SOIL AND VEGETATION RESOURCES of the pend-d'oreille valley, b.c.

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SOIL AND VEGETATION RESOURCES OF THE PEND-D'OREILLE VALLEY, B.C.

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PREFACE

This report contains detailed information and maps on the soil and vegetation resources of the Pend-d'Oreille Valley in southeastern British Columbia, and, with the assistance of the Fish and Wildlife Branch, provides biophysical interpretations for the management of white-tailed deer winter range. The report also contains information on geology, climate, human history, and land use; and soil interpretations for agriculture, forestry, recreation, and engineering uses.

The report is primarily aimed at complementing the soil and vegetation maps so that they can be used most effectively for resource management. Consequently, the chapters on soil and vegetation provide descriptions of map units and interpretations for land uses. The report is not intended to be read cover to cover, but to be used as a manual for field and office use.

Most readers will be interested only in certain sections or chapters of the report. A quick review of the Table of Contents will direct you to those appropriate sections which are most relevant.

Please note that the Resource Analysis Branch referred to in the text is now the Terrestrial Studies Branch and Air Studies Branch.

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Chapter One

GENERAL DESCRIPTION OF STUDY AREA

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1.1. Objectives of the Study

The Resource Analysis Branch, B.C. Ministry of Environment, received a request in 1977 from the Fish and Wildlife Branch, B.C. Ministry of Environment, for a relatively detailed assessment of the Pend-d'Oreille Valley's soil and vegetation resources. The information was needed for input into a detailed wildlife management plan intended to compensate for wildlife losses resulting from the construction of a B.C. Hydro dam on the Pend-d'Oreille River. In developing a preliminary wildlife management plan for the area (Dick et al., 1977), the Fish and Wildlife Branch recognized the need for a more thorough evaluation of wildlife habitat, and thus requested the soil and vegetation inventory.

In recognition of other potential land uses in the valley, and the need for coordinated resource planning with a sound biophysical (soil and vegetation) data base, the Resource Analysis Branch encouraged other agencies having concerns in the valley to indicate what kinds of land use interpretations they would require. As a result of this interchange, a number of land use interpretations have been prepared in this report. In addition to the wildlife interpretations presented in Chapter Four for white-tailed deer management, interpretations have also been prepared for agriculture, forestry, recreation, and engineering uses.

Chapter One of the report provides a general description of the Study Area. The setting of the Pend-d'Oreille River Valley is described in terms of location, land use characteristics, physiography, geology and climate. Climatic characteristics are discussed in relative detail because of their direct effect on the soil resource inventory, particularly soil climate. Consequently, a number of background climate tables are presented in Appendix C.2 which support the general conclusions arrived at in the report itself.

Chapter Two describes the soil resource inventory program and its application to a number of land uses. Survey methods are first discussed, soil resources are then described with respect to soil parent materials (surficial materials) and soil classification. Each soil type is described in detail in Appendix A.2. The soil maps for the valley are in the back pocket.

Soil interpretations for recreational uses such as campgrounds and picnic sites, and for engineering uses such as septic tanks, shallow excavations, dwellings, and roads are also presented in Chapter Two. Potential soil erosion hazard ratings are provided with the engineering interpretations. Lastly, capability ratings for agriculture and forestry are presented.

Chapter Three describes the vegetation resource inventory and emphasizes its applications for wildlife management. Appendix B contains a key of vegetation types and an indication of successional relationships. Soil and vegetation relationships are also presented. The vegetation maps for the valley are also found in the back pocket.

Chapter Four discusses the soil and vegetation resource inventory in the context of wildlife management, and presents specific interpretations for white-tailed deer winter range management. White-tailed deer winter range losses due to B.C. Hydro's new dam were the basis for compensation to the Fish and Wildlife Branch, and are the main focus of wildlife management for the Study Area.

