

UTZIG

RESOURCE INVENTORY  
OF  
ARGENTA-JOHNSON'S LANDING WATERSHEDS

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## I. INTRODUCTION

### 1.1 Natural Resource Inventory: A Tool for Land Use Planning

The basic requirements of food and shelter make all people completely dependent on the ultimate resources: land and water. Human population growth and changes in lifestyles have brought ever increasing demands for the earth's natural resources including energy, water, food, and building materials. It has become evident however, that the supply of these resources is limited. Even the "renewable resources" such as wood and water can only be supplied in quantities determined by the sustainable production capacity of the land base. If the yields of the resources are to be maximized and/or sustained, there has to be more consideration given to determining the productive potential of land for various uses, and developing land management plans which optimize land use over the long term. The land manager has to recognize the interaction between resource sectors and guard against maximizing the production of one resource while destroying another.

The first step in formulating any long-term management plan is an inventory of what resources exist in an area including their: quantity, quality, spatial distribution and ecological relationships. From this basic inventory data the capability and suitability for various resource uses are recognized, and a range of management options are formulated. The political process then determines which options suit societies' needs best (adapted from Utzig 1978).

### 1.2 Recent Land Use Conflicts in the Argenta-Johnson's Landing Watersheds

The continuing demand for timber from British Columbia and the Kootenay Lake Timber Supply Area in particular is a recognized fact. However, simultaneously residents of the Argenta-Johnson's Landing area are utilizing water flowing from these watersheds for both domestic and agricultural needs. Until recently, timber stand ages and economics of harvesting have made the area less than attractive for timber development, except on a very limited basis.

In 1971 Kootenay Forest Products Ltd. (now a division of BC Timber Ltd.) in Nelson, announced plans to harvest timber in Carter Creek, an important water source for some residents of Argenta. The residents were legitimately concerned that road construction and timber harvesting might adversely affect their water supply. In addition, concerns were raised regarding social issues such as the safety of log-hauling through the community and the long-term development plan for the Argenta-Johnson's Landing watersheds as a whole. The conflict in Carter Creek was slowly resolved, some logging proceeded, and water continued to flow.

The issue did force the community to realize that even they were not remote enough to escape development. The community pressured the Ministry of Forests to accept further public involvement and the concept of Regional Planning for the area as a whole, based on resource inventory data of suitable precision and reliability (i.e., the "folio system" plus minimum data standards). The Argenta Folio Area, as it was then called, included all watersheds flowing into Kootenay Lake between and including Hamill and Clute Creeks.

Between 1975 and 1980 all available data relating to the resources of the folio area was compiled by the local residents and the Ministry of Forests. Upon reviewing the folio maps generated, it became clear that there were information deficiencies related to hydrologic regimes, soils, timber, and vegetation. In 1980 Kootenay Forest Products Ltd. and the Ministry of Forests initiated studies to upgrade information related to hydrology, timber, soils, and vegetation of the area. These involved the establishment of cruise strips and preliminary road corridors by Kootenay Forest Products Ltd. and terrain mapping and hydrologic sampling by the Ministry of Forests.

### 1.3 Objectives and Terms of Reference

After review of the 1980 work, early in 1981 the Ministry of Forests decided to expand the program to a point that logging development could begin in the near future. The 1981 program included:

- 1) Hydrology study to establish base line hydrologic data, provide information for development planners and evaluate potential impacts on water supplies.
- 2) Silvicultural study to evaluate timber stands and recommend silvicultural treatments.
- 3) Terrain, soil, and vegetation study (described in this brief report and accompanying maps).

The objectives of the terrain, soil, and vegetation study are listed below:

- 1) To provide maps and accompanying descriptive legends of terrain, soil, and vegetation of the map area (scale 1:15,840).
- 2) To provide interpretations of the resource data to aid in forest management planning and selecting forest harvesting systems.
- 3) To provide data and interpretations for assessing potential conflicts between forest harvesting and water users.

The terms of reference are listed below:

- 1) The study area would include the watersheds draining into Kootenay Lake between and exclusive of Hamill and Fry Creeks.
- 2) Sampling would be most intensive in the subareas specified by the Ministry of Forests as likely development areas (see Figure 1.1).
- 3) Areas above 1 950 m in elevation were to be mapped using airphoto interpretation and minimal sampling.
- 4) Maps would be produced at a scale of 1:15,840 and 1:50,000 where applicable.
- 5) Field work would be limited to the 1981 field season and constrained by available helicopter budget. Data thus collected would be complemented with 1980 data.
- 6) Field work would be coordinated with the Regional Ecological Classification Program and the results compatible with their classification system.
- 7) Road corridors as specified by Kootenay Forest Products Ltd. were to be examined and evaluated on the ground.

#### 1.4 Guide to the Study Results

The study results are presented with a variety of formats which are described below. The majority of the information is displayed in the map series, however, additional written materials are found in the report and unpublished data is on file with the Ministry of Forests.

- a) Primary Data Maps: These maps will be of interest to all users for general information, however, the interpretative maps are more directly applicable. The primary data maps can be used to establish new interpretations not presented in the study (Figures 1.1 - 1.5).
  1. Plots and Field Checks (1:50,000); distribution and types of field samples.
  2. Bedrock Geology (1:50,000); distribution and types of bedrock; diagrammatic cross-section.
  3. Biogeoclimatic Subzones (1:50,000); distribution of subzones; table of tree species occurrence; diagrammatic cross-sections.

4. Terrain (1:15,840); distribution and characteristics of surficial materials; genetic material, texture, surface expression, modifying processes.
  5. Soils and Vegetation (1:15,840); distribution and characterization of soils; parent material (terrain), depth, % coarse fragments, texture, soil development, nutrient regime, moisture regime, depth of LFH; distribution and characterization of vegetation, species list, successional stage, Biogeoclimatic subzone, moisture regime; soil-vegetation correlation.
- b) Interpretive Maps: these maps present information in a refined form which should be applicable to most users. Additional information regarding the interpretations can be found in Chapter IV (Figures 1.6 - 1.8).
6. Interpretations for Predicting Hydrologic Impacts (1:15,840); distribution of hydrologic features; mass wasting hazard; surface erosion hazard; sediment delivery hazard; vegetative-hydrologic recovery rates.
  7. Engineering Features (1:15,840); distribution of slope classes; slope configurations; bedrock occurrence; bedrock rippability; occurrence of construction materials (aggregate sources).
  8. Forest Capability (1:15,840); distribution of forest capability classes; distribution of limitations for forest management.
- c) Report: The materials presented in the report are summarized in the table of contents. Sections of specific concern to most users are:
- 1) Methods: Chapter III explains how the data was collected, analyzed and interpreted. It is essential that all users read this chapter to gain an appreciation of the limitations inherent in the data and interpretations presented.
  - 2) How to Use the Results: This information is presented in this section (1.4) and in Chapter IV. These sections will be especially helpful to users unfamiliar with natural resource inventories.
  - 3) Results and Interpretations: Information not presented in the maps described above can be found in Chapters IV and V.
  - 4) General Information: Material present in Chapters I and II will familiarize the user with the study area and the purpose and scope of the study itself.

- d) Raw Field Data: This information may be of concern to users wishing to prepare additional interpretations or to evaluate this study's methodology. The following materials are on file with the Regional Pedologist, Nelson Forest Region, B. C. Ministry of Forests, 518 Lake Street, Nelson, B. C., V1L 4C6.

1. Typed airphotos and associated polygon data
2. Field plot sheets and notes
3. Raw computer output
4. Draft maps
5. Laboratory results

- e) Mapping Limitations: Maps are merely two-dimensional representations of the landscape; they are not a true-to-life reproduction of the landscape, complete with full detail. The user should be aware that mapping projects generally assume that an acceptably accurate map unit may include up to 15% of undescribed components. Basically, it has been concluded that 85% accuracy is about the best that can be achieved given normal financial constraints and landscape complexity. The map unit boundaries of this study are primarily based on airphoto interpretation with field checking as indicated in Figure 1.1. Potential sources of mapping errors include: mapper judgement, outdated and poor quality airphotos, inaccurate base maps, Kail plotting errors due to rugged topography, drafting errors and printing distortion. The interpretations are a further step of abstraction from the real landscape and can be no more accurate than the base data maps they are prepared from. It is essential that the user familiarize him/herself with the methods used to prepare the maps and realize that for critical decisions maps are no replacement for on-site inspection.

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## II. STUDY AREA DESCRIPTION

### 2.1 Location and Physiography

The Argenta-Johnson's Landing watersheds are located on the west flank of the Purcell Mountains of southeastern British Columbia (50°03'-13'N latitude; 116°48'-57'W longitude). The topography consists of west-facing slopes ranging from an elevation of 2 750 m at Mt. Willet to 535 m at Kootenay Lake along the western edge (see Figure 1.1). The upper elevations are dominated by a series of steep-sided cirque basins and intervening horns, aretes, and cols at the headwaters of Argenta, Bulmer's, Salisbury, and Kootenay Joe Creeks. The mid-elevations are composed of moderately to steeply sloping fluted topography dissected by a series of deeply incised, steep gradient stream channels. The lower slopes include areas of terraced valley train materials, steep rock bluffs dropping into Kootenay Lake and minor fluvial fan-deltaic areas at the stream mouths. The study area is 17.5 km long (N-S) and 6 km wide (E-W), with a total area of approximately 80 km<sup>2</sup>.

### 2.2 Bedrock Geology

The bedrock of the study area is dominated by low to medium grade metasediments including mica schists, quartzites, limestone, and dolomite. Intrusive quartz monzonite is found south of Kootenay Joe Creek. The metasediments belong to a regional structural belt known as the Kootenay Arc, specifically the Hamill group, Mohican and Badshot Formations, and the Lardeau Group. The sediments were deposited during the lower Palaeozoic and metamorphosed, folded and faulted during the Mesozoic. The rock strata generally are steeply dipping and strike NNW-SSE. They are complexly folded and faulted along a similar trend (NNW-SSE), plunging to the NNW. The area south of Kootenay Joe Creek is dominated by the Fry Creek Batholith, which was intruded during the Cretaceous. (Fyles 1964 and Reesor 1973). A more detailed discussion of the rock types is presented in Chapter IV. (See Figure 1.2).

### 2.3 Regional Pleistocene Setting

The surficial materials and topographic character of the study area are a reflection of the last major Pleistocene glaciation (termed the Pinedale in the Rocky Mountains of the United States or the Fraser at Coastal British Columbia). During this glacial interval coalescing ice sheets from the Coast and Columbia Mountains formed an ice dome over the interior plateau of central British Columbia. From this accumulation area, ice flowed south through the Kootenay valley, unto the Columbia plateau of Washington state (Clague 1981).

The timing of the last major ice advance of interior British Columbia has been reasonably well established for the Kootenay area. A maximum radiocarbon date for its onset near Lumby is 19,100+ 240y B.P. and near Trail 17,240+ 330y B.P. (Clague 1981). The Kootenay valley would have been occupied with a regional ice flow sometime between these dates, with accompanying advances from local source areas as well. Radiocarbon dates from Washington state indicate that deglaciation began by 13,000y B.P. Upland areas, except local source areas, became ice-free first, while the main Kootenay valley was not ice-free until approximately 10,000y B.P. (Clague 1981).

Deglaciation was accomplished initially by downwasting of an active Kootenay valley ice mass, exposing ice-free uplands. This was accompanied by downwasting and retreat of local tributary glaciers from Hamill and Fry Creeks and the cirque basins within the study area. Eventually this was followed by stagnation, further downwasting and retreat of the valley ice itself. The glaciofluvial and glaciolacustrine deposits on the lower slopes and benches of the study area were deposited and dissected during the final stagnation and downwasting phases as meltwaters flowed along the melting ice. The extensive colluvial and localized fluvial materials have been deposited since deglaciation.

## 2.4 Climate

Regional climate information provides an overall framework of expected temperatures, precipitation, winds and seasonal patterns, however, in mountainous terrain the variation due to local conditions can be highly significant. For any given position, local valley climate varies with aspect, elevation, slope position and the influence of adjacent landscape features such as mountain masses (shading effect), glacier ice or water bodies. Sites on southerly aspects are significantly warmer than level sites of equivalent elevation or sites on northerly aspects because of increased solar radiation. Valley bottom positions are likely to be slightly warmer during the day and distinctly colder at night than equivalent elevations in a midslope position because of restricted air movement along the valley floor (i.e., cold air pooling and inversions).

The study area is located in the southern portion of the "interior wet belt". Seasonally, the climate is dominated by easterly moving Pacific-coastal air masses, which lose the last major portion of their moisture in this area prior to crossing the Purcell Mountains. During the winter, polar air moving south through the Kootenay and Columbia valley systems inundates the area for short periods. During the summer, hot dry air occasionally moves into the area from the Columbia plateau in the United States. The general patterns of temperature and precipitation are typical for mountainous terrain, with increases in mean annual precipitation and decreases in mean annual temperature coincident with increasing elevation.

Table 2.1 Local climatic data

Table 2.1 Local climatic data (summarized from: Environment Canada 1975, B. C. Ministry of Agriculture 1958, Connor 1949)	Howser	Lardeau	Kaslo 1	Kaslo 2	Sandon
Elevation (metres)	571	550	588	588	1067
Years of data (or adj.-normalized)	13	adj.	30	44	adj.
Mean annual temperature ( $^{\circ}\text{C}$ )	6.7	7.0	7.0	6.7	--
Mean summer temp. ( $^{\circ}\text{C}$ , May-Sept.)	14.7	14.7	14.9	14.7	--
Mean temp. warmest month ( $^{\circ}\text{C}$ )	18.3	17.7	18.1	17.8	--
Mean Winter temp. ( $^{\circ}\text{C}$ , Nov.-Mar.)	-1.4	-0.6	-0.7	-1.0	--
Mean temp. coldest month ( $^{\circ}\text{C}$ )	-4.4	-3.8	-3.7	-3.9	--
Mean annual precipitation (mm)	537	676	785	691	1055
Mean annual snowfall (cm)	164	198	227	206	467
Mean winter ppt. (mm, Nov.-Mar.)	281	361	431	385	509
Mean ppt. wettest month (mm)	87	88	107	100	122
Mean summer ppt. (mm, May-Sept.)	186	220	242	206	375
Mean ppt. driest month (mm)	19	35	40	29	58
Frost free period (days)	145	--	157	--	--
Potential evapotranspiration (cm)	--	43.5	43.2	--	--

Precipitation patterns are probably a reflection of frontal cloud patterns, which are most active below about 1 500 m in elevation. Precipitation increases with elevation to that level, above which it often decreases slightly. During the summer months the maximum precipitation belt will be slightly higher in response to convection storms. The annual precipitation distribution is seasonal with a maximum during mid-winter (December-January), and a minimum in mid-summer (July-August). These temperature and precipitation patterns result in rapidly increasing snowpack with elevation. At the lower elevations the winter maximum may be reached in January, while at the higher elevations it continues to collect until April (adapted from Utzig 1978).

Table 2.1 illustrates some climatic trends for the region. The applicability is limited however, as none of the stations are located within the study area. Local observations indicate that the study area tends to be warmer and/or drier than is typical for the northern West Kootenays. Temperatures are probably similar to Kaslo 1 and precipitation is similar to Howser (see Table 2.1).

