Figure 6
GENERALIZED LAND CAPABILITY FOR FORESTRY

A given capability class is a grouping of soils that have a similar inherent ability to grow commercial timber. The classes are defined in terms of soil characteristics and expected productivity levels.

HIGH CAPABILITY (CLI CLASSES I and 2)

Lands having few to slight limitations to the growth of commercial forests. Soils are deep, well to moderately well drained and have good water holding capacity. Topographic position is generally lower slopes and toe-slopes. Limitations are usually climate-related. Productivity exceeds 6.4 m^3/ha/year*.

MODERATE CAPABILITY (CLI CLASSES 3 and 4)

Lands having moderate to moderately severe limitations to the growth of forests. Soil characteristics are variable. Common limitations include adverse climate and periodic moisture imbalances. Productivity from 3.6 to 6.3 m^3/ha/year.

LOW CAPABILITY (CLASSES 5 and 6)

L

Lands having severe to very severe limitations to the growth of forests. Soils are frequently shallow, stony and well to rapidly drained. Limitations are adverse climate due to high altitude, shallowness of soil and deficiency of moisture. Productivity from 0.8 to 3.5 m^3/ha/year.

NIL CAPABILITY (CLI CLASS 7)

N

Lands having no capability to grow commercial forests. Alpine areas, talus slopes, and avalanched areas are included here.

* More detailed forest capability interpretations are available for each soil type in the Cascade Soil Survey report by Vold and Daykin (1980).