1.2. The Study Area

The 220 sq. km Study Area (Figure 1.1) abuts the Washington (U.S.A.) border over a distance of about 21 km, from the Columbia River to 1.6 km east of where the Pend-d'Oreille River crosses the international boundary. The northern limit of this semi-circular area follows the divide between streams draining into the Pend-d'Oreille River to the south and Beaver Creek to the north (along which Highway 3 is located). The eastern limit of the Study Area includes the drainage of McCormick Creek and was extended about 6 km up the Salmo River to include elk winter range areas on south-facing slopes. The Study Area is located on 1:50 000 map sheets 82 F/4E (Rossland-Trail) and 82 F/3W (Salmo), and lies between 117° 20' and 117° 37' West latitude, and between 49° 00' and 49° 07' North longitude. Elevations range from about 450 m at Waneta Dam to 1500 m on the south side of the river and 1800 m on the north side.

The Pend-d'Oreille River (named after a local Indian group, so-called by French Canadian voyageurs because of their practice of wearing dangling shell ear-rings) is the outlet of a major

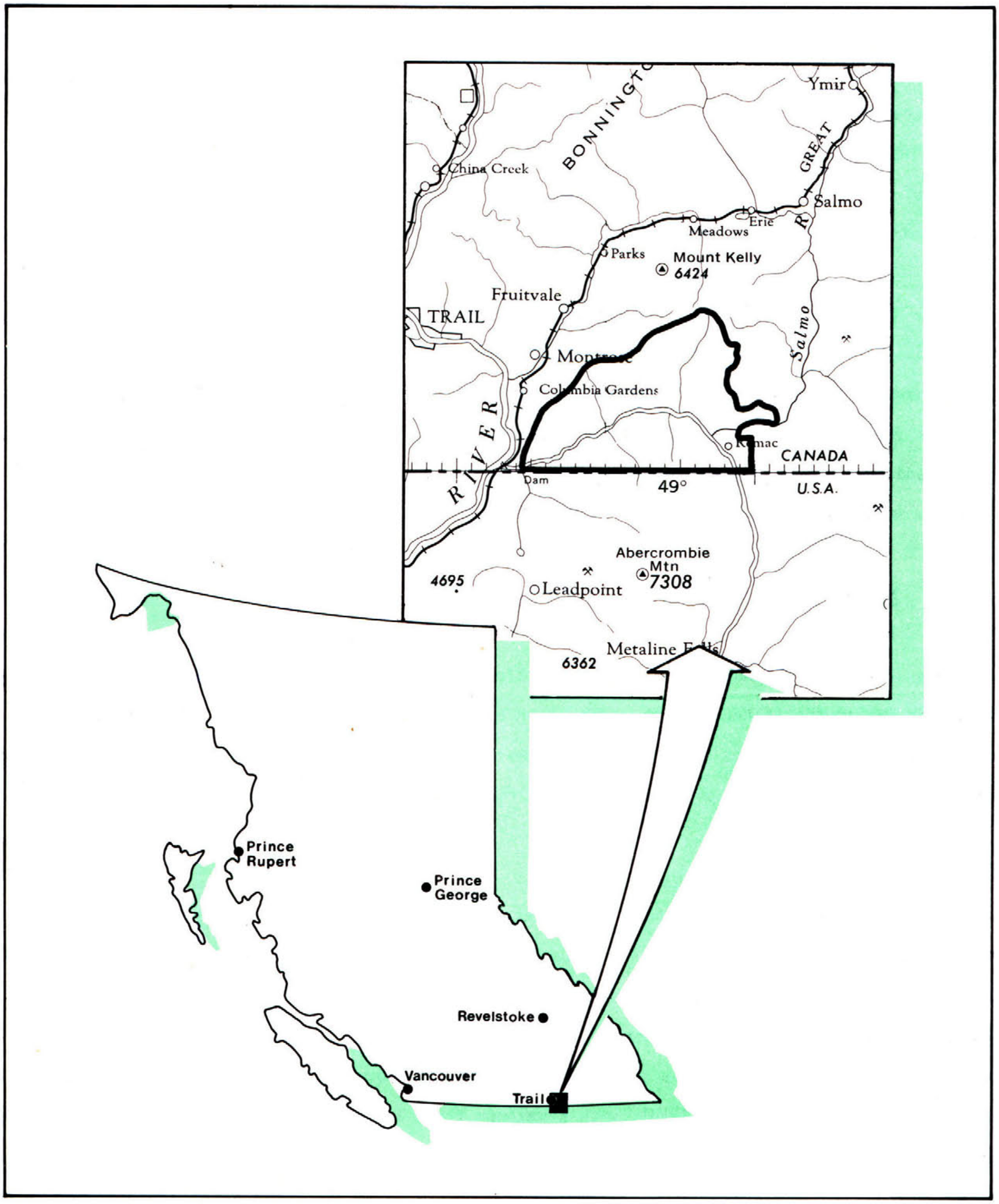


Figure 1.1. GENERAL LOCATION OF STUDY AREA

river system originating in northwestern Montana. The Pend-d'Oreille River drains Lake Pend-d'Oreille in Idaho, from whence it flows northward into Washington State, and on to the Canadian border. Once in British Columbia, the river flows along a generally westward course, dropping 125 m over 24 km to where it empties into the Columbia River at Waneta. This westerly course creates a predominance of southern aspects on the relatively steep slopes north of the river. As detailed later, due to favourable climate, soil, and vegetation patterns, the lower levels of these south-facing slopes possess the highest capability for white-tailed deer winter range in the West Kootenay region.

Before dams were built on the Columbia River, spring salmon and steelhead migrated from the Pacific up the Columbia and Pend-d'Oreille Rivers to spawn in the waters of the Salmo River (once known as the Salmon River). The Pend-d'Oreille's peak flow usually occurs in June when the river is very turbulent as a high volume of water (in excess of 2800 cu.m/sec.) pours over numerous rapids and several low falls. In the summer, the river's level drops considerably, and its water warms to swimming temperatures (low 20° C's).