## 2.5 Hydrology

The water resources of the study area can be characterized as a complex system of surface waters (including streams, lakes, and perennial snow), subsurface aquifers and springs, resulting from the combination of a dissected fluted mountain slope and bedrock aquifers. The fluted topography, resulting from an interaction between differential bedrock weathering and glacial scouring, has produced a trellis drainage pattern north of Kootenay Joe Creek. However, infiltration into permeable soluble bedrocks (i.e., limestones and calcareous schists) interbedded with impermeable types (i.e., quartzite) has reduced the surface water component of the system and resulted in a relatively low density and poorly developed drainage pattern. With the exception of Carter Creek, which flows on surficial materials, the main streams occupy channels probably incised prior to the last glaciation. The reduced density of tributary streams, incised nature of the major channels and the irregular topography make it virtually impossible to accurately define surface watershed boundaries.

The presence of numerous springs associated with calcareous bedrock sources raise questions concerning the correlation between surface watershed divides and actual source areas related to stream discharge (compare spring locations with limestone outcrops on the geology map Figures 1.2 and 1.6). Gardner and Carter Creeks receive most of their flow from springs, while Argenta, Salisbury, and Gar Creeks receive a smaller portion from springs. The recharge areas for the subsurface aquifers are unknown and a portion of them may even lie outside the study area (see Section 4.1c and Figure 4.1).

The annual hydrographs for the streams are quite variable because of the differing source areas. Streams which are primarily spring-fed (i.e., Carter and Gardner Creeks) have little seasonal variation in discharge. Argenta Creek, which is fed by springs and perennial snow fields also has somewhat moderated low flows. Bulmer's, Salisbury, and particularly Kootenay Joe Creek respond more clearly to snowmelt inputs with typical early summer peak flows and fall low flows.

The area south of Kootenay Joe Creek is characterized by the presence of massive intrusive rocks which are generally impermeable. This area has a better developed surface drainage network and lacks springs.

## 2.6 Vegetation

The study area contains four Biogeoclimatic Subzones as described by the Ministry of Forests (Utzig et. al. 1982): Moist Southern Interior Cedar-Hemlock (ICHa), Moist Southern Forested Engelmann Spruce-Subalpine Fir (ESSFc), Moist Parkland Southern Engelmann Spruce-Subalpine Fir (ESSFcp), and the Moist Interior Alpine Tundra (ATe). (See Figure 1.3). The B.C. Ministry of Environment has described three forest zones for the area: Interior western hemlock-western red cedar (IwH-wC), Subalpine Engelmann spruce-alpine fir (SAeS-aLF), and the Alpine tundra (At) (Wittneben 1980). These two systems are more or less equivalent, with the SAeS-aLF including both the ESSFc and ESSFcp. Due to an extensive fire history, there is a complex mosaic of plant communities ranging from early seral to old-growth stands. The vegetation is briefly described below, for more detail see Figure 1.5 and Section 4.4.

The lower elevations of the ICH are dominated by mixed seral stands of Pseudotsuga menziesia (F), Larix occidentalis (Lw), and Pinus contorta (Pl) (Veg. types M,V,G,P). More advanced seral stages and less exposed sites include Pinus monticola (Pw), rarely Abies grandis (Bg) and an understory of Tsuga heterophylla (Hw) and Thuja plicata (C) (Veg. types V,G,O,T). Dry exposed sites tend more to F and Pinus ponderosa (Py) (Veg. types B,J). Wet sites generally include C, Hw, Populus balsamifera ssp. trichocarpa (Ac), Picea engelmannii (Se) and minor Abies lasiocarpa (Bl) (Veg. types T,O,E). Severely and/or repeatedly burned sites are dominated by Betula papyrifera (Ep), Populus tremuloides (At) and Pl (Veg. type P).

Within the ICH/ESSF transition, climax and near-climax stands include Hw, Se, Bl, and minor C (Veg. types O,T,A). Seral stands may include F, Lw, Pl, and Pw (Veg. types G,P,C). Dry sites are dominantly open stands of F (Veg. type J).

The ESSFc is characterized by climax stands of Se and Bl and seral stands dominated by Pl with lesser amounts of F and Lw (Veg. types C, O). Mesic and wetter sites have an increased frequency of Se (Veg. type A), while dryer sites include the occurrence of Pinus albicaulis (Pa) (Veg. type R). Rock outcrops on exposed south and westerly aspects maintain open stands of F (Veg. type J).

The ESSFcp, which occurs at the upper elevations of the study area is characterized by clumpy stunted stands of Se, Bl, Pa, and Larix lyallii (La). Pa and La predominate on the drier sites (Veg. types H), while Se and Bl dominate the moister sites (Veg. types L). Wet sites are often open meadow communities (Veg. type S).

The crest of Mt. Willet is beyond the elevational range of tree species and is therefore designated as ATe. Disclimax snow avalanche sites occur sporadically throughout the study area. These are variable shrub and herb communities depending on available moisture levels (Veg. types U, D). Naturally non-vegetated rock outcrops and coarse colluvium also occur, primarily at the upper elevations (Veg. type Z).

## 2.7 Cultural Setting

Permanent settlement of the study area commenced with the twentieth century. Native people maintained seasonal camps for hunting and tool making prior to then, but had no permanent communities in the area.

Mining activities in the first decade of the twentieth century brought some early settlers, but the boom was short-lived, and concentrated further north in the Lardeau and Duncan Valleys. The few miners remaining were joined by settlers who were attracted by developers with preemptions of land in the area. Most of these early settlers established homesteads and managed to make a living through ingenuity and hard work. Small scale farming, orcharding, trapping, and "working out" in logging and mining camps were typical of the employment available for maintaining these early families. Farming and orcharding were suited to the mild climate, benchland soils and good sources of irrigation water.

Logging was not a major activity in the study area at any time, although it has been sustained on a small scale continuously.

Production of railroad ties, mine timbers, and cord wood for sternwheelers were early activities. Pilings and cedar poles were loaded out from Lardeau for the Canadian Pacific Railway (C.P.R.), including some timber from the study area. Small scale sawlog production from private land added to the incomes of several residents.

After World War II (and even today), a few small sawmills in Argenta and Johnson's Landing produced lumber for local use and ties for the C.P.R. Timber from surrounding Crown Land could be secured from the Ministry of Forests, prior to the establishment of the quota system. In the early days, the presence of the Ministry of Forests in the area had been primarily aimed at fire control.

Forest fires began to occur with increased frequency following the arrival of settlers. Much of the timber surrounding the inhabited areas is under 80 years of age. While some of these fires were the result of lightning strikes, some were accidentally started and others were deliberately set to clear land. Most of the fires were controlled, in some way, by human effort.

The area has continued to be sparsely populated with loose concentrations of households in Argenta and Johnson's Landing. There have been modest "waves" of immigration (1900-1910, late 1920's, 1950's, 1960's), as well as periods of decline during World War I and during the depression of the 1930's. There has been a slow but steady increase in population since 1950, with a marked increase in seasonal habitation since 1960.

The modernization of transportation and communication facilities (i.e., replacement of the sternwheelers with roads, electricity, telephone) since 1960 has increased the economic, educational, and cultural possibilities available to the residents of the study area. However, the pleasant natural setting and potential for small scale agriculture have still been the two most important elements in maintaining habitation of the area. Most permanent residents today still depend on the same employment sources as the early settlers, small scale farming, orcharding, "working out", or supplying services to the local community. People have continued to depend on the local streams and springs for domestic and irrigation water and the local forests for lumber and fuel. The most recent change has been increased pressure for recreational use in the area (adapted from Chapman 1981).

### III. METHODS

#### 3.1 Pre-field Planning

Prior to commencement of field work, existing data sources were reviewed to avoid any unnecessary duplication of effort. A number of discussions were held with the Ministry of Forests, Kootenay Forest Products Ltd., and hydrologic study personnel to coordinate field work and assure that the field sampling program would satisfy the data requirements of all those involved. Mapping criteria were selected to meet the needs of requested interpretations.

Relying on previous field experience in the area by the authors, existing data sources and utilization of standard airphoto interpretation techniques, the study area was stratified into broad terrain and vegetation types. These were used to familiarize the authors with the study area, to estimate variability within the study area and to locate transects for sampling and ground verification of mapping units. Criteria for stratification included the elements of airphoto pattern (i.e., tone, texture, topography, drainage patterns, erosional features and micro details), forest cover maps, geology maps, terrain and soil maps and vegetation zonation maps (Utzig 1978, Jones 1978).

The density of field sampling and ground verification was designed to meet requirements defined for a #2 Survey Intensity Level (Mapping Systems Working Group 1981). As a general rule, it is recommended that soil maps require between 0.2 and 2 inspections per square centimetre of published map. The total study area is approximately 3 200 cm<sup>2</sup> at 1:15,840, and the area below 1 950 m in elevation is approximately 2 600 cm<sup>2</sup>, requiring between 520 and 5,200 inspections. With approximately 250 field inspections from the 1980 Ministry of Forests sampling program (Wells 1981), the 1981 field work was scheduled to include a minimum of 300 additional field inspections.

#### 3.2 Field Work

As described in the last section, the field work was designed to meet the sampling requirements of a #2 Survey Intensity Level and cover the anticipated variation, both spatially and environmentally. In addition, the field work was constrained by four factors:

1. Limited road access.
2. Location of the subareas designated as high priority sampling areas in the terms of reference.
3. Deeply incised creeks restricting foot travel.
4. Restricted helicopter access due to the lack of heliports and a limited budget.

The areas with road access were examined more intensely with regard to terrain and soil features, taking advantage of roadcut exposures. However, many of the road accessible areas have disturbed vegetation types and were consequently of diminished value for intensive vegetation sampling.

The high intensity subareas were overlaid with a 400 m rectangular grid for the purpose of reconnaissance timber cruising. The cruise plots and intervening strips were used as a basis for locating terrain, soil and vegetation plots. In addition, extensive field notes were recorded while chaining between plot locations.

The remainder of the area was covered by a series of prelocated foot transects originating and ending at helicopter drop points or road access. Plots were located along these transects as differing environmental conditions (i.e., genetic material, aspect, slope class, etc.) and/or vegetation communities were encountered. Notes were kept during these transects, plot locations and type changes were recorded on airphotos as the field work progressed.

The field work was primarily carried out by a crew of two people, one soil scientist-geologist and one vegetation specialist. They were occasionally accompanied by an additional soil scientist-ecologist, a forest technician or a hydrologist. During the field work three classes of sample plots were established. The sampling procedures are described below and their locations are shown in Figure 1.1.

All definitions and sampling procedures are according to Walmsley et. al. 1980.

- a) Formal Plots: Initially formal plots were established whenever a differing plant community and/or environmental conditions were encountered along a field transect. As repetition of various ecosystems was built up, sites with sufficient sampling were treated with ground checks (approximately 10-12 plots). Formal plots were continued in newly encountered ecosystems and those with insufficient repetition. Each plot was approximately 400 m<sup>2</sup> and located within an area of relatively homogeneous vegetation and environmental conditions. A data form is included in the appendix.

Vegetation data included:

- 1) complete listing of vegetation species by stratum (unfamiliar species were sampled for later identification)
- 2) estimate of strata heights
- 3) estimate of total % cover for each species by stratum and combined strata
- 4) description of vigour for each species
- 5) description of utilization (browse) for each species
- 6) a listing of species on atypical substrates (i.e., rocks, decaying wood, bare soil, etc.) and their abundance

- 7) successional status
- 8) sample tree measurements (age, diameter, height and pathology)

A soil pit was excavated to approximately 1 m in depth (occasionally less) with the following information recorded:

- 1) horizonation including depth and color
- 2) soil texture by horizon
- 3) % coarse fragments by horizon
- 4) parent material (terrain classification)
- 5) depth to carbonates, root restricting layer, rock, free water, or other impermeable layer where applicable
- 6) rooting depth and distribution
- 7) bedrock and/or coarse fragment lithology

Environmental information recorded included:

- 1) elevation
- 2) aspect
- 3) slope
- 4) slope position
- 5) moisture regime
- 6) nutrient regime
- 7) surface substrate description
- 8) biogeoclimatic subzone
- 9) special conditions such as site history, exposure type, evidence of instability, etc.

- b) Ground Checks: When sufficient representation of vegetation and soil types had been made through data collection in formal plots, then less detailed ground checks were conducted instead. This enabled the completion of appropriate sampling coverage and field checks of map units within the limited field time available. Each ground check was similarly located within a relatively homogeneous area and approximately 400 m<sup>2</sup>, as with the formal plots.

Vegetation data collected at each ground check included a complete vegetation list (not formerly listed by stratum), successional status and selected measurements of tree ages.

Excavation of soil pits was limited to depths of 50-100 cm. Information recorded included terrain classification, abbreviated horizonation, texture, % coarse fragments, bedrock and/or coarse fragment lithology, and other factors where deemed significant.

Environmental information included elevation, aspect, slope, moisture regime, biogeoclimatic subzone, and potentially significant factors.

- c) Ecological Classification Program Plots: Near the end of the field season, once the major soil and vegetation types had been recognized, ten sampling sites were selected to exemplify the major types within the study area. These samples were carried out by the Ministry of Forests' sampling crew according to their program specifications (i.e., Walmsley et. al. 1980). The plots included a complete environmental, vegetation and soil description, soil sampling and laboratory analysis and tree mensuration data. A data form is included in the appendix.

### 3.3 Road Location Investigations

Throughout the field season the authors conferred with Kootenay Forest Products Ltd. personnel regarding various road location options. These included examination of proposals on paper and walking all "P-lines" in the field. A number of alternative proposals by the authors were incorporated into the locations on the ground. Field checks were made along the road corridors and incorporated into the final mapping. Locations walked included primary access above C.P. 21 (Carter Creek) and into the subareas between Argenta/Bulmer's Creeks and Bulmer's/Salisbury Creeks.

### 3.4 Data Analysis and Mapping

- a) Terrain: The terrain of the study area was classified and mapped using the Terrain Classification System (1978) developed by the B.C. Ministry of Environment. For this study some modifications of definitions were introduced, and can be noted in the map legend. Major modifications included inclusion of the surface expression "bv" to describe shallow surficial materials over an undulating bedrock surface and adapting definitions to handle the continuum between basal moraine, ablation moraine, poorly sorted glaciofluvial, well sorted and stratified glaciofluvial and fluvial materials, as shown below:

morainal (M): materials with no significant modification by glacial meltwaters; surface textures similar to compact basal moraine at depth.

Morainal-washed (M-W): materials with a shallow (less than 150 cm) capping of coarser textured material overlying compact morainal material below (e.g., gLS over L).

glacio-fluvial (FG): materials deposited by glacial meltwaters in association with glacial ice; poorly to well sorted and/or stratified; greater than 150 cm deep if overlying compact morainal materials.

fluvial (F): materials associated with present stream patterns; well sorted and/or stratified.

blanket-veneer (bv): a mantle of unconsolidated material ranging from a thin blanket to a veneer; generally 10 cm to 2 m in depth.