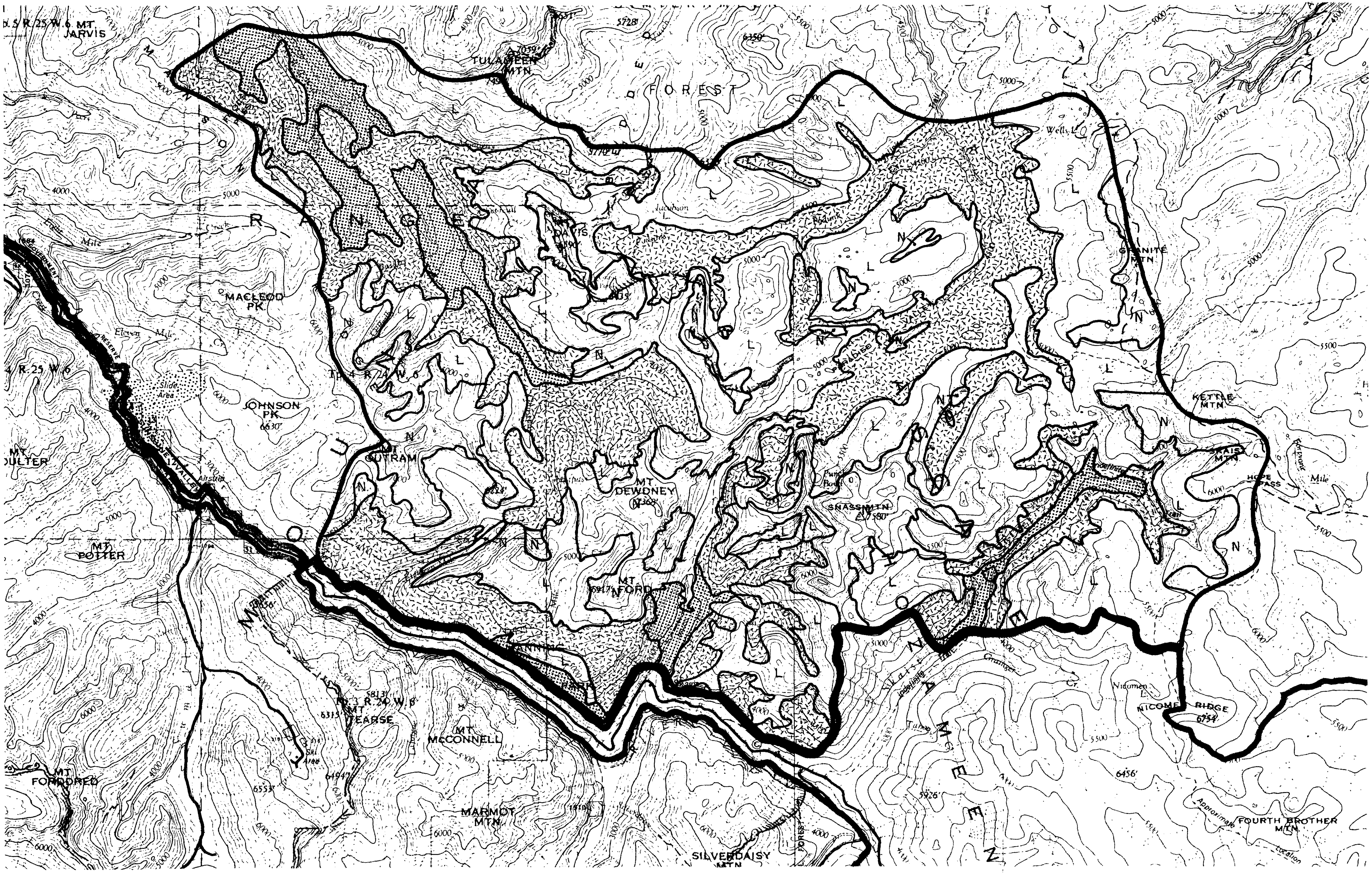

MT. JARVIS
TULAMEEN MTN
FOREST
MACLEOD PK
JOHNSON PK
6630'
MT. COULTER
MT. OUTRAM
MT. DEWDNEY
MT. POTTER
MT. FORD
SNASS MTN
GRANITE MTN
KETTLE MTN
HOPE PASS
NICOMEN RIDGE
6754'
MT. TEARSE
MT. McCONNELL
MT. FORDORED
MARMOT MTN
SILVERDAISY MTN
FOURTH BROTHER MTN
6456'
5926'
6553'
6494'
5813'
6315'
T. 4 R. 25 W. 6
T. 3 R. 25 W. 6
Slide Area