Hydro-electric Dams on the Pend-d'Oreille River

Two dams already exist on the Pend-d'Oreille River in or adjacent to the Study Area. Just upstream from the international boundary, Seattle City Light's Boundary Dam floods 28 km of river valley in Washington State, forming a reservoir 675 ha in area. In the mid-fifties, Cominco Ltd. constructed the Waneta dam at the mouth of the Pend-d'Oreille River, utilizing 63 metres of the river's fall and flooding approximately 7 km of river and an area of 175 ha.

B.C. Hydro's Seven Mile Project

B.C. Hydro's hydro-electric dam (under construction as of this writing) is located midway on the Pend-d'Oreille River's loop into Canada, near the mouths of Church Creek and Nine Mile Creek. The site is about 9.5 km upstream from Waneta Dam and 16 km downstream from Boundary Dam. The new dam will flood most of the river's remaining fall in B.C. (about 60 m) creating a reservoir over 13 km long, extending nearly to the American border. Normal high water level in the reservoir will be about 523 m above sea level, with a maximum flood level of 530 m (Envirocon et al., 1975). Because this will be a run-of-the-river power system, drawdown in the reservoir will reportedly be relatively small. Reservoir flooding will inundate 170 ha of existing river channel, and will remove about 210 ha of hillside from its present use: 96 ha on the south side and 114 ha on the north side. This land has Class 3 forest capability but its main value is as important winter range (Class 2 and 3) for deer (Envirocon et al., 1975). The reservoir formed behind Seven Mile Dam will be long and narrow (roughly 0.5 km wide) and should not prevent deer from crossing the valley.

Early in the project, a 12 km long paved access road was constructed on the north side of the Pend-d'Oreille Valley, linking both the City of Trail and some gravel pits along the Columbia River with the dam site. According to B.C. Hydro, a road across the dam itself will also provide access to the south side of the river.