The terrain mapping was initiated by typing odd numbered 1:15,840 airphotos through airphoto interpretation prior to the field work. These photos were modified and retyped following field checking. Field transects and plot locations were located on even numbered airphotos, and viewed stereoscopically as ground verification for the final terrain typing. The information was then Kail Plotted onto 1:15,840 base maps provided by the Ministry of Forests and Kootenay Forest Products Ltd.

b) Vegetation:

i) Data Analysis Strategy: Midway through the field work vegetation data collected to that point was coded for computer analysis. The analyses were carried out at the University of B.C. Computing Centre using the Ceska-Roemer Program (1971), as described below. The resulting preliminary vegetation types were characterized and evaluated for sampling requirements. Those which were adequately sampled became a low priority for full sample plots and generally received ground checks for the remaining portion of the field work. New types encountered, as well as those not adequately sampled during the previous field work, continued to receive formal sample plots.

Following completion of all field work, the remaining vegetation data was coded and combined with the earlier data. One data set (219 samples) was established to include both formal plots and ground checks (the plot types could be identified by the numbering sequence). Since the classification process is based on species presence-absence, the ground checks and formal plots could be used equitably. The whole data set was then reanalyzed, and final vegetation types identified and characterized.

ii) Computer Data Synthesis: The Ceska-Roemer Program (1971) is essentially a computer-assisted tabular analysis which is used to define vegetation types. The mechanism of group formation consists of two processes which are repeated: selection of those species which typify a given group of plots, and selection of those plots which are typified by a given group of species. The program identifies combinations of differentiating species which tend to occur in association with one another and have restricted distributions in the study area. The vegetation types are in turn identified by the presence or absence of the defined species group combinations.

A "vegetation type" is derived from a number of sample plots whose species composition optimally differentiates those plots from other sample plots. Conditions for the selection of species and plots are numerically defined in the constraints of the program.

The final printout from the program consists of a two-dimensional table showing the species groups listed on the y-axis and the plots comprising each vegetation type listed on the x-axis. Table entries are cover abundance values for each species listed on the y-axis.

The initial data sort formed all possible associated species groups within the constraints of the program. Those species groups which were most useful for differentiating groups of plots were employed in the next sorting process. The second printout produced a table grouping those plots together which were typified by the selected species groups. Eight successive sorts were run with varying combinations of species groups to optimize the allocation of plots to the groupings. When a satisfactory result was reached, a final table was constructed with vertical lines between the plot groupings identified. Each grouping was identified by the presence and/or absence of specific species groups and subsequently designated as a vegetation type.

iii) Characterization of the Vegetation Types: Fifteen vegetation types were identified by the computer sorting process. These vegetation types were characterized by combinations of ten species groups and described on the basis of species composition by layer and cover values. Additional species occurring in each type, but not included in the species groups, were examined as well. Those that occurred with a greater than 60% constancy value were noted as "associated species" in the map legend. These associated species are useful for identifying the vegetation types in the field.

From the fifteen vegetation types described it was noted that four were sufficiently similar to be incorporated into existing types while still conforming to the constraints of the program. The final vegetation legend was thus comprised of eleven types.

In addition certain plots that were not allocated to a type by the computer program were subjectively analyzed. Plots that showed vegetative and physical similarities were grouped into types (i.e., types D and E) and described in a separate table where the vegetation was listed simply as "characteristic species". Similarly, certain types were known to occur at higher elevations within the study area but were insufficiently sampled to be represented by the computer analysis. Using data collected in the ESSFc and ESSFcp subzones by the Ministry of Forests, Ecological Classification program (Nelson Region) it was possible to describe four vegetation types to represent these lower priority areas of the study area. Species occurring together within a given range of soil moisture were grouped together to form these vegetation types (R,H,L,S) with no strict quantitative constraints.

Vegetation types were each given a single species name, the first letter of which was used as the map symbol. Each type was listed in the legend sequentially by subzone and characterized according to certain vegetative and physical features (see Figure 1.5).

- c) Soils: Based on the requirements of the desired soil interpretations, a number of soil and environmental characteristics were selected for a computer-assisted soil classification. Following completion of the field work, the twelve parameters listed below were coded from the formal plot and selected field check data for a total of 172 samples:

1. % slope
2. elevation (tens of meters)
3. aspect (180° to 360° as is; 0° to 180°, coded value equals 360° minus real value)
4. moisture regime (0 to 7)
5. % coarse fragments (B horizon)
6. % sand in fine fraction (center of textural class for hand textured samples; B horizon)
7. % clay in fine fraction (center of textural class for hand textured samples; B horizon)
8. depth to impermeable layer (cm; measured value for less than 100 cm; estimated to a maximum of 350 cm)
9. depth of LFH (cm)
10. depth to free carbonates (measured value for less than 100 cm; calcareous coarse fragments equals 199 cm; calcareous bedrock equals 299 cm; non-calcareous equals 399 cm)
11. rooting depth (cm)
12. depth of solum (cm)

These samples were grouped into a number of soil types with the use of a "cluster program" available from the U.B.C. Computing Centre entitled: "C Group Hierarchical Grouping Analysis with Optional Contiguity Constraint" (Patterson and Whitaker 1978). The agglomeration process is constituted by a step-wise grouping of individual samples according to the calculation of a minimum error value for all specified parameters (i.e., Ward's methods). Parameters with varying ranges (i.e., moisture regime 0-7 vs. coarse fragments 0-99) are adjusted to a common scale for comparison. Once groups are formed they are identified by the centroid of their respective members. The output consists of a dendrogram depicting the step-wise grouping process and a table listing the samples and their characteristics as ordered by the grouping process. The user is free to select an appropriate hierarchical level of classification.

After examining 9 classification scenarios resulting from various combinations of the 12 parameters, the following combination was considered most acceptable.

1. % coarse fragments
2. % sand
3. % clay
4. depth to impermeable
5. depth of LFH
6. moisture regime

The acceptance criteria for the resulting classification included:

1. Mapability; were the defined classes well correlated with features recognizable on aerial photographs (i.e., terrain features, slope position, vegetation patterns, etc.)
2. Interpretive value of defined classes; were the differentiating and accessory characteristics of the classes and their ranges relevant to the desired interpretations.

The 25 potential soil types resulting from this analysis were eventually reduced to the 11 types shown in the map legend for a number of reasons, primarily to simplify the final presentation. Some of the potential types recognized were not considered significantly different for the intended interpretations, some were inadequately sampled to characterize and probably occurred very rarely within the study area, and others could not be consistently recognized during the mapping phase without further field work.

Following the data analysis each formal plot and field check was identified as belonging to a particular soil type. Using additional soil and environmental data, ranges in characteristics of each soil type were defined (including accompanying terrain type and vegetation type) and a soil legend prepared.

- d) Soil and Vegetation Mapping: Airphotos with superimposed terrain unit polygons were used as the basis for creating the soil-vegetation map. By utilizing stereo-pairs composed of terrain polygons on the odd numbered photo and pretyped vegetation polygons and plot-transect locations on the even numbered photo, each terrain polygon was assigned an appropriate combination of soil and vegetation types. Areas without ground checks were extrapolated by standard airphoto interpretation methods. Through experience gained viewing areas with samples and/or transects, airphoto patterns were recognized for specific types. In areas where significant and recognizable soil and/or vegetation breaks crossed the terrain polygons, the terrain polygons were modified.

To establish the relationships between soil, vegetation and terrain types, a correlation table was generated from the computer-stored sample data. In addition a correlation matrix was manually derived from the polygon designations. These established relationships were used to cross-check airphoto interpretations and prepare the associated soil and vegetation columns of the legend.

- e) Interpretations: The interpretations were prepared according to the generalized methodology described below. Specific characteristics considered for each interpretation are recorded in the description of the classes or the explanatory notes of the map legend.
- 1) Define the site characteristics significant to the desired interpretation (i.e., Mass Wasting: slope, drainage, texture, depth to impermeable).
  - 2) Define interpretive classes (i.e., low-high) and set class limits for the range of characteristics relevant to the study area and interpretation. Some interpretive classes can be based on bedrock, terrain, soil, and/or vegetation types already defined (i.e., Bedrock Occurrence or Vegetative-Hydrologic Recovery), whereas others require additional information (i.e., Sediment Delivery Hazard). Complex interpretations such as Surface Erosion or Forest Capability require many pieces of information.
  - 3) Assign an interpretive class (or classes) to each map polygon based on their expression of the characteristics significant to the interpretation. In cases of complex map units the most limiting class is used unless it occupies less than 20% of the unit (except Vegetative-Hydrologic Recovery and Forest Capability where weighted averages were used).

To facilitate assigning interpretations to the map units, each polygon was sequentially numbered and described by each mapping criterion. Map labeling and subsequent checking was completed from this master list.

## IV. RESULTS

### 4.1 Bedrock Geology

The Bedrock Geology Map (Figure 1.2) is adapted from the work of Fyles (1964) and Reesor (1973) with the inclusion of observations by the authors during the field seasons of 1980 and 1981. The purpose of the map is to inform the user of the geologic strata underlying the soils and unconsolidated materials of the study area. There is a brief description of the physical properties of the rocks, their weathering characteristics, and their potential effect on the hydrologic regime. A general description of the bedrock geology is presented in Section 2.2.

- a) Fry Creek Batholith: (See Reesor, 1973, pp. 93-94) The typical Fry Creek granitic rock is an impermeable, white, white-weathering, medium grained, leuco-quartz monzonite, containing a little muscovite and biotite.

It contacts and interrupts metasedimentary rocks in the vicinity of Kootenay Joe Creek and the ridge just north of Kootenay Joe Creek along which the Kootenay Joe Road rises. In this area there is some deformation of the metasediments and some foliation in the granite. It can be described as a contact zone. Weathering in this contact zone is more pronounced. The channel of Kootenay Joe Creek occurs in this zone. Other stream erosion of this rock type occurs in jointed or fractured areas easily seen on airphotos.

Weathering and erosion of Fry Creek rock is unlike that in the remainder of the map area. The homogeneity of the rock accounts for a generally smooth and massive surface overlain by loose, skeletal soil materials rarely as deep as 3 m. Erosion channels that incise this rock occur only in the contact zone or in fractures and joints. The rock is extremely hard and impermeable except in the fractures.

- b) Lardeau Group--Index Formation: (See Fyles, 1964, pp. 25-28)

1. Interlayered fine grained green and grey schist, minor limestone and quartzite.
2. Fine grained grey mica schist and garnet mica schist.

Index formation rocks generally are the softest rock in the map area. Terrain which is relatively subdued is typical of these schists, minor limestones and thin quartzites. Foliation or "grain" coincides with the NNW strike. Weathering is rapid by both climate and roots: the minerals in the darker schists are relatively unstable and produce relatively rich soils. Soils developed in saprolite or rotten rock are frequently encountered. It is often

possible to dig by shovel 50 to 75 cm into these rocks. It is evident that roots delve even deeper. Doubtless water penetrates at least as deep as the roots grow into the rock, but the grain of the rock tends to redirect subsurface moisture flow in the direction of the strike (i.e., NNW or SSE depending on which direction is downhill). The micas have high water holding capacity; as do the weathered micas in the heavier soils developed on these rocks.

The minor limestones and quartzites of the Index create relatively prominent features on the landscape, though they do not account for the dramatic elevational changes in the map area. These limestones and quartzites also redirect surface waterflow, by virtue of their relative prominence, although they are not absorbent or permeable as are the schists. Some dissolution of the limestones occurs, yielding secondary carbonate deposition in the soils.

- c) Badshot and Mohican Formations (See Fyles, 1964, pp. 23-24)  
Grey and white crystalline limestones, dolomite and siliceous dolomite, and interlayered limestone and mica schist. (The two formations will be treated as one.)

The Badshot/Mohican Formation is in conformable contact below the Index Formation. It is a significant structural feature of the study area, being a major element in the dramatic elevational changes found. It is characteristically steeply dipping and prominent in the landscape. The limestone and dolomites, along with the Marsh-Adams rocks described below, are observable over a large portion of the map area on the ground and on airphotos.

The schists are relatively subdued in the landscape, but are in association with the Lime Dyke, (as the Badshot Limestone was called by the early prospectors and geologists). The schists are relatively less stable in the atmosphere and near the surface, and are more easily weathered and penetrated by roots than the harder rocks in the formation, but the slopes at the surface over the schists are influenced by the steeper limestone and dolomite topography. Saprolites occur in these schists as in the Index, and are absorbent and permeable, usually not deeper than 1 m.

The limestones and dolomites are soluble and solution cavities are evident in occurrences of the Formation in the alpine and in the area of Apache Pass, west of Carter Creek. Some of the schists have calcareous constituents which dissolve in ground water.

In some areas the Badshot may act as a subsurface aquifer, and probably accounts for the spring activity in the area between Gardner Creek and Gar Creek. One possibility is that limestone outcroppings under snow in the headwaters of Salisbury Creek are recharged with melt water, which then discharges from limestone outcrops in the area of springs above Johnson's Landing. The water from these springs is very limey, and the relative constancy of their annual hydrographs indicate a deep bedrock aquifer rather than near-surface seepage sources. A simplified schematic diagram demonstrates the theoretical sequence described above (Figure 4.1).

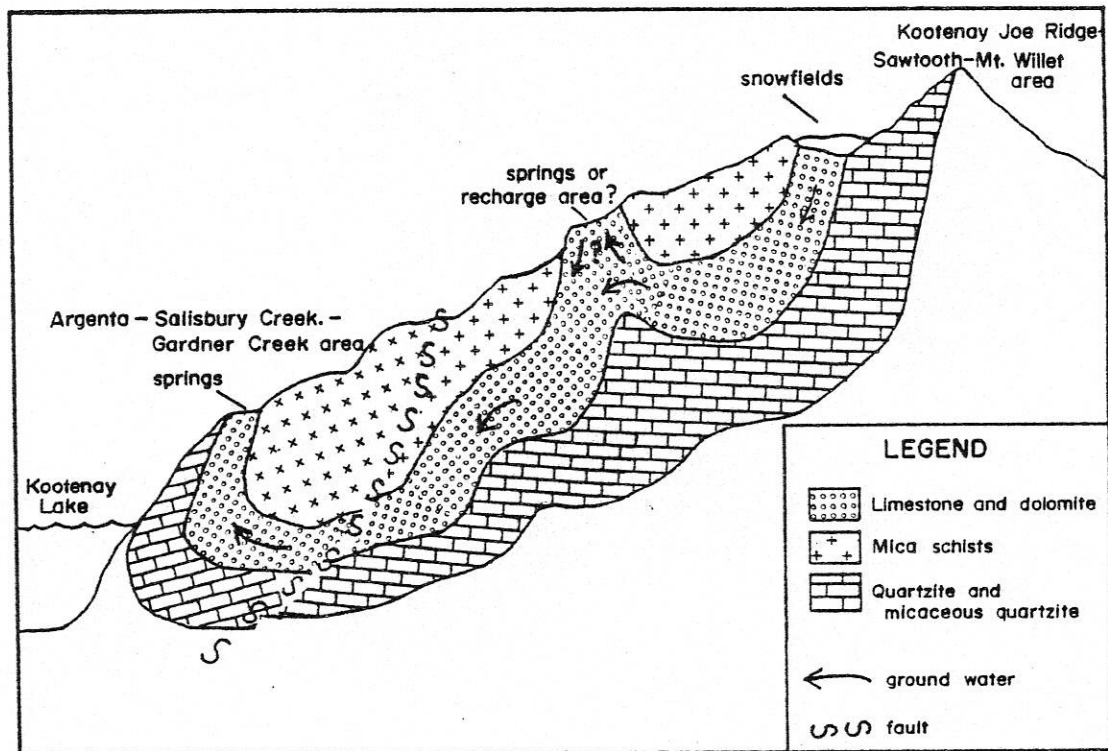


Fig. 4.1 Possible bedrock aquifer sequence.