Eleven Mile Cr.
Wells L.
Nicomen L.
Grainger Cr.
Approximate Location
R A N G E
L
N

Figure 7

EROSION POTENTIAL / ENGINEERING SUITABILITY MAP

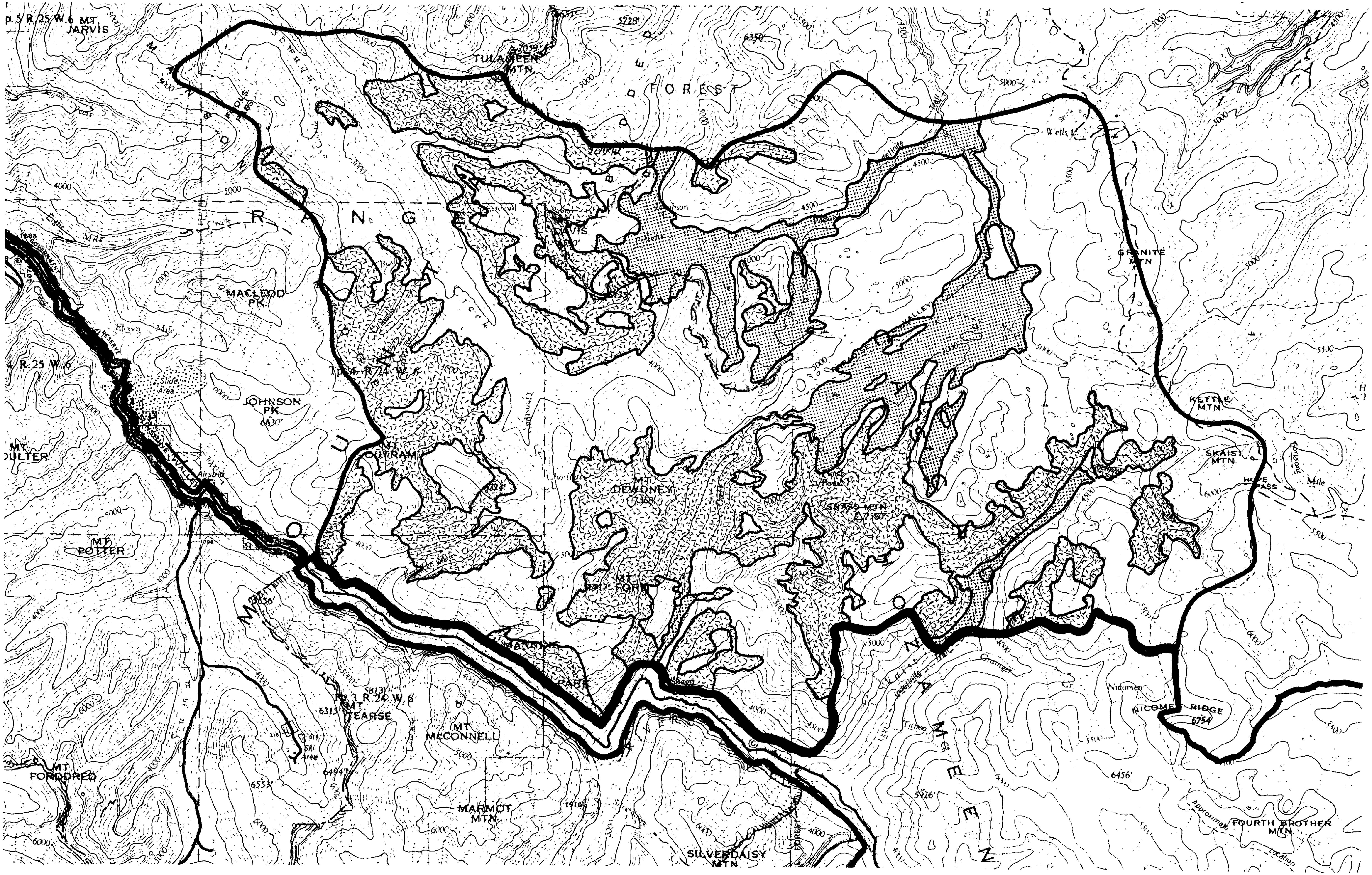
This map aims to provide two contrasting interpretations useful for engineering/planning purposes. Interpretive methods are explained in the Cascade Soil Survey report by Vold and Daykin (1980).