Also to be constructed in conjunction with the dam, spillway, powerhouse, and temporary camp is a new switching station, to be located 3 km up Nine Mile Creek, from whence power will be routed northward, thence eastward via the Salmo valley, and southward to the U.S. via a new substation between Remac and Nelway. These power transmission routes, amounting to over 21 km of lines in the Study Area, will be cleared of all tree cover to a width of nearly 50 metres.

A system of secondary access roads of undetermined total mileage will also be constructed in conjunction with the project. Most conspicuous of those remaining after the reservoir is filled will be access roads to the transmission lines.

The main all-weather gravel road presently situated on the north side of the Pend-d'Oreille Valley (connecting the dam site, the now defunct Remac mine area, and the Nelway border crossing) will also be affected by the flooding of the valley. Over 5 km of this road will be flooded or subject to slumping once the reservoir is filled. The desirability of an alternate route in the Pend-d'Oreille Valley by-passing this flooded section, and whether the north or south side of the valley is preferable for such a replacement route are questions having important wildlife management implications. The Salmo Chamber of Commerce is promoting an extension of the paved road from the dam site east to Highway 3 - the Salmo-Creston Highway (Dick, et al., 1977).

Should extensive slumping occur along the reservoir shoreline after flooding, additional white-tailed deer winter range will be lost, as will other shoreline sites with recreation potential and scenic attractiveness.

1.3. Land Use Characteristics

Present land use, land capability, and resource conflicts and problems have been described in detail by Dick et al. (1977) and Envirocon et al. (1975). A review of historical land use is presented in Appendix D.

The Pend-d'Oreille Valley is an area where a number of land use activities are taking place. The reservoir behind Seven Mile Dam is scheduled to be filled, beginning in 1980. Logging and transmission line clearings are proceeding. Access to and within the area continues to be improved, and the resultant land use conflicts and pressure for development are mounting. Careful planning will be needed to ensure a healthy environment and balanced land use. Following is a summary of present land use.

Tenure and Zoning

A summary of the various administrative and political subdivisions in which the Study Area falls is reproduced from Dick et al. (1977) as follows:

Resource Region: Kootenay
Land District: Kootenay
Land Recording District: Nelson
Land Registration District: Nelson
Mining Division: Nelson
Fish and Wildlife District: Nelson
Fish and Wildlife Management Unit: 4-8
Forest District: Nelson
Grazing District: Nelson
Water District: Nelson
Regional Districts: Kootenay Boundary and Central Kootenay

As noted by Dick et al. (1977), the majority of the important wildlife lands in the Study Area (north side of the valley under 750 m elevation) were subdivided into large tracts (over 65 ha) in the early decades of this century. Some of these lots have reverted to Crown tenure, while others remain in private ownership or have recently been sold to B.C. Hydro. Private properties are used for cattle ranching, "hobby" farming, rural residences, or recreational cottage sites. Construction of a paved highway to the dam site at Nine Mile Creek has greatly improved access to the western half of the Pend-d'Oreille Valley - travel from Trail to the dam site now takes only one-half hour by car. With demand for rural residential and recreational lots on the increase, several local landowners are considering subdividing their holdings. Pressure on the Study Area would be further increased with an extension of the paved road eastward to Nelway and the Salmo-Creston Highway, or with the provision of electricity to more of the rural homes in the valley.

From the viewpoint of wildlife management, subdivision and settlement of any land parcels within the critical white-tailed deer winter range will seriously constrain programmes to improve remaining habitat. Moreover, in addition to the habitat destruction directly associated with road construction and improvement, the provision of further access will increase both the probability of wildlife losses from collisions with vehicles, and the disturbance of wintering animals through more intensive human activity (Dick et al., 1977).

Zoning in the western portion of the valley, administered by the Regional District of Kootenay Boundary, restricts the minimum lot size to 8 ha. No zoning exists in the eastern portion of the Study Area, administered by the Regional District of Central Kootenay, and subdivision lots of any size may be developed outside of the Agricultural Land Reserve if approval is received from the Ministry of Highways (Dick et al., 1977).