- d) Hamill Group--Marsh-Adams Formation (See Fyles, 1964, pp. 20-21)  
 Grey and brown micaceous quartzite and mica schist, white quartzite and minor brown weathering limey schist.

The Marsh-Adams Formation is in conformable contact under the Badshot/Mohican Formations. It characteristically is prominent in the landscape. The Badshot limestones and the Marsh-Adams quartzites together are constituents in the most prominent landscape features and elevational changes in the map area.

The quartzites are impermeable and insoluble, but are often ridged and jointed so that water may be redirected along their strike. The soils and ecological moisture regimes of landscapes underlain by the Marsh-Adams Formation and the harder rocks of the Badshot/Mohican are shallower and drier than in the more subdued areas underlain by the schists and softer rocks of the Badshot/Mohican and the Index Formations.

## 4.2 Terrain and Soil Parent Materials

The terrain map describes the distribution of surficial materials throughout the study area (Figure 1.4). These materials act as the parent materials for the soils of the area, and therefore have a significant impact on soil properties, vegetation distribution and the hydrologic regime. The terrain is primarily a reflection of the local bedrock (both composition and structure), the pleistocene glaciation, or an interaction between those two factors.

North of Kootenay Joe Creek, the NNW-SSE trend in schistosity and bedding of the metasediments has been accentuated by the differential erosion of the southerly moving ice, resulting in "fluted" topography (see Figure 4.2). The flute bottoms are dominated by medium to fine textured morainal materials (soil types M,K) which grade to shallow veneers and weathered schists or saprolites (soil types C,I). More resistant outcrops of quartzites or limestones are more likely to occur as steep rock walls or flute ridges with associated colluvial soils (soil types A,B,C,D).

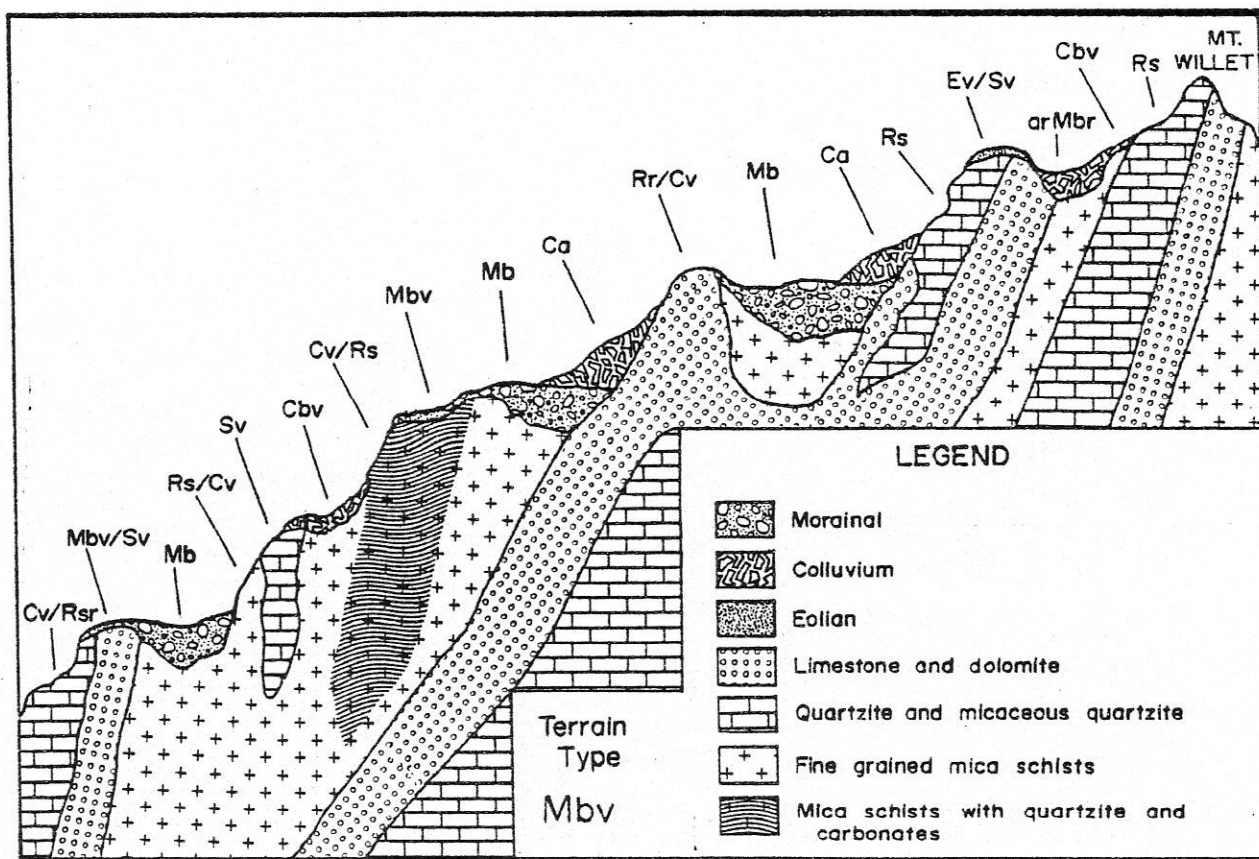


Fig. 4.2 Mid to upper slope cross-section with fluted terrain sequence.

The upper elevations of the study area are dominated by more resistant bedrock types, steep slopes and colluvial materials (soil types A,B,D). Cirque basins in upper Salisbury, Argenta, and Bulmer's Creeks include some blocky morainal materials (soil type D). Minor areas of rolling alpine meadows usually occur on saprolites, eolian cappings or morainal veneers (soil types C,I).

The terrain of the lower elevations is primarily a reflection of extensive kame terrace development during deglaciation. (See Figure 4.3.) The glaciofluvial materials (soil types F,G) were deposited as blankets and veneers over the fluted terrain described for the mid-elevations and subsequently down-cut into terraces and dissected by gullies as the ice downwasted. The complex pattern of ice disintegration resulted in numerous rearrangements of the drainage patterns and temporary stream impoundments. This unstable environment has resulted in wide ranging soil textures and interbedded lacustrines (soil type O). The dissection of the kame materials has been sufficient to expose morainal materials and bedrock, creating a complex mosaic of surficial materials and soil types (e.g., Johnson's Landing area).

Areas south of Kootenay Joe Creek have had a similar history, however the more resistant and massive bedrock has resulted in shallower coarse textured materials. Morainal deposits are generally sandy textured materials (soil type K), as are the glaciofluvial blankets and veneers (soil types F,G).

Since glaciation the major stream drainages have become reincised into the flanks of the main Kootenay Valley. The steep sides of these channels are dominated by colluvial materials (soil types D,B,A) with some morainal and glaciofluvial materials in the lower sections. The colluvial materials are quite variable in texture and coarse fragment content, reflecting the complex pattern of bedrock exposed along the valley walls. The valley bottoms and stream channels are gravelly and sandy fluvial deposits (soil type P) interbedded with more angular and less well sorted colluvial-fluvial materials deposited by debris torrents and snow avalanche activity (soil types D,P). Where the streams enter Kootenay Lake fluvial fan or deltaic materials have been deposited (soil types G,P).

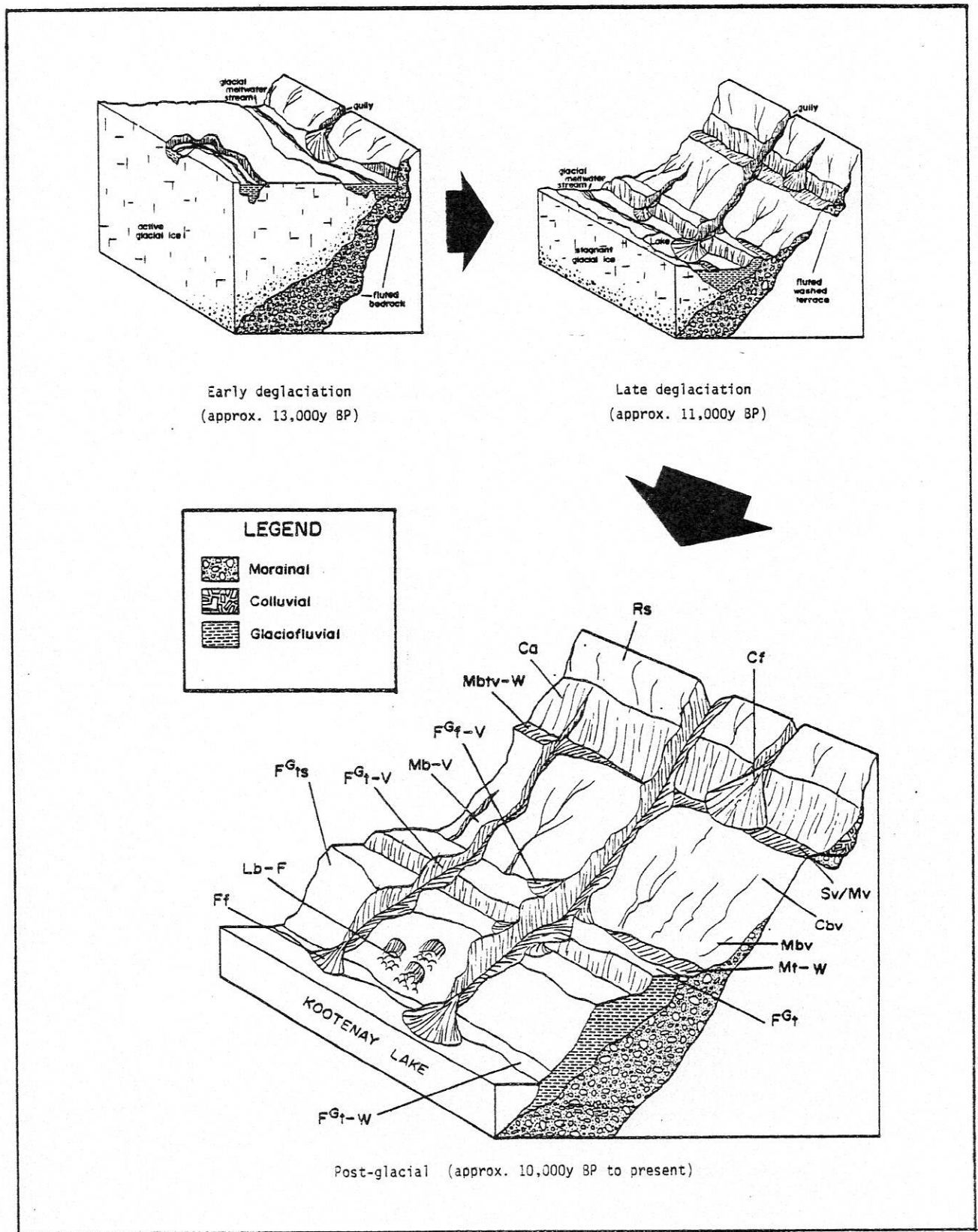


Fig. 4.3 Deglaciation of lower slopes with terrain sequence.

### 4.3 Soil Properties

The Soil and Vegetation map (Figure 1.5) describes the distribution and properties of the soil types, including the correlation between the soil and vegetation. The study area is dominated by Brunisolic soils which grade to Podzols under conditions of increased effective moisture and more acidic parent materials, or to Luvisols on the fine textured materials. Gleyed subgroups or Gleysols occur in the receiving sites. The soils of the study area are generally less well developed than those described for most of the West Kootenay area. This is the result of a number of factors, including: a somewhat drier climate, extensive fire history, seral vegetation and the presence of calcareous parent materials.

Soil physical properties were the primary focus of the study. Chemical laboratory analyses were kept to a minimum, therefore few comments can be made regarding chemical properties. In general, north of Kootenay Joe Creek, pH levels and base saturation values are higher than normal for the ICHA. This should result in better fertility for most species, except where excess lime becomes a problem. In areas with a recent fire history, LFH depths tend to be shallow, but do reach normal levels in mature stands.

Brief descriptions of the soil types are given below and their occurrences are diagrammatically represented in Figures 4.4 and 4.5. For further information consult the Soil and Vegetation map legend (Figure 1.5).

- A) This soil type includes bedrock outcrops of the more resistant rocks (primarily quartzites) and associated shallow blocky and rubbly colluviums. The soils are often non-existent or shallow and poorly developed with rapid drainage (18 plots).
- B) This soil type includes outcrops of the moderately resistant bedrocks (schists with interbedded quartzites and calcareous rocks) and associated shallow rubbly colluviums. These soils have a moderate coarse fragment content, sandy loam textures and rapid drainage. They often occur on flute ridges and along less steeply sloping bedrock outcrops (13 plots).
- C) These soils are found in association with the less resistant bedrock types (schists) as colluviums, saprolites or morainal blanket-veneers. They have greater water holding capacities than A or B soils due to increased depth, finer texture or decreased coarse fragments. They are well drained and often occur on moderate slopes or in shallow flute bottoms (32 plots).
- D) These soils are formed from deep rubbly colluvial or recent morainal materials. They are coarse textured and range from non-vegetated talus cones to well forested colluvial slopes. They are usually found at the base of bedrock outcrops (soil type A or B). Soil drainage is generally rapid, but can be moderately well to imperfect with seepage on debris torrent deposits or meltwaters from snow avalanche activity (4 plots and field notes).

- F) These soils are formed from sandy, well to rapidly drained glaciofluvial materials of variable depth. The shallow components of this soil type often intergrade with soil type C and the deeper components with types G and K (14 plots).
- G) These soils are formed from sandy glaciofluvial or fluvial deposits with a high percentage of coarse fragments. They occur on the lower slopes as kame terraces, as raised terraces along streams and as fluvial fans along Kootenay Lake. They are generally rapidly drained, however some fluvial deposits have available water at depth creating moderately well to imperfectly drained areas grading to soil type P (15 plots).
- I) These moderately shallow to shallow soils are associated with the most easily weathered rocks (mica schists). These soils are formed from saprolites, morainal blanket-veneers or rarely colluvium. Their medium to fine textures create good water holding characteristics, but they are still primarily well drained. These soils intergrade to types C and M (20 plots).