AREAS WITH HIGH SOIL EROSION POTENTIAL

Refers to soils which will be highly susceptible to erosion if disturbed. In the study area, this includes all very steep slopes (>70% or 9-10 slope class), colluvial slopes in alpine areas, talus slopes and avalanched slopes.

AREAS PHYSICALLY SUITABLE FOR DEVELOPMENT

Based on those soils interpreted as offering 'slight' limitations to logging road construction and maintenance. Soils included in this class are fluvial terraces and morainal materials on slopes less than 15% (slope classes 1 to 5). These materials have good subgrade, are deep, and well to rapidly drained.


MT. JARVIS
TULAMEEN MTN.
FOREST
RANGE
MACLEOD PK.
JOHNSON PK.
MT. COULTER
MT. POTTER
MT. OUTRAM
MT. DEWDNEY
SNASS MTN.
MT. FORK
GRANITE MTN.
KETTLE MTN.
SKAIST MTN.
HOPE PASS
NICOMEN RIDGE
MANNING PARK
MT. TEARSE
MT. McCONNELL
MT. FORDORED
MARMOT MTN.
SILVERDAISY MTN.
FOURTH BROTHER MTN.
Wells L.
Slide Area
Airstrip
Nicomen L.
Approximate Location

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APPENDIX 1

VEGETATION OCCURRENCE BY GENERALIZED ECOSYSTEM UNIT

	CWHya mesic	CWHyb mesic	MHya mesic	ESSFya mesic	ESSFyb mesic	CWHy dry	CWHy wet	ESSFya dry	ESSFya wet
TREES									
Abies amabilis	U	VC	VC	O	U	C	VC	C	U
Abies lasiocarpa		U	U	VC	VC	U		VC	VC
Picea engelmannii			U	VC	VC	R		C	C
Pinus contorta				O		U		O	U
Pinus monticola	U	U		U		O		O	
Pseudotsuga menziesii	VC	VC				VC	C	C	
Thuja plicata	VC	VC				O	VC	O	
Tsuga heterophylla	VC	VC				VC	VC		
Tsuga mertensiana		U	VC	U	U			U	U
SHRUBS									
Acer circinatum	O	U				O	O		
Acer glabrum	O	U				O	U		
Alnus sinuata	O	U				U	U		
Amelanchier alnifolia	U	U				C		O	
Berberis nervosa	C	O				C	U	U	
Linnaea borealis	U	U				C			
Menziesia ferruginea	O	O	VC	U	U	O	O	U	U
Oplopanax horridus		U					O		
Paxistima myrsinites	VC	O		U	U	VC	U	VC	
Phyllodoce empetriformis			U	U	C				U
Rhododendron albiflorum			C	O	O				U
Ribes lacustre				C	U		U		
Rubus parviforus	U	U				U	O		U
Rubus pedatus		U	VC	O			O		C
Rubus spectabilis							O		
Sorbus scopulina/sitchensis		U	VC	O	O		O	U	
Taxus brevifolia	O	U				U			
Vaccinium alaskaense/ovalifolium	O	O	U			U	O		U
Vaccinium caespitosum				U	O				U
Vaccinium membranaceum	C	C	C	C	O	C	O	C	VC
Vaccinium scoparium				O	O			U	C
HERBS									
Actaea rubra							O		
Anemone occidentalis					O				
Arnica latifolia			O	C	O			U	
Asarum caudatum							C		
Chimaphila umbellata	C	O				VC	U	O	
Clintonia uniflora	C	O		U		O	C		
Cornus canadensis	O	U					O	U	
Fragaria sp.	U	U						O	
Galium boreale		U				U	O		
Goodyera oblongifolia	O	O				O			
Lupinus spp.		U		U	O			C	C
Phlox diffusa					O				
Pyrola spp.	C	O		U		O	O	U	

HERBS cont.d	CWHya mesic	CWHyb mesic	MHya mesic	ESSFya mesic	ESSFyb mesic	CWHy dry	CWHy wet	ESSFya dry	ESSFya wet
Ranunculus spp.					0				
Smilacina stellata	0	U	U	U			0		
Tiarella unifoliata		0	0	0		U	VC	U	0
Valeriana sitchensis			C	C	0				C
Veratrum viride			0	0	0				
FERNS									
Athyrium filix-femina		U	U			U	C		
Gymnocarpium dryopteris		U	U				0		
Pteridium aquilinum	C	0				U			
No. of Plots per Unit	4	10	3	17	10	7	5	4	3
No. of species which are common or occasional:									
Trees	3	4	2	4	2	5	4	7	2
Shrubs	9	5	5	6	6	8	9	3	3
Herbs and Ferns	7	6	4	4	7	4	10	3	3

Notes:

VC - Very Common: >90% of plots have species.
C - Common: 66-90% of plots have species.
0 - Occasional: 33-65% of plots have species.
U - Uncommon: 1-32% of plots have species.
blank - species was not found in any plot.

Due to recent subzone symbol changes employed by the B.C. Ministry of Forests, (Klinka and Mitchell, pers. comm.), the following correlation exists:

CWHya = CWHc
CWHyb = CWHd
MHya = MHb
ESSFya = ESSFf
ESSFyb = ESSFfp
AT = ATb

APPENDIX 2

GUIDE FOR ASSESSING SOIL LIMITATIONS FOR CAMPGROUNDS AND PICNIC SITES*

SOIL PROPERTY AFFECTING USE	DEGREE OF SOIL LIMITATION		
	SLIGHT	MODERATE	SEVERE
Drainage Class[1] (Wet)[2]	Well to Moderately Well Drained	Imperfectly Drained	Poorly to Very Poorly Drained
Flooding (Flood)	None	None during season of use	Floods during season of use
Slope	0-9%	9-15%	> 15%
Texture[1]	SL, FSL, VFSL, L	SiL, CL, SCL, LS, SiCL, sand other than loose sand	SC, SiC, C, loose sand subject to severe blowing, organic
Coarse fragments (CF)	0-50%	50-75%	> 75%
Rockiness[3] (Rock)	Rock exposures cover less than 5% of area	Rock exposures cover from 5 to 20% of area	Rock exposures cover more than 20% of area
Depth to Bedrock (depth)	> 1 m	0.5-1.0 m	< 0.5 m