Crown lands in the Study Area are contained within the Salmo Public Sustained Yield Unit and are under the jurisdiction of the B.C. Forest Service. No grazing leases or permits exist on Crown land as the forage resources are estimated to be minimal (Dick et al., 1977).

Agriculture

Agricultural Land Reserves (ALR) exist in five areas within the Study Area: along both sides of the Pend-d'Oreille east of Waneta, in the upper reaches of the Nine Mile Creek Valley, along the Lomond Creek beginning a mile up from the Pend-d'Oreille River, and on the Salmo River east of Wallack Creek. Only small portions of the present ALR's are being farmed. Opportunities exist to redefine ALR boundaries by using the updated agricultural capability class ratings provided in section 2.4 of the report.

Domestic Grazing

Although domestic grazing does take place in the Study Area, most forage production occurs on private lands cleared for pasture. No grazing leases or permits occur on the Crown lands. Not all private lots are completely fenced, however, and trespass grazing is common (Dick et al., 1977). This results in an unknown degree of direct competition with white-tailed deer since, because of the limited grass production of the area, cattle resort to utilizing forbs and browse (Envirocon et al., 1975).

This lack of adequate crop land necessitates the purchase of winter feed from outside the valley in order to sustain a large year-round cattle operation. Because this is expensive, most of the agricultural usage is for summer grazing. In 1974, apparently only about 100 to 150 cattle remained in the valley over the winter (Envirocon et al., 1975).

Forestry

Because of insufficient stocking, much of the forest land in the Study Area cannot at present support large cutting operations. Major logging operations were conducted from 1940 to 1955 (Envirocon et al., 1975). Between 1974 and the present, logging has occurred over a large portion of the Study Area north of the Pend-d'Oreille River. In particular, logging has taken place over much of the Crown land between Tillicum and Nine Mile Creeks.

One problem is that root rot (Armillaria mellea) is prevalent in maturing stands of Douglas-fir throughout the Study Area. Stands of approximately 50 years of age appear most susceptible to infection. According to Dick et al. (1977), the only practical method of dealing with this situation is to reduce the Douglas-fir rotation, and to plant resistant species such as ponderosa pine. Such measures could deleteriously affect white-tailed deer by reducing their winter cover.

Mineral Potential

At least one hundred mineral claims and seven placer leases still exist in the Study Area. The rock formations having greatest mineral potential are described in section 1.4 on geology. Currently the Pend-d'Ôreille and Salmo Rivers, and all tributaries in the Study Area, are open to placer (gold) staking (Dick et al., 1977).

Wildlife-based Outdoor Recreation

The major recreational activities in the Study Area relate to the consumptive and non-consumptive use of the wildlife resource. It has been estimated that the wildlife of the Pend-d'Oreille Valley (deer and grouse) support approximately 4350 hunting-days per year, and account for a significant proportion of the estimated 2000 visitor-days spent annually in non-hunting recreational use. The white-tailed deer herd was thought to provide an annual harvest of roughly 350 deer (Envirocon et al., 1975). Some hunting of other species also occurs - such as mule deer, coyote, bobcat, lynx, wolverine, black bear, and cougar.

One important feature of the Pend-d'Oreille Valley that attracts non-hunting recreational use is the dense concentration of readily-observed white-tailed deer at low elevations in late winter and early spring. Results of one study of winter deer distribution demonstrated that over half of the area traversed by the main road between Waneta Dam and the mouth of the Salmo River supports a population density of over 75 deer per square kilometre (Envirocon et al., 1975). According to Dick et al. (1977), the north side of the Pend-d'Oreille Valley below 780 m elevation should be rated Class 1W deer range, and as such is among the highest capability winter range in the entire West Kootenay region. Opportunities for deer observation and photography are excellent in this easily accessible area.