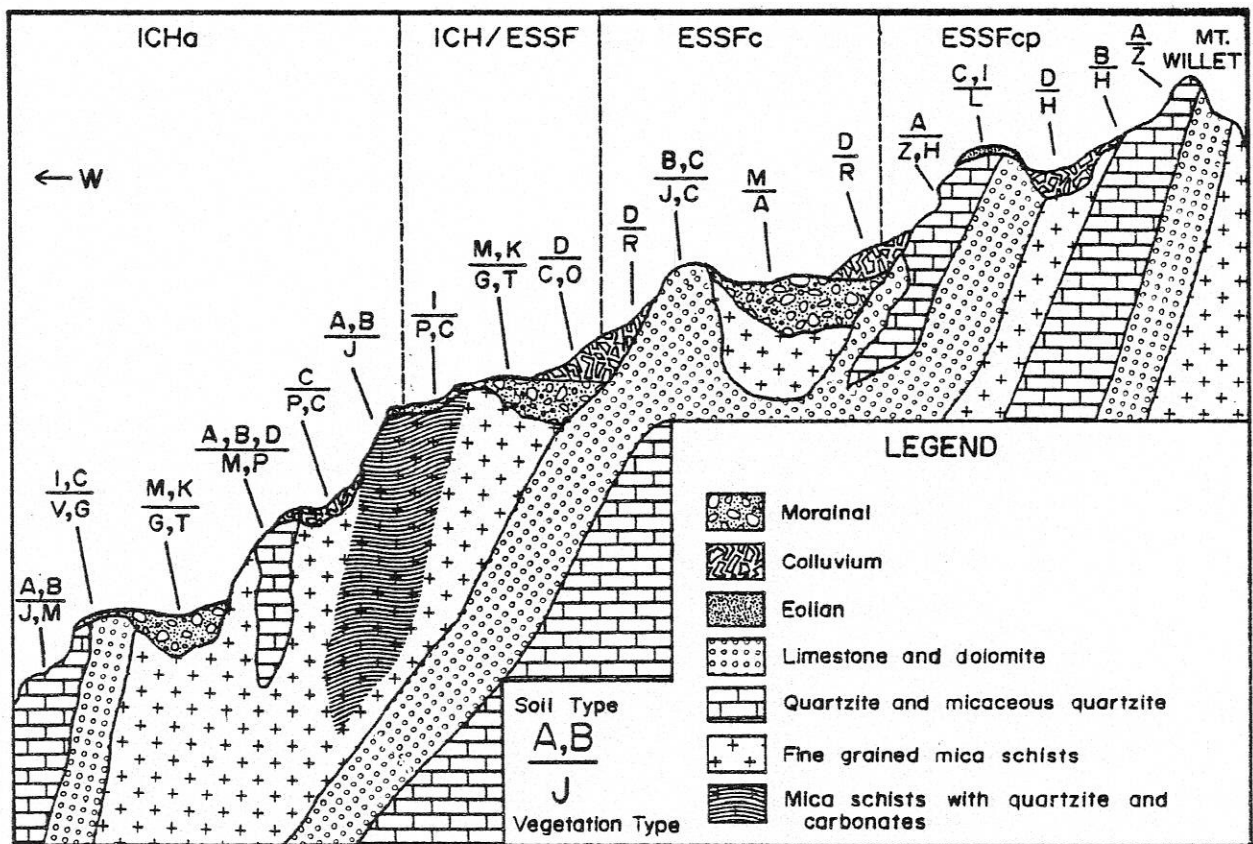


Fig. 4.4 Fluted terrain cross-section with soil-vegetation sequence.

- K) These are sandy soils with low to moderate coarse fragment content developed from morainal materials. Often they are the result of finer textured morainal materials reworked (i.e., washed) by glacial meltwaters. These soils are well drained and intergrade with soil types F, C, M, and G (13 plots).
- M) These soils are formed from moderate to fine textured deep morainal materials. They occur in flute bottoms or on slopes associated with easily weathered mica schists, grading to soil type I in shallower areas. Soil drainage varies from well to imperfect depending on slope position and the presence of seepage (32 plots).

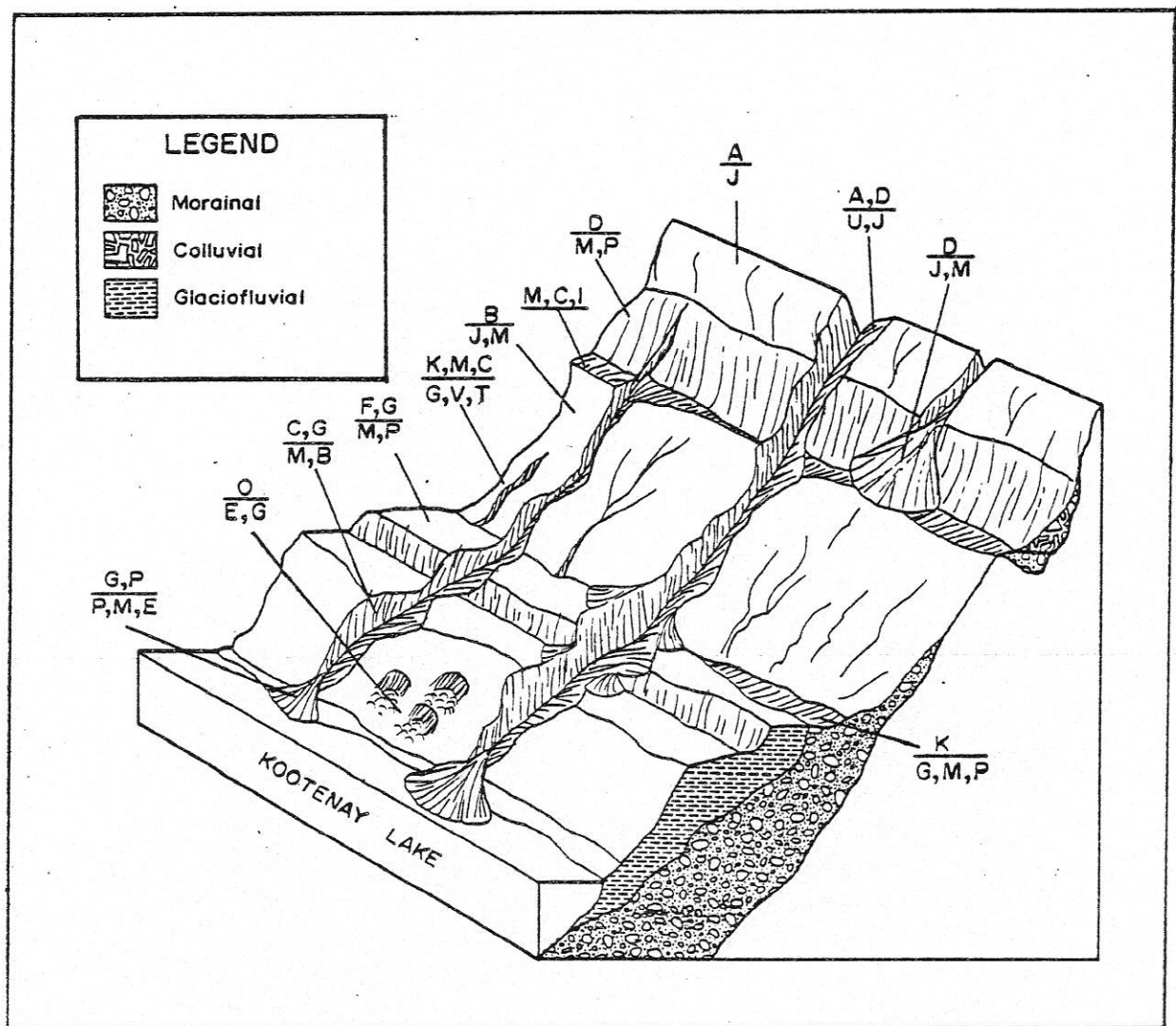


Fig. 4.5 Lower slopes with soil-vegetation sequence.

- O) Lacustrine sediments are the parent materials for these fine textured soils. Their occurrence is generally restricted to the lower slopes. They are moderately well to poorly drained and grade to soil types F and M (5 plots).
- P) These are moderately coarse to coarse textured soils which occur in areas affected by seepage or a high water table (adjacent to streams or springs). They are imperfectly to poorly drained and associated with fluvial, colluvial or coarse morainal materials (6 plots).

#### 4.4 Vegetation

The vegetation of the study area reflects the drier climate (Section 2.4) and the predominance of seral stands due to the extensive fire history. A large proportion of the study area is comprised of moderately-steep to steep slopes with well drained, moderately coarse textured soils resulting in a high incidence of edaphic vegetation types (Figure 1.5). Relatively few moist sites occur. Less frequent still are receiving sites or seepage sites with imperfectly to poorly drained soils. Thus the nature of the terrain severely limits the incidence of mesic and wetter vegetation types. A general overview of the subzones, tree species and associated vegetation types was previously given in Section 2.6.

- a) The Vegetation Legend: The vegetation and soil map legends (Figure 1.5) represent a generalized summary of vegetation and soil relationships identified in the study area. A given vegetation type can occur on a range of soil types and a given soil type can support a range of vegetation types. Therefore both the vegetation and soil legends should be consulted for maximum information retrieval. Listed in each legend are the most common relationships found, but they should not be considered definitive.

Selected terms from the vegetation legend are defined here:

##### Map Symbol

A letter symbol representing each vegetation type (with subscript, if applicable, indicating corresponding successional stage).

##### Vegetation Type

Vegetation types are identified by the presence or absence of defined "species group" combinations. Definition of vegetation types and species groups was accomplished using the Ceska-Roemer computer program (see Section 3.4). Each vegetation type was named by a single representative species.

##### Species Group

Species groups are defined combinations of differentiating species which occur in association with one another and have restricted distributions in the study area.

### Number of Required Species

The number of species which must occur on a site out of the total listed for the species group in order for that group to be considered present and the corresponding vegetation type to be recognized.

### Associated Species

Species that occur with a frequency of greater than 60% within each vegetation type. These species can be used as additional information for determining which type is present on a site.

### Similar Vegetation Types

Vegetation types that have more than 50% species in common (evaluated from species listed in the "species group" and "associated species" columns).

A simple guide to using the vegetation map and legend follows (adapted from Moon 1980):

- 1) Locate the site on the map and note the corresponding vegetation map symbol (see Figure 1.5 for an explanation of map symbol notation).
- 2) Go to the vegetation legend and locate the appropriate map symbol. Information on the successional stage, subzone, moisture regime, and associated soil types is listed for the vegetation type represented by the map symbol.
- 3) Check that the vegetation type is correctly represented by ensuring that the indicated number of required species are present or that a majority of the characteristic species are present on the site. A further check can be made for occurrences of "associated species". Similar vegetation types are indicated in the last column of the legend.
- 4) If the vegetation map unit symbol is a composite (i.e., composed of two or three vegetation types; see Figure 1.5--map symbol notation), the appropriate vegetation type for a particular site can be determined using the following method. Look at the respective species group for each type indicated in the map unit and evaluate for which type the site contains the number of required species, then check for occurrences of corresponding associated species. In some cases a management unit may occupy a sufficiently large area to include more than one vegetation type. The above information enables the user to determine the extent of each vegetation type and thus apply the appropriate management prescriptions for each area.

5) The vegetation type(s) for sites located outside the map area, yet within reasonable proximity, may be determined by similarly going through the species group descriptions on the legend and evaluating for which type the number of required species criteria is satisfied. Check for occurrences of corresponding associated species for confirmation. The additional information on subzone, moisture regime, associated soil types, and successional stage is useful for reducing the initial number of types to consider.

b) Vegetation Types: Brief descriptions of the vegetation types are given below and their occurrences are diagrammatically represented in Figures 4.4 and 4.5. Stand composition is indicated by listing tree species in decreasing order of occurrence, and species with less than 16% frequency of occurrence are in parentheses. Insignificant occurrences were often not noted as the objective here was to give a general overview of the most representative stands. For further information describing the distribution and properties of the vegetation types refer to the soil and vegetation map legend (see Figure 1.5).

M - usually maturing seral stands (75-80 years) of F, Ep (Lw) with moderate F regeneration or mature edaphic climax sites (approx. 130 years) of F, Py with limited F regeneration; fire history evidenced by Lw, Py vets and burnt snags; moderate to steep slopes with well to rapidly drained, generally coarse textured soils and a moderate to high content of coarse fragments; frequently open-canopied stands with a high ground cover of shrubs, notably Mahonia aquifolium, Acer glabrum and Amelanchier alnifolia; occurs exclusively in the ICHa (35 plots).

V - predominantly fairly open-canopied maturing seral stands (75-80 years) of Lw, F (C) with frequent C regeneration; Lw, C vets are often present; well drained moderately fine to coarse textured soils on low to moderately steep slopes; lush understorey vegetation, dominated by Alnus viridis ssp. sinuata, Rubus parviflorus, and Thalictrum occidentale, reflects high light and nutrient supply and adequate soil moisture availability; found exclusively in the ICHa (6 plots).

B - often mature edaphic climax sites with open-canopied stands (60 years) dominated by Py, F with limited F regeneration; Py, F vets can occur; well to rapidly drained medium textured soils with a moderate to high content of coarse fragments; usually steep slopes where limited soil moisture and insolation restrict tree growth; high ground cover of Agropyron spicatum and frequent presence of Balsamorhiza sagittata and Lupinus sericeus are characteristics of this type; occurs exclusively at the lower elevations in the ICHa (5 plots).

- G - maturing seral (75-80 years) of F, Lw, P1 (Pw) with frequent C, Hw regeneration or closed-canopied, mature climatic climax stands (approx. 130 years) dominated by C with moderate C, Hw regeneration; Lw, F, Pw, Py vets, and burnt snags may be present; usually well drained medium to coarse textured soils with a moderate content of coarse fragments; sparse vegetation often predominated by Paxistima myrsinites, Vaccinium membranaceum, Clintonia uniflora, and Goodyera oblongifolia; low ground cover of vegetation due to dense regeneration and/or canopy-closure producing low light conditions in the understorey; common in both the ICHa and ICH/ESSF (56 plots).
- P - usually maturing seral stands (75-80 years) of F, P1, Ep, Lw with moderate F regeneration and limited C regeneration on the moister sites; F, Lw, Py vets, and burnt snags can occur; well drained medium to coarse textured soils on a wide range of slopes; often lush sites of diverse vegetation dominated by Shepherdia canadensis, Rubus parviflorus, Chimaphila umbellata, and Disporum hookeri; predominantly occurs in the ICHa (34 plots).
- T - mainly maturing seral stands (75-80 years) of F, Lw, C, Hw with frequent C, Hw regeneration or dense, mature climatic climax stands (approx. 150 years) of C, Hw with moderate C, Hw regeneration; F, Lw, C, Hw vets may be present; well to imperfectly drained medium to fine textured soils in normal to receiving slope position; good available moisture supply for plant growth, but high competition for light limits species diversity and ground cover of understorey vegetation; low herb growth of Clintonia uniflora, Goodyera oblongifolia, and Orthilia secunda is common; mainly occurs in the ICHa (26 plots).
- O - often dense, mature climatic climax stands (approx. 150 years) of mixed Se, B1, C, Hw with moderate regeneration of these species equivalently mixed; Lw vets may occur; well to moderately well drained medium to fine textured soils in normal to receiving slope position; good available moisture supply for plant growth yet understorey cover can be limited by low light conditions; Menziesia ferruginea, Ribes lacustre, Tiarella unifoliata, and Thalictrum occidentale are characteristic of this type; predominantly occurs in the ICH/ESSF (7 plots).
- C - mainly maturing seral stands (75-80 years) of P1, B1, Se, Lw with moderate B1 regeneration; Lw vets can occur; well drained medium to coarse textured, often shallow soils on moderate slopes; limited soil moisture for much of the growing season can inhibit tree regeneration; high ground cover of shrubs, notably Paxistima myrsinites and Vaccinium membranaceum, reflects high light conditions in the understorey; occurs most frequently in the ICH/ESSF (10 plots).