GUIDE FOR ASSESSING SOIL LIMITATIONS FOR TRAILS AND PATHS*

SOIL PROPERTY AFFECTING USE	DEGREE OF SOIL LIMITATION		
	SLIGHT	MODERATE	SEVERE
Drainage Class[1] (Wet)[2]	Well to Moderately Well Drained	Imperfectly Drained	Poorly and Very Poorly Drained
Flooding (Flood)	None	Light floods can occur every 3-4 years	Floods more frequently than every 3-4 years
Slope	0-15%	15-70%	> 70%
Texture[1]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS	SC, SiC, C, S, organic
Coarse Fragments (CF)	0-50%	50-75%	75% +
Rockiness[3] (Rock)	Rock exposures cover < 20% of area	Rock exposures cover from 20-50% of area	Rock exposures cover > 50% of area
Depth to Bedrock (depth)	> 50 cm	10-50 cm	< 10 cm

* These tables adapted from Montgomery and Edminister (1966).
1 See Walmsley et al. (1980) for definitions.
2 The abbreviations in brackets are used in Table 4 to indicate limitations.
3 Each mapping unit must be considered separately to determine the amount of rock in the unit, therefore, rockiness is not considered in Table 4.

GUIDE FOR ASSESSING RECREATIONAL CARRYING CAPACITY*

SOIL PROPERTY AFFECTING USE	LIMITATION CLASSES[1] NONE TO SLIGHT	MODERATE	SEVERE
Texture[2] -fine (> 2 mm)	S^{f1}: L	S^{f2}: CL, SiCL, SCL, SiL	S^{f3}: SC, SiC, C
-coarse	S^{c1}: SL	S^{c2}: LS	S^{c3}: S
Coarse Materials (> 10 cm)	S^{b1}: < 25%	S^{b2}: 25-50%	S^{b3}: > 50%
Bedrock/Rockiness[3]	S^{r1}: Rock exposures < 25% of area	S^{r2}: Rock exposures 25-50% of area	S^{r3}: Rock exposures > 50% of area
Depth to Impervious Layer	S^{s1}: > 1 m	S^{s2}: 0.5-1.0 m	S^{s3}: 0.1-0.5 m
Depth to Bedrock	S^{k1}: > 1 m	S^{k2}: 0.5-1.0 m	S^{k3}: 0.1-0.5 m
Drainage: Wet	S^{w1}: Moderately well drained	S^{w2}: Imperfectly drained	S^{w3}: Poorly and very poorly drained
Dry	S^{m1}: Well drained	S^{m2}: Rapidly drained	
Surface Organic Accumulation	S^{o1}: < 15 cm of organic matter	S^{o2}: 15-40 cm of organic matter	S^{o3}: > 40 cm of organic matter
Flooding	H^{i1}: no flooding hazard	H^{i2}: some flooding may take place during high rainfall event or snowmelt period	H^{i3}: flooding may occur in response to limited rainstorms of overnight duration; area not accessible during spring melt or high rain periods

Slope				
T^{s1}: 0-2%	T^{s2}: 3-15%	T^{s3}: 16-30%	T^{s4}: 31-60%	T^{s5}: > 60%

Other Limitations:

- S^u: unspecified soils or landform factor.
- L^g: gullying.
- L^f: failing slope.
- L^a: avalanching.
- L^p: periglacial processes.
- L^u: unspecified landform modifying process

* This table is adapted from Block and Hignett (1976).

1 The symbols for limitation classes (e.g. S^{f1}) are used in Table 4.

2 See Walmsley et al. (1980) for definitions.

3 Each mapping unit must be considered separately to determine the amount of rock in the unit, therefore, rockiness is not considered in Table 4.

GUIDE FOR ASSESSING POTENTIAL FROST ACTION

Potential frost action pertains to the heaving of soil as freezing progresses and to the excessive wetting and loss of soil strength during thaw. Soils that are high in silt have the highest potential for frost action. Potential frost action ratings should be considered when selecting sites for roads or structures that are to be supported or abutted by soil that freezes.

ITEMS AFFECTING USE[1]	LOW[2]	MODERATE[2]	HIGH
Unified Soil Class	GW, GP, SW, SP	GM, GC, SM, SC, CH, OH	ML, CL MH, OL
CDA Soil[3] Texture	s, ls, sl	c, sic, scl, sc	si, sil, sicl, l, cl, fsl
Soil Temperature Class	mild to cool	cold	very cold

[1] Potential frost action ratings for each soil type ae given on Table 6.
[2] These soils are rated one class higher when imperfectly to poorly drained.
[3] Gravel and other coarse fragments in soils tend to reduce the potential for frost action, particularly if the content of such materials is high. Textural symbols according to Canada Soil Survey Committee (1978).