- J - predominantly mature edaphic climax sites with no trees or open-canopied stands ( > 60 years) of poor-growing F(Py) with limited F regeneration; F, Py vets may be present; steep shedding slopes of coarse textured materials and shallow soils or rock outcrops; very low soil moisture availability and insolation severely limits regeneration, combined with the intense browsing of tree seedlings by wildlife; vegetation adapted to very dry conditions such as Juniperus communis, Penstemon fruticosus, Arctostaphylos uva-ursi, Heuchera cylindrica, and Sedum stenopetalum, are characteristic of this type; occurs most commonly in the ICHa and ICH/ESSF (20 plots).
- U - disclimax vegetation on frequently active avalanche tracks; dense vegetation and physical action of avalanches inhibit tree regeneration; well drained coarse textured soils with a high coarse fragment content on steep gullied terrain; sporadic seepage caused by late-lying snow at higher elevations; lush herb growth dominated by Heracleum sphondylium, Epilobium angustifolium, and Veratrum viride; extends from upper elevations of the ICHa into the ESSFc (2 plots).
- A - fairly open mature climatic climax stands (approx. 150 years) of Se, B1 with moderate Se, B1 regeneration; no evidence of fire-scarred vets or burnt snags; well to imperfectly drained medium to fine textured soils, often with a low to moderate content of coarse fragments, on low to moderate slopes; open-canopied conditions provide adequate light for regeneration but high competition exists with the dense shrub growth of Rhododendron albiflorum, Menziesia ferruginea, and Vaccinium membranaceum; most commonly occurs in the ESSFc (7 plots).
- E - mainly maturing seral stands (60-80 years) of Ac, Ep, C with moderate C regeneration; no evidence of fire history recorded; poorly to moderately well drained, fine to coarse textured soils occasionally with a high coarse fragment content; flood plains, seepage sites or moisture-receiving slope positions with frequent high water tables; nutrient and moisture-rich sites which produce a high cover of understory vegetation when light is not limited by a closed canopy; Cornus sericea, Oplopanax horridus, and Equisetum arvense are characteristic of this type; occurs exclusively in the ICHa (2 plots and field notes).

- D - disclimax vegetation on frequently active avalanche tracks; high competition with vegetation, and physical action of avalanches inhibit tree regeneration; moderately well to well drained medium to coarse textured soils in normal to receiving slope positions; frequently gullied by stream channels, with seepage originating from late-lying snow above; dense shrub growth dominated by Alnus viridis ssp. sinuata, Sambucus racemosa, and Rubus parviflorus; extends from upper elevations of the ICHa into the ICH/ESSF (2 plots and field notes).
- R - open mature edaphic climax stands (60 years) of B1, (Se, P1) with sparse B1 regeneration; tree growth and establishment of regeneration limited by drought and the short growing season at higher elevations; steep rocky slopes and/or shallow coarse textured soils on shedding upper slope positions; moderate ground cover of low growing shrubs and herbs; occurs in upper elevations of the ICH/ESSF or in the ESSFc (field notes).
- H - mature edaphic climax sites, frequently treeless or with isolated tree islands of stunted Pa and L1, but mostly dominated by low-growing shrubs, herbs, and lichens interspersed among rocky areas; steep, exposed upper slope positions with shallow coarse textured soils, talus slopes or rock outcrops; harsh climatic conditions and the short growing season restrict growth and establishment of trees; occurs exclusively in the ESSFcp (field notes).
- L - mature climatic climax of treeless alpine areas or islands of stunted B1 with limited regeneration; low-growing shrubs and herbs or lush meadows on lower slope positions; cirque basins or moderate to low slopes with deep colluvium or coarse to medium to fine textured morainal, saprolite or eolian soils; harsh climatic conditions and the short growing season limit growth and establishment of trees; occurs exclusively in the ESSFcp (field notes).
- S - mature edaphic climax of treeless alpine areas or islands of stunted trees of B1 and Se with limited regeneration; moderately dense cover of shrubs and herbs reflects adequate soil moisture availability but climatic conditions (frost pockets and late-lying snow) and the short growing season limit growth and establishment of trees; open receiving areas, meadows, and gently sloping or flat seepage sites at the base of rocky talus slopes which stay moist from on-site or up-slope snowmelt; occurs exclusively in the ESSFcp (field notes).

Z - non-vegetated areas.

X - highly disturbed or cleared areas.

- c) Correlation: At the time field work was being conducted for this study, the ICHa and ESSFc subzones were still under revision by the Ministry of Forests Ecological Classification Program (Nelson Region). In January 1983, the subzones were finalized for the region. A short discussion of the correlation between the vegetation types presented in this study (Figure 1.5) and the ecosystem associations of the revised ICHa and ESSFc subzones is given below. For further information describing the distribution and properties of the subzones and ecological units, refer to the regional field guide (Utzig et. al. 1983).

The subzone designations over the study area have been modified in that the ICHa has been split into two variants, the ICHa1 and ICHa2. The ICHa1 occupies lower elevations between 400-1 200 m<sup>2</sup> while the ICHa2 is found above the ICHa1; i.e., at elevations above 1 200 m. The ICHa1 can be distinguished from the ICHa2 by the presence of Py and Bg and the lesser occurrence of B1. In general, the ICHa2 has a greater predominance of Se and B1, and appears to primarily include the ICH/ESSF transition described in this study (Section 2.6 and Figure 1.3). The ICHa1 and ICHa2 variants are still subject to further clarification by ground checking and mapping. The ESSFc occupies higher elevations between approximately 1 500-1 980 m but can occur at elevations below the ICHa2 in areas where there is cold air drainage. The characteristics of the ESSFc defined in the regional field guide correspond well with the ESSFc described in this study. The presence of vigorous Se and B1 regeneration, Rhododendron albiflorum and Valeriana sitchensis on zonal sites, and the general absence of Hw and C regeneration distinguishes the ESSFc from the ICHa2 at lower elevations.

The vegetation types described in this study are more refined classification units than the ecosystem associations of the regional ecological classification program. The vegetation types cover the range of successional stages encountered throughout the study area while the ecosystem associations primarily represent maturing seral or maturing climax stages.

Correlations between the two categories of classification can be based on similarities in vegetation composition, moisture regime and subzone. The table below summarizes these correlations. The ecosystem associations are indicated by their respective numbers and are vegetatively described in the species/association tables for the ICHa1, ICHa2, and ESSFc in the regional field guide (Utzig et. al. 1983).

Table 4.1 Vegetation types correlated with the B.C.F.S.  
Ecological Classification Program

VEGETATION TYPE	ICHa1 ECOSYSTEM ASSOCIATION	ICHa2 ECOSYSTEM ASSOCIATION	ESSFc ECOSYSTEM ASSOCIATION
M	3	--	--
V	1	--	--
B	2	--	--
G	1(3)	3(1)	--
P	3(1)	3	--
T	1(4)	1	--
O	--	1(4)	1
C	3	3	3
J	2	2	2
U*	--	--	--
A	--	--	4(1)
E	4(5)	4(5)	--
D*	--	--	--
R	--	--	3
*not comparable as disclimax vegetation.			

On the whole, the vegetation types described for this study area appear to be drier vegetationally than the ecosystem associations occupying the same range of soil moisture regime in the regional studies. The vegetation types largely characterize seral stages (and often young seral stages), so consequently greater amounts of light and heat can penetrate through the more open tree canopies. The serality, in combination with drier climatic characteristics of the study area (Section 2.4) are the probable causes of the drier composition of the vegetation types and the overlap of vegetation types and ecosystem associations.

## V. INTERPRETATIONS

### 5.1 Interpretations for Predicting Hydrologic Impacts

This map is intended to present a series of interpretations which will aid resource managers to plan future activities in a way that will protect the hydrologic resources. The map allows the land manager to recognize areas with potential hazards and plan around them where feasible. Where hazard areas cannot be avoided, the map provides information which can be used to anticipate impacts from development and project the costs of mitigating unacceptable impacts. The map, however, is not a replacement for site-specific, on-the-ground inspection. The map is intended for detailed planning, not site-specific management.

Forestry operations should find the map beneficial for planning preliminary access corridors, selection of harvesting systems, predicting environmental impacts of harvesting and access development, and assessing the costs of various alternatives. This interpretive map should be used in conjunction with the other folio maps, as the other maps provide additional information which can apply to specific situations (i.e., cost-effectiveness of two road options may depend on stability and bedrock occurrence, as well as the capability of the sites accessed).

The map is composed of five components which are described in the map legend and discussed briefly below (see Figure 1.6).

- a) Hydrologic Features: This component depicts the surface hydrology of the study area. For more detailed descriptions, licensing information, and intake locations one should consult the accompanying Hydrology Study (Salway 1983) or the B.C. Ministry of Environment, Nelson, B.C.

In general, most of the streams are of sufficient gradient to transport sediment to downstream water-users, however, some do have pools and irregularities in their profiles to offer some protection. Most streams also contain a number of debris jams, which if disturbed could lead to significant sediment movement. Most water-users have little or no sediment protection, or water storage facilities at this time.

The springs are primarily associated with bedrock aquifers, making them less susceptible to shallow disturbances, however, their recharge areas are not well defined (see Section 4.1c). Extreme caution should be exercised when disturbing any potential recharge areas.

- b) Mass Wasting: Mass wasting hazard designations can be an aid in evaluating road corridors and selecting harvesting systems. In general, as the hazard rating increases, the cost of an operation will increase, if adverse impacts are to be minimized.

Very Low and Low - These areas offer few problems to forest development. Careful application of standard road construction and ground skidding techniques should result in minimal impacts.

Moderate - These areas will require careful planning and maintenance to keep impacts at an acceptable level. Good management may require shovel construction, full benching, and occasionally, end hauling. Regular maintenance will be required to keep ditches and culverts open. Ground skidding may require prelocation of skid trails or logging on snowpack to limit disturbance. Cable systems may be preferred in some areas.

High - These areas will require specialized engineering procedures and low impact harvesting systems to maintain natural stability. Road construction will often require shovel construction, full benching, end hauling, retaining walls or outsloping of the road bed. In areas of bedrock, controlled blasting may be required. Cable or other non-ground skidding harvesting systems will be required, and selective logging may be required to maintain root systems. Revegetation of disturbed areas with shrubs will reduce impacts.

Extreme - These areas should be avoided whenever possible. If unavoidable for road construction, techniques listed above will be required. Forest harvesting will likely result in mass wasting. These areas should be designated EPA-(Es).

- c) Surface Erosion: Surface erosion is an important (but often subtle) contribution to site degradation and high road maintenance costs. Downstream it often results in reduced water quality.

Very Low--Moderate - These areas offer few problems to forest management. Normal prudence in drainage system design and maintenance should keep surface erosion to a minimum.

High and Extreme - These areas will require special attention to avoid soil loss through erosion. Recommended treatments include: increased frequency of culverts, outsloped road beds, minimize road grade, protect fills with culvert extensions or riprap, water bars, avoid ground disturbance during logging, avoid broadcast burning, and revegetate with grass seeding and mulching (see Utzig et. al. 1982 for grass seeding mixes).

- d) Sediment Delivery Hazard: This interpretation attempts to define areas where eroded material (initiated by mass wasting or surface erosion) is likely to be delivered into a stream channel or other water body. These designations are useful to separate the risk of sedimentation or reduced water quality from the risk of soil erosion per se. If eroded material does not reach a stream channel or water body, the hydrologic impact is negligible, even though the erosion may create a significant loss of site quality and should be of concern to the land manager.

Low - These areas are unlikely to supply eroded material to a stream channel or water body. Normal prudent management practices should bring acceptable results.

Moderate - These areas may deliver eroded materials to a stream channel or water body. If these areas are disturbed, special measures, as described below and in Sections 5.1b and 5.1c should be employed to reduce the risk of soil erosion.

High - These areas are likely to deliver eroded material to a stream channel or water body due to their proximity and slope. If water quality is to be maintained, soil disturbance should be avoided in such areas. Areas with moderate to high surface erosion and mass wasting hazards should be avoided completely (i.e., EPA-Eh). Areas with low to moderate mass wasting and surface erosion hazards will require careful management including grass seeding, mulching, detailed drainage design, and careful maintenance.

- e) Vegetative-Hydrologic Recovery: This interpretation is useful for predicting the duration of impacts on the hydrologic cycle due to vegetation removal. Removal of forest cover may affect the timing and increase the quantity of water reaching stream channels due to increased rate of snowmelt, loss of interception, and a decrease in evapotranspiration. Sites with rapid revegetation have short-lived effects (a matter of decades), while other sites may not fully recover for centuries. This interpretation should be used for planning cut-leave ratios and the timing of a harvesting program. For further information consult Isaacson (1977).

## 5.2 Engineering Features

The Engineering Features map is intended to present information useful in planning access development and forest management. The map allows the land manager to recognize areas with potential hazards and areas with favorable slope conditions and surficial materials. The map, however, is not a replacement for site-specific, on-the-ground inspection. The map is intended for detailed planning, not site-specific management.

Forestry operations should find the map beneficial for planning access corridors, selection of harvesting systems, locating aggregate sources, predicting environmental impacts of harvesting and access development, and assessing the costs of various alternatives (both developmental and mitigation of undesirable impacts). The Engineering Features map should be used in conjunction with the other folio maps, as these maps provide further information which may apply to specific situations (i.e., cost-effectiveness of two road options may depend on stability, bedrock occurrence and rippability, aggregate availability, as well as forest capability of the sites accessed).

The Engineering Features map includes five components which are described in the map legend and discussed briefly below (see Figure 1.7).

- a) Slope Classes: This information is relevant for planning a wide variety of management practices. In general, as the slope increases the difficulty and therefore the cost of an operation increases. Changes in slope are a factor in mass wasting, surface erosion and sediment delivery hazard evaluations. The slope classes were derived by considering ranges of slope relevant to forestry practices and evaluating the frequency distribution of slope measurements recorded during field work.
- b) Slope Configuration: These descriptions of ground surface conditions are useful for planning forest harvesting operations and silvicultural treatments. Specifically they affect the choice of yarding equipment, road and skid trail patterns, landing locations and construction costs, and the ease of mechanized site treatment.

Dissected - The shallowness of these gully-like depressions will be of minor significance to road construction, but should be considered when locating drainage structures and prescribing silvicultural treatments. Differences in soil drainage between the crests and swales may be sufficient to require special treatments (see Gullied).

Fluted - This type of configuration offers potential problems to road location, cut block layout or blanket applications of silvicultural treatments. With careful ground location of roads, landings and skid trails, however, the topography can often be used to the operator's advantage. Because the fluted topography is composed of a series of bedrock-cored ridges and intervening deeper soils, or a series of rock-faced terraces with alternating steep slopes (see Figure 4.2), it is essential that management operations include careful on-the-ground location and inspection prior to

construction or application. Silvicultural treatments will require careful planning in areas with a complex of productive sites and steep shallow soils or rocky sites. Fluted terrain generally has a reduced hazard for sediment delivery.

Gullied - Gullied slopes generally include steeply sloping areas with increased mass wasting hazard and a high potential for sediment delivery. Road and landing development will require on-the-ground location and careful drainage design, and may require special construction techniques such as shovel construction, riprap or retaining walls and extended culverts for cut and fill control. Cut block design and harvesting techniques should reflect the potential windthrow associated with moist soils and exposed crests, as well as the need for filter strips for sediment control. Silvicultural treatments should include consideration of the variation in soils between the crests and gully bottoms.

Hummocky - These areas offer few special problems. On-the-ground inspection will insure advantageous use of the varied topography. Because this configuration is usually associated with glaciofluvial deposits, there will be minimal variation in soil drainage between swales and crests. Mechanical maneuverability may be limited in extreme cases, however, sediment delivery hazard is low.

Random - These areas are a diverse assemblage of slopes, often composed of a topographic crest with slopes dropping away in numerous directions. These areas should be assessed on an individual basis for potential problems.

Simple - These areas are uniform and straightforward for planning most operations. Attention must be given to steeper slopes and their increased mass wasting, surface erosion, and sediment delivery hazards.

- c) Bedrock Occurrence: This component describes the probability of encountering bedrock within a particular map unit. In general, increased frequency of bedrock near the surface results in increased construction costs, the degree of costs depending on rippability and depth. An increase in bedrock occurrence may also result in decreased forest productivity, particularly with more resistant bedrock types.
- d) Bedrock Rippability: This component compares the relative resistance of the bedrock types to mechanical loosening by ripper teeth attached to a crawler tractor. This information is useful for planning road and landing construction, and assessing costs of various alternatives. Non-rippable bedrock types will require drilling and blasting, consequently increasing costs.

These interpretations are based on the relative differences in bedrock characteristics which affect rippability: fracturing, weathering, crystalline nature, presence of stratification or foliation, cementation and hardness. They are not based on field trials and therefore may require revision with actual field applications. Results may also vary somewhat, depending on the size of machine employed (the authors assumed D-7 to D-8).

- e) Occurrence of Construction Materials: This component describes the occurrence of materials for use as aggregate or fill. This information can be used in planning road location, locating gravel pits and assessing costs of road options. The high quality materials are primarily glaciofluvial or coarse textured morainal materials. The moderate to poor quality materials are medium to fine textured morainals and saprolites or medium to coarse textured colluvial deposits. The areas of high quality materials will provide adequate fill and surfacing materials, while other areas may require hauling of suitable surfacing and/or fill material. Coarse riprap material sources will be designated as poor quality, but can be identified on the terrain map as arC, raC, or aC map units.

### 5.3 Forest Capability

The Forest Capability map indicates the inherent ability of the map units to grow timber. It is intended as a planning tool for the identification of areas where forest management is more suitable. It also allows for a comparison between forestry values and other resource values in a multiple-use decision making process. It should not be used as a timber inventory, nor for defining specific silvicultural prescriptions. The various subclasses describe naturally occurring limitations to timber production, and these should be considered when assessing various management options (see Figure 1.8).

Brush Hazard - Brush competition can often be reduced by choosing harvesting techniques which favor advance regeneration or employing site treatments such as scarification or controlled burning. Immediate reforestation with large stock types can also reduce the problem.

Cold Climate - Careful choice of species and seed source will reduce reforestation losses. Maintenance of partial forest cover may be necessary to protect regeneration.

Slope - All management planning on these sites should carefully consider the potential for site degradation. Mechanical site preparation will not be an option.

Shallow and Coarse Textured Soils - These sites are droughty with shallow organic layers. Broadcast burning should be avoided. Reforestation may require partial cuts for maintenance of shade and a careful choice of species and stock type.

#### 5.4 Silvicultural Interpretations

The silvicultural interpretations are displayed in the following table. These interpretations are primarily derived from data collected for the Ecological Classification Program - Nelson Forest Region (Ministry of Forests), with minor modifications based on observations within the study area. A correlation of vegetation types and ecosystem associations can be found in Section 4.4. The potential uses and limitations of these interpretations are fully explained in the Forest Service publications (Utzig et. al. 1982, 1983). More specific stand management information was beyond the scope of this study and awaits collection of further mensuration data.

#### 5.5 Management Priorities

Long-term forest management priorities can generally be summed up with an answer to the following question: "Which areas will produce the largest volume of wood, in the shortest time, at the least cost?" (assuming acceptable harvesting impacts). To answer such a question in detail would require years of study, including such topics as market trends, insect and disease problems, social costs of harvesting impacts, response to fertilization and stocking control, tree species selection, etc. However, for a planning exercise, a relative comparison of forest capabilities and harvesting cost should suffice to demonstrate priority areas. The table below combines Engineering Features, Hydrologic Impacts and Forest Capability information in such a way. This scheme does not consider other conflicting uses such as recreation, wildlife, or agriculture. The left column describes a range of management priorities and non-operable areas. Each horizontal line within the priority designations, gives a combination of characteristics defining that priority level. Specific symbols are defined on the respective map legends.

Table 5.1 Silvicultural interpretations

SOIL TYPE	BIOGEO-CLIMATIC SUBZONE	MOISTURE REGIME	VEGETATION TYPE <sup>1</sup>	RECOMMENDED TREE SPECIES <sup>3</sup>	MINIMUM REGENERATION STOCKING LEVEL (St./ha) <sup>4</sup>	WINDTHROW HAZARD	PRESCRIBED BURNING	RELATIVE FOREST PRODUCTIVITY
A	ICHa	0-1	J	F,P1,Py,Lw	300 <sup>5</sup>	high	avoidance	very low
		2	M,P(G)	Pw,Lw,F,Py(P1)	600			
	ESSFc	0-1	J	Se,P1,F,Pa	300 <sup>5</sup>			
		2	R	P1,Se(F) <sup>2</sup>	600			
B	ICHa	1	J	F,P1,Py,Lw	400 <sup>5</sup>	high	avoidance	very low
		2(3)	M,P(C,G,V)	Pw,Lw,F,Py(P1)	600			low
	ESSFc	1	J	Se,P1,F,Pa	400 <sup>5</sup>			very low
		2(3)	R	P1,Se(B1) <sup>2</sup>	600			low
C	ICHa	2	B(J)	Py,F(P1,Lw)	400 <sup>5</sup>	moderate	avoidance	very low
		2-3	M,P	Pw,Lw,F,Py(P1)	800			low
	ESSFc	3-4	G,T(V)	Pw,Lw,F(P1,Py,Se)	1000		spot burning	medium
		2-3	R	P1,Se(B1) <sup>2</sup>	700		avoidance	low
		3-4	A	Se,P1,B1 <sup>2</sup>	800		spot burning	medium
D	ICHa	1-2	J(B)	F,Py(P1,Lw)	400 <sup>5</sup>	low	avoidance	very low
		2-3	M,P(G,C,V)	Pw,Lw,F,Py(P1)	800			medium
	ESSFc	1-2	J	Se,P1,F,Pa	400 <sup>5</sup>			very low
		2-3	R	P1,Se(B1) <sup>2</sup>	700			low
		3	A	Se,P1,B1 <sup>2</sup>	800			medium
F	ICHa	2	J,B(C)	F,Py(P1,Lw)	400 <sup>5</sup>	low	avoidance	very low
		3(4)	G,P(M,T)	Pw,Lw,F(P1,Py,Se)	800		spot burning	medium
	ESSFc	2-3	R	P1,Se(B1) <sup>2</sup>	700		avoidance	low
G	ICHa	2	J(B)	F,Py(P1,Lw)	400 <sup>5</sup>	low	avoidance	very low
		2-3	M,P(G)	Pw,Lw,F,Py(P1)	800			low
I	ICHa	2-3	P(C,M,V)	Pw,Lw,F,Py(P1)	800	moderate	spot burning	low
		3-4	G(M,P,T)	Pw,Lw,F(P1,Py,Se)	900		light broadcast	medium
	ESSFc	2-3	R,C	P1,Se(B1) <sup>2</sup>	700		avoidance	low
		3-4	A	Se,P1,B1 <sup>2</sup>	800		spot burning	medium
K	ICHa	3	M,P	Pw,Lw,F,Py(P1)	600	low	spot burning	medium
		3-4	G,T	Pw,Lw,F(P1,Py,Se)	1100		light broadcast	medium
	ESSFc	3-4	A(O)	Se,P1,B1 <sup>2</sup>	800		spot burning	medium
M	ICHa	3-4	G(P)	Pw,Lw,F(P1,Py,Se)	900	low	light broadcast	medium
		4-5	T(E,G,O,V)	Lw,Pw,F,Se(Hw,C)	1100	moderate		high
	ESSFc	4-5	A(C)	Se,P1,B1	900	moderate		medium
O	ICHa	4-5	G(P,T)	Pw,Lw,F,Se(P1,Lw)	1000	moderate	light broadcast	high
		5-6	E(O)	Ac,Lw,Se,F,C(Hw)	1200	high	medium broadcast	high
P	ICHa	5-6	E(G,T)	Ac,Lw,Se,F,C(Hw)	1200	high	medium broadcast	high
	ESSFc	5-6	A	Se,P1,B1	800		light broadcast	medium

<sup>1</sup> vegetation types X,Z,U,O are non-forested; H,L,S are ESSFc parkland and are EPA or non-forested

<sup>2</sup> F,Lw and Pw may show good growth below 1700m, but occur sporadically; correct provenance is essential

<sup>3</sup> Bg occurs sporadically and may be useful for increasing volume due to its shade tolerance; use with F,Lw or Pw on submesic to subhygric sites

<sup>4</sup> increases the number of stems by 30% where P1 exceeds 70% of the total

<sup>5</sup> some sites non-forested

Table 5.2

Management Priorities

Priority	Forest Capability	Mass Wasting	Bedrock Occurrence	Sediment Delivery	Surface Erosion
High	G	1-2	1-5	---	---
	G	3	1-3	x,b	---
	M	1-2	1-5	---	---
Moderate	G	3	1-3	a	---
	G	3	4-5	---	---
	G	4	1-5	x,b	---
	M	3	1-3	---	---
	P	1-2	1-3	---	---
Low	M	3	4-5	---	---
	M	4	1-5	x,b	---
	P	1-2	4-5	---	---
	P	3-4	1-5	---	---
EPA (Es)	---	5	---	---	---
EPA (Eh)	---	4-5	---	a	---
	---	---	---	a	4-5
EPA (Ep)	V	---	---	---	---
Non-forested	N	---	---	---	---

## 5.6 Wildlife Habitat

This section attempts to describe the capability of the various vegetation types for use by selected wildlife species by season. The abundance of seral stands within this study area provides highly diverse habitats for wildlife species. The climax stand types provide essential cover for thermal protection. Cultivated fields and orchards provide winter to early spring range for elk and deer. Frequent evidence of elk and deer was observed in most of the lower and mid elevation vegetation types. Bear are wide spread throughout the area, while mountain goats are restricted to the upper elevations. Between 1940 and 1970, mountain caribou were encountered regularly by trappers in Clint, Carney, Fry, Salisbury, and Gar Creek drainages in mature forests above 1100 m. Snowfall variation and snow quality (hardness, density, etc.) affect movement patterns of all species year to year. The criteria used to describe the habitats is discussed below (adapted from Vold et. al. 1980).

- a) Snow interception: tree canopy cover,  $<40\%$  = low snow interception;  $40-60\%$  = moderate snow interception;  $>60\%$  = high snow interception; snow depths exceeding 1 m are generally limiting for deer and elk; C and F are most effective at intercepting snow.
- b) Movement corridors: winter-areas with reduced snow depth; summer open areas with low to moderate shrub growth or mature stands with sparse undergrowth.
- c) Lower elevation areas: preferred for winter habitat by deer and elk due to lower snow depths.
- d) Winter range: critical areas for deer and elk are low elevation, open, insolated slopes or dense closed canopy stands of F or C with good snow interception and adequate thermal cover; tall shrubs offering spring browse above the snow are also desirable; critical areas for caribou are mature stands at mid to upper elevations supporting a high density of epiphytic lichens, especially Alectoria sp., and tall shrubs available for browse above the snow.
- e) Aspect: exposed, insolated south-southwest aspects have reduced snow depths and lose winter snow cover early providing late winter range.
- f) Canopy cover: provides hiding cover, snow interception, thermal protection.
- g) Summer and fall range: abundance of suitable shrub and herb forage, valley bottom and high elevation slopes and meadows provide good habitat for most ungulate species.

The vegetation types are characterized below, including observations recorded during this study (additional information from Herbison 1981).

Table 5.3 Wildlife Capability

Vegetation Type	Wildlife Observations	Wildlife Habitat Descriptions
Mahonia Aquifolium (M)	elk scats deer scats trails heavy browse direct sighting-deer	low snowpack on steep south-southwest facing slopes provides good winter or early spring range for deer and elk snags present for woodpecker habitat mineral lick noted in lacustrine-like material (g F6b) north of Weir's spring dense canopies of Pseudotsuga menziesia provide high snow interception, moderated temperatures and cover for elk and deer low elevation type, thus snow is off sites early providing spring range good shrub growth of browse species: Amelanchier alnifolia, Rosa gymnocarpa, Acer glabrum, Shepherdia canadensis, Symphoricarpos albus moderate herb growth of browse species: Calamagrostis rubescens, Lilium columbianum, Disporum hookeri, Fragaria vesca
Viola glabella (V)	deer scats elk scats bear scats trails moderate browse	moderate snow pack on low slopes provides spring or early summer range for elk, deer, and bear fairly open canopies provide low to moderate snow interception and cover sites with high shrub growth of Alnus viridis ssp. sinuata and Acer glabrum are suitable for caribou winter range good shrub growth of browse species: Rubus parviflorus, Paxistima myrsinites, Spiraea betulifolia, Lonicera utahensis good herb growth of browse species: Thalictrum occidentale, Aster conspicuus
Balsamorhiza sagittata (B)	elk scats deer scats bear scats trails moderate-heavy browse	low elevation steep south-southwest facing slopes with very low snowpack provide excellent winter range for deer and elk open tree canopies with lush grassy understories provide good winter forage low to moderate shrub growth of browse species: Amelanchier alnifolia, Spiraea betulifolia good herb growth of browse species: Agropyron spicatum

Vegetation Type	Wildlife Observations	Wildlife Habitat Descriptions
<i>Goodyera oblongifolia</i> (G)	deer scats elk scats bear scats trails low-moderate browse	mid elevation low to moderate slopes with low snow interception by tree canopy provide late spring to fall range for elk and deer climax stands provide lichens ( <i>Alectoria</i> sp.) suitable as winter forage for caribou snags present for woodpecker habitat shrub strata generally low in height so unobtainable by deer and elk until snowmelt sufficient (spring) berries of <i>Vaccinium membranaceum</i> provide good summer forage for bear low shrub growth of browse species: <i>Rosa gymnocarpa</i> , <i>Mahonia aquifolium</i> , <i>Paxistima myrsinites</i> , <i>Lonicera utahensis</i> , <i>Vaccinium membranaceum</i> no herbs of significant forage value
<i>Pinus contorta</i> (P)	elk scats deer scats bear scats trails moderate browse	steeper southwest facing slopes with moderately high shrub growth are suitable for late winter and early spring range for deer and elk lower slope sites with moderate snowpack provide late spring to fall range generally moderate snow interception by tree canopy snags present for woodpecker habitat berries of <i>Vaccinium membranaceum</i> provide good summer forage for bear good shrub growth of browse species: <i>Amelanchier alnifolia</i> , <i>Rosa gymnocarpa</i> , <i>Shepherdia canadensis</i> , <i>Spiraea betulifolia</i> , <i>Acer glabrum</i> , <i>Vaccinium membranaceum</i> moderate herb growth of browse species: <i>Calamagrostis rubescens</i> , <i>Disporum hookeri</i> , <i>Fragaria vesca</i>
<i>Thuja plicata</i> (T)	deer scats trails	dense canopy covers of <i>Thuja plicata</i> effectively intercept snow and the resulting low to moderate snowpack provides areas of winter to early spring range for deer and elk closed canopy conditions provide cover and moderated temperatures mature and decadent trees of <i>Thuja plicata</i> provide lichens ( <i>Alectoria</i> sp.) as winter forage for caribou springs and seeps occurring through this type provide a summer water source the only significant forage species is <i>Vaccinium membranaceum</i> (berries for bears)
<i>Orthilia secunda</i> (O)	elk scats deer scats bear scats low-moderate browse	dense canopy closure provides moderate to high interception of snow yet most sites are too high in elevation for deer or elk winter range good winter forage ( <i>Alectoria</i> sp.) for caribou in the older climax stands canopy closure provides cover and thermal protection in extreme temperatures seeps and springs provide a summer water source moderate shrub growth provides late spring to fall forage for deer and elk while berries of <i>Vaccinium membranaceum</i> supply summer forage for bear shrubs utilized as browse species: <i>Rubus parviflorus</i> , <i>Paxistima myrsinites</i> , <i>Vaccinium membranaceum</i> , <i>Menziesia ferruginea</i> , <i>Ribes lacustre</i>