GUIDE FOR ASSESSING SOIL SUITABILITY FOR SAND AND GRAVEL

The ratings are designed to point out the probability of sizeable quantities of sand and/or gravel. The main purpose of the ratings is to guide users to local sources since these materials are expensive to transport.

ITEMS AFFECTING USE[1]	DEGREE OF SOIL SUITABILITY			
	GOOD	FAIR	POOR	UNSUITED
Unified Soil Class	GW, GP, SW, SP	SW-SM SP-SM GP-GM GW-GM	GM, GC, SM, SC	All Other Groups
Depth	> 200 cm	100-200 cm	50-100 cm	< 50 cm
Boulders	< 5%	5-10%	10-50%	> 50%
Flooding Hazard	None	Rare	Occasional	Frequent
Drainage	Rapidly, well and moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained

[1] Soil suitability ratings for sand and gravel are given for each soil type on Table 6. The relative percent of sand and gravel can be inferred from soil texture and Unified soil group.

GUIDE FOR ASSESSING SOIL LIMITATIONS FOR LOGGING ROADS

ITEM AFFECTING USE	DEGREE OF SOIL LIMITATION SLIGHT	MODERATE	SEVERE
Drainage	Rapidly, well, and moderately well drained	Imperfectly drained	Poorly and very poorly drained
Subgrade: (a) AASHO Group Index	0-4	5-8	more than 8
(b) Unified Soil Class	GW, GP, GC, GM, SW, SP, SC, SM	ML CL (PI<15)[1]	MH, CH, CL (PI>15)[1], OH, OL, PT
Slope (Slope Class)	0-15% (1-5)	16-70% (6-8)	> 70% (9-10)
Flooding Hazard	None	Rare or occasional (less than once in 5 years)	Frequent (more than once in 5 years)
Depth to Bedrock	Deep (> 100 cm)	Shallow (50-100 cm)	Thin (< 50 cm)
Rockiness	Bedrock cover < 10% surface	Bedrock cover 10-50% surface	Bedrock cover > 50% surface
Boulders	<10%	10-50%	>50%
Frost Action (Heaving)	Low	Moderate	High, active cryoturbation
Geologic Hazards (e.g. avalanching)	Absent	Present, Infrequent	Present, Active

[1] PI refers to Plasticity Index.

GUIDE FOR ASSESSING SOIL LIMITATIONS FOR POTENTIAL EROSION HAZARD

Erosion is used here to describe the process whereby soil is detached and subsequently transported downslope by running water. The ratings indicate the potential of a soil for erosion once disturbed; for example, once vegetation is removed from the site. Potential soil erosion hazard is important to consider since erosion can result in soil losses, a decline in soil productivity damage to structures and roads, and sedimentation of nearby streams and rivers. Most of the items considered relate to the ability of soil to absorb precipitation and prevent the detachment of soil particles. Gravel tends to be resistant to detachment, whereas silt-sized particles are most easily detached. The forest floor protects the mineral soil from direct contact with the forces of precipitation and running water and thus help bind the soil. Slope affects the speed of running water on the soil surface.

ITEM AFFECTING USE[1]	DEGREE OF SOIL LIMITATION		
	SLIGHT	MODERATE	SEVERE
Drainage (Wet)[1]	Rapidly to well drained	Moderately well to imperfectly drained	Poorly to very poorly drained
Unified Soil Class (Text)	GW, GP, SW, SP	GM, GC, SC, SM, OH, CH	ML, CL, OL, MH
Permeability[2] Class (Perm.)	Rapid	Moderate	Slow
Depth to Impermeable Layer (Depth)	> 100 cm	50-100 cm	< 50 cm
Forest Floor Thickness (Litter)	> 5 cm	1-5 cm	< 1 cm
Slope (Slope Class)	< 16% (1-5)	16-70% (6-8)	> 70% (9-10)
Erosional Processes	Absent	--	Active (e.g. cryoturbation, avalanched, rockfalls)

1 The abbreviations in brackets are used in Table 6 to indicate the nature of the limitation.
2 Permeability class inferred from soil texture, structure, and soil development.
3 This includes depth to bedrock or other impervious material.