Vegetation Type	Wildlife Observations	Wildlife Habitat Descriptions
<i>Chinaphila umbellata</i> (C)	deer scats bear scats elk scats moderate browse	higher elevation sites and areas with moderate snow interception by the tree canopy layer provide late spring to fall range for deer and elk extensive shrub cover of <i>Vaccinium membranaceum</i> supplies good summer forage for bears good shrub growth of browse species: <i>Paxistima myrsinites</i> , <i>Lonicera utahensis</i> , <i>Vaccinium membranaceum</i>
<i>Juniperus communis</i> (J)	deer scats elk scats trails- extensive direct sighting-mt. goat heavy browse	low snowpack on steep exposed south-southwest facing slopes provides winter range for deer and elk at lower elevations extensive elk trails indicate use of this type as a movement corridor to higher elevations in spring heavy use by wildlife produces large areas of bare mineral soil susceptible to surface erosion moderate shrub growth of browse species: <i>Anelanchier alnifolia</i> , <i>Spiraea betulifolia</i> , <i>Shepherdia canadensis</i> , <i>Symphoricarpos albus</i> low herb cover of browse species: <i>Agropyron spicatum</i> , <i>Calamagrostis rubescens</i>
<i>Urtica dioica</i> (U)	No observations	high elevation and lack of trees results in a high winter snowpack so this type is mostly restricted to late summer and fall range for elk, deer and caribou steeper south facing slopes lose snow first providing earlier summer range streams and seepage provide a summer water source lush slide vegetation provides summer forage and cover for elk, deer, caribou, and bear good shrub growth of browse species: <i>Sambucus racemosa</i> , <i>Rubus parviflorus</i> , <i>Cornus sericea</i> good herb growth of browse species: <i>Erythronium grandiflorum</i> , <i>Veratrum viride</i> , <i>Thalictrum occidentale</i>
<i>Abies lasiocarpa</i> (A)	trails	high elevation sites with low to moderate snow interception by the tree canopy provide summer and fall range for deer and elk stands of older trees have a high density of lichens ( <i>Alectoria</i> sp.) providing winter forage for caribou some sites have seepage providing a summer water source tree canopy provides hiding cover and cooler temperatures in the summer months moderate to high shrub growth of browse species: <i>Lonicera utahensis</i> , <i>Menziesia ferruginea</i> , <i>Vaccinium membranaceum</i>

Vegetation Type	Wildlife Observations	Wildlife Habitat Descriptions
<i>Dryopteris assimilis</i> (D)	No observations	high elevation and lack of trees result in a high winter snowpack so this type is most suitable for late summer and fall range for deer, elk, and caribou south facing aspects lose snow first providing earlier summer range streams and seepage provide a summer water source lush slide vegetation provides cover and summer forage for elk, deer, bear, and caribou good shrub growth of browse species: <i>Rubus parviflorus</i> , <i>Sambucus racemosa</i> , <i>Ribes lacustre</i> , <i>Vaccinium membranaceum</i> good herb growth of browse species: <i>Streptopus amplexifolius</i> , <i>Thalictrum occidentale</i>
<i>Equisetum arvense</i> (E)	No observations	low elevation sites with moderate to high snow interception by the tree canopy provide good late winter to spring range for deer and elk wet floodplain sites with dense tall shrubs provide ideal moose habitat water available year round on most sites high shrub growth and tree canopy cover provide hiding places and cool temperatures in summer months moderate to excellent growth of browse species: <i>Acer glabrum</i> , <i>Cornus sericea</i> , <i>Rubus parviflorus</i> , <i>Thuja plicata</i> regeneration, <i>Disporum hookeri</i>
<i>Rhododendron albiflorum</i> (R)	No observations	high elevation sites with low snow interception by the tree canopy result in a high winter snowpack yet the steep south-southwest facing slopes lose snow early providing early summer range for deer, elk, and caribou winter range potential for caribou as the more open stands of <i>Abies lasiocarpa</i> have a moderate cover of epiphytic lichens ( <i>Alectoria</i> sp.) suitable summer and fall range for elk, deer, caribou, and bear moderate shrub growth of browse species: <i>Lonicera utahensis</i> , <i>Paxistima myrsinites</i> , <i>Vaccinium membranaceum</i> moderate herb growth of browse species: <i>Vaccinium scoparium</i> , <i>Arnica latifolia</i>

Vegetation Type	Wildlife Observations	Wildlife Habitat Descriptions
Parkland Types	Grizzly bear	harsh climatic conditions and high snowpack limit suitability of this type to late summer and early fall range for elk, deer and bear
Hieracium gracile (H)		tree islands provide lichen forage for caribou in the early spring until the snow melts sufficiently to expose shrub vegetation in the meadows
Luzula parviflora (L)		streams and seepage in the wettest vegetation type (Senecio triangularis) provide a summer to fall water source
Senecio triangularis (S)		rocky areas and talus slopes provide year round range for mountain goat
		cool temperatures at these higher elevations provide thermal protection during the hottest summer period
		low to moderate shrub growth of browse species: Sorbus sitchensis, Lonicera utahensis, Vaccinium membranaceum
		low to moderate herb growth of browse species: Veratrum viride, Senecio triangularis, Vaccinium scoparium, Valeriana sitchensis, Carex sp.
		open meadows provide an unrestricted movement corridor in summer and fall and also are utilized as elk mating areas

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## APPENDIX

DATE _____		RECONNAISSANCE FORM										SITE No. _____																																																																																																													
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<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <b>GEOLOGY</b>  <b>BEDROCK TYPE</b> _____ <b>COARSE FRAG. LITH.</b> _____ </div> <div style="border: 1px solid black; padding: 5px;"> <b>SOILS</b>  <b>SOIL CLASSIF.</b> _____ <b>TERRAIN CLASSIF.</b> _____  <b>HUMUS FORM</b> _____ <b>DRAINAGE CLASS</b> _____ <b>ROOTING DEPTH</b> _____ cm  <b>SEEPAGE WATER DEPTH</b> _____ cm <b>ROOT RESTRICTION LAYER AND DEPTH</b> _____ cm </div>		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" rowspan="2"></th> <th colspan="10" style="text-align: center;">SURFACE SUBSTRATE</th> </tr> <tr> <th colspan="2">HUMUS</th> <th colspan="2">D. W.</th> <th colspan="2">BEDROCK</th> <th colspan="2">ROCKS</th> <th colspan="2">MINERAL SOIL</th> <th colspan="2">WATER</th> </tr> </thead> <tbody> <tr><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> </tbody> </table>														SURFACE SUBSTRATE										HUMUS		D. W.		BEDROCK		ROCKS		MINERAL SOIL		WATER																																																																																					
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Mark a slash (/) over parameter number when not found. Parameters which must be filled in are circled.

Comments:

- | 27. Ecological Moisture Regime | 28. Nutrient Regime | 29. Soil Temperature Class | 30. Soil Moisture Subclass |
|--------------------------------|---------------------|----------------------------|----------------------------|
| a. very xeric                  | a. oligotrophic     | a. extremely cold          | a. xeric                   |
| b. xeric                       | b. submesotrophic   | b. very cold               | b. arid                    |
| c. subxeric                    | c. mesotrophic      | c. cold                    | c. subarid                 |
| d. submesic                    | d. permesotrophic   | d. cool                    | d. semiarid                |
| e. mesic                       | e. eutrophic        | e. mild                    | e. subhumid                |
| f. subhygric                   | f. hypereutrophic   |                            | f. humid                   |
| g. hygric                      |                     |                            | g. perhumid                |
| h. subhydric                   |                     |                            | h. subaquic                |
| i. hydric                      |                     |                            | i. aquatic                 |
|                                |                     |                            | j. peraquic                |

31. Soil drainage  
 a. rapidly  
 b. well  
 c. mod. well  
 d. imperfectly  
 e. poorly  
 f. very poorly

32. Perviousness  
 a. rapidly  
 b. moderately  
 c. slowly

33. Free Water  
 a. present  
 b. absent

34. Flood hazard  
 a. frequent and irregular  
 b. frequent  
 c. may be expected  
 d. rare  
 e. no hazard

36. Bedrock type      37. Bedrock structure

35. Depth to (cm)

- a. water table \_\_\_\_\_  
 b. rooting (effective) \_\_\_\_\_  
 c. root restricting layer \_\_\_\_\_  
 d. frozen layer \_\_\_\_\_  
 e. bedrock \_\_\_\_\_  
 f. carbonate \_\_\_\_\_  
 g. salinity \_\_\_\_\_

_____ : _____	_____
_____ : _____	_____

38. Coarse fragment lithology  
 a. type (in order of dominance)  
 \_\_\_\_\_ : \_\_\_\_\_ | \_\_\_\_\_ : \_\_\_\_\_ | \_\_\_\_\_ : \_\_\_\_\_  
 b. mixed

40. Factors Influencing Stand Establishment  
 \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_

39. Successional Status

Present Stage: PS, YS, MS, OS, YEC, YCC,  
 MC, MCC, MEC, DC, NV

Expected climax \_\_\_\_\_

42. Humus Form Class. \_\_\_\_\_ - \_\_\_\_\_ . \_\_\_\_\_

Rate of succession

- a. very slow      d. rapid  
 b. slow            e. very rapid  
 c. normal

Variants \_\_\_\_\_ : \_\_\_\_\_ : \_\_\_\_\_ : \_\_\_\_\_

41. Veg. Plot: Area \_\_\_\_\_ (ha) Shape \_\_\_\_\_  
 Dim \_\_\_\_\_ x \_\_\_\_\_ (m)

44. Profile Status  
 a. modal  
 b. variant  
 c. taxadjunct  
 d. undecided

45. Profile Deviation  
 a. none  
 b. solum thickness  
 c. colour  
 d. texture  
 e. drainage  
 f. chemical  
 g. horizon thickness  
 other \_\_\_\_\_

46. Soil Mapping Unit  
 a. series  
 b. family  
 c. associate  
 d. association  
 e. catena  
 f. complex  
 g. land system  
 h. land type  
 z. other

43. Surface Substrate

SUBSTRATE	% COVER
Decaying Wood	_____
Bedrock	_____
Cobbles and Stones	_____
Mineral Soil	_____
Organic Matter	_____
Water	_____
Total	100%

47. Soil name \_\_\_\_\_

48. Associated soil \_\_\_\_\_ 49. Profile No. \_\_\_\_\_

(50) Project Coordinator      Surveyor

(51) Agency

(52) Type of Soil Sample

- A. Sampled  
 1. Chemical      2. Physical  
   a. full          a. full  
   b. partial        b. partial  
 B. No Sample

53. Veg. Sampling Tech. \_\_\_\_\_

54. Notes on Site Description \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

-	8	1
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DEFECT 1.0.

59

Province of British Columbia Ministry of Environment Ministry of Forests

0	1	15	16	17	18	19	20	21	22	23
	HORIZON DESIG.	PH	PORES	HOR. POR.	CLAY FILMS	EFFER	SECONDARY CARBONATE DESCRIPTION	SAL	CONCRECTIONS, NODULES AND CASTS	CEMENT.
		reaction	Ab. Size Op. Dist Cont Mor Type		Freq. Thi Loc.	Degr	Cont Ab. Size Shape Str. Spo	Consist. Mst Dry	Kind Ab. Size Loc Shape Aspect Hue Letter(s) Value Chroma	Agent Degree Extent
L			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
E			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
V			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
E			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
L			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
a			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
b			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
c			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
d			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
e			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
f			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
g			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
h			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
i			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D
j			V F P A	S V S	F C M CS	VM	1 F F F	W M S	1 F F F	1 M C D

0	1	24	25	26	27
	HORIZON DESIG.	ORGANIC MATERIAL DESCRIPTION	GENERAL COMMENTS ON SOIL CHARACTERISTICS	SOIL TEMP	SCHEMATIC SOIL PROFILE
		Material Composit Kind Decom Hard Woody Material Hard Vol Pyro. Index Von Post Scale		Depth Cm °C	
L		1 2 1 2 3 4		0 .	10
E		1 2 1 2 3 4		5 .	0
V		1 2 1 2 3 4		10 .	25
E		1 2 1 2 3 4		20 .	50
L		1 2 1 2 3 4		50 .	75
a		1 2 1 2 3 4		100 .	100
b		1 2 1 2 3 4			
c		1 2 1 2 3 4			
d		1 2 1 2 3 4			
e		1 2 1 2 3 4			
f		1 2 1 2 3 4			
g		1 2 1 2 3 4			
h		1 2 1 2 3 4			
i		1 2 1 2 3 4			
j		1 2 1 2 3 4			

FORM NUMBER

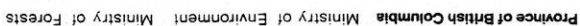
				-	8	0
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SURVEYOR \_\_\_\_\_

[illegible]

R. D. PENHALL LTD., MADE IN VANCOUVER, CANADA  
DUKSBAK WATERPROOF

7. Comments on Vegetation Characteristics:

[illegible]

FORM NUMBER

				-	8	0
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PLOT NO.

PAGE OF

CURVEYOR

[illegible][illegible][illegible]

# WILDLIFE AND RANGE FORM

FORM NUMBER

80

PROJECT ID \_\_\_\_\_

PLOT NO. \_\_\_\_\_

PAGE \_\_\_\_\_ OF \_\_\_\_\_

SURVEYOR \_\_\_\_\_

## 1. Utilization of Browse Plants (recorded on Vegetation Form)

- a. Utilization Rating
- b. Utilization Form Class

## 2. Ungulate Pellet Group Counts

- a. Method A
- b. Method B
- c. Method C
- d. Other Method \_\_\_\_\_

UNGULATE SPECIES	SUBPLOT					TOTAL
	1	2	3	4	5	

3 Wildlife List	4 Wildlife Sign	5 Habitat Characteristic	6 Avail. Food Source	7 Season of Use	8 Comments

## 9. Utilization of Forage Plants 11. Productivity

- a. No Utilization
- b. Trace (1-5%)
- c. Light (6-25%)
- d. Moderate (26-50%)
- e. Heavy (>50%)

## 10. Range Condition

- a. Excellent
- b. Good
- c. Fair
- d. Poor
- e. Not determined

Plant Group	Estimated	Measured		
	Green Wt. kg/ha	Green Weight kg/ha	Air-Dry Weight kg/ha	Oven-Dry Weight kg/ha
Grasses, forbs				
Browse species				
Other (specify)				

## 12. General Comments on Wildlife and Range

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