During spring and summer in the same area, visitors may stop to observe the many different birds of prey which either migrate through or temporarily reside in the Study Area. For example, four active osprey nests were discovered along the border of the Pend-d'Oreille River or Waneta Reservoir during the 1978 field season.

Water-oriented Outdoor Recreation

The conversion of the Pend-d'Oreille River (above Seven Mile Dam) and the lower mile of the Salmo River from free-flowing rivers to a large reservoir will change the availability of water-based recreation in the Study Area. The only activity not seriously affected will be sports fishing for rainbow trout and Dolly Varden char on the remaining reaches of the Salmo River. In the Pend-d'Oreille Valley, river fishing will be replaced by reservoir fishing and boating. Since the Canadian section of the Pend-d'Oreille River no longer supports a significant population of sports fish, reservoir flooding will have little effect. It is expected that the fish colonizing the Seven Mile Reservoir will be similar to those presently in the Waneta Reservoir - predominantly northern squawfish, redside shiners, and largescale suckers. These species are not generally sought by sports fishermen (Envirocon et al., 1975).

The reservoir formed behind the Seven Mile Dam will be long and narrow, thus closely resembling the Waneta Reservoir in general configuration. In most places the shoreline will be steeper than 10 percent slope and poorly suited to recreation access. However, small areas of moderate slope along the shore may be suitable for development of access to the reservoir for boating, swimming, and modest camping facilities. Although water temperatures in the reservoir are expected to be high enough, it has been recommended that swimming only be encouraged where the underwater drop-off is gradual (Envirocon et al., 1975).

With reservoir flooding of almost all of the free-flowing reach of the Pend-d'Oreille River, present opportunities for swimming in eddy pools along sandy riverbanks, and for gold panning adjacent to the river will be eliminated.

Other Outdoor Recreation Activities

Though still under construction, the Seven Mile hydro-electric project is already serving as a minor tourist attraction. Visitors drive to the dam site to view the cofferdam and diversion tunnel, and to inspect progress being made on construction of the dam, spillway, and powerhouse. A few venture further up the valley to watch the reservoir being cleared prior to flooding, and to get a last glimpse of the powerful river thundering over several falls and through its many boiling rapids.

Until recently, some recreational use of the valley has centered on the scenic values of the river. While the reservoir will transform the existing character of much of the valley, one source expects that it will be "reasonably attractive in appearance itself" (Envirocon et al., 1975). Stable reservoir levels will be required during the recreation-use season to prevent the valley's scenic values from deteriorating.

Most recreational use of the Study Area in the past has been day-use. This use and camping may increase once the reservoir level has stabilized. Developments, including improved access east of the dam, will require careful planning to prevent further detrimental impacts on wildlife populations (Dick et al., 1977).

Good opportunities exist for several other outdoor recreation activities in the Study Area, such as exploring old mining properties, relic collecting, cross-country skiing, berry-picking, and spring and summer wild flower photography.

1.4. Geology

The Pend-d'Oreille Valley is located in the southern portion of the Selkirk Range of the Columbia Mountains. The mountains of the southern Selkirks have been described as more subdued and rounded than those to the north, with few rugged peaks and serrated ridges, and without youthful glacial forms caused by higher uplift and more recent sculpture by mountain glaciers. In this portion of the Selkirks there are practically no glaciers, and the ranges form a transition between the high and rugged northern Selkirks and the low, subdued ranges of the same system bordering the Columbia lava plain in Washington State (Holland, 1976).

The Study Area lies within the Bonnington Range of the Selkirk Mountains, separated from the Rossland Range of the Monashee Mountains by the Columbia River to the west, and from the Nelson Range of the Selkirks by the Salmo River to the east.

1.4.1. Generalized Bedrock Geology

The Study Area lies within the Salmo lead-zinc area studied in detail by Fyles and Hewlett (1959). Their report and maps should be consulted by those interested in the complex structural geology of the area and detailed descriptions of the many different rock types present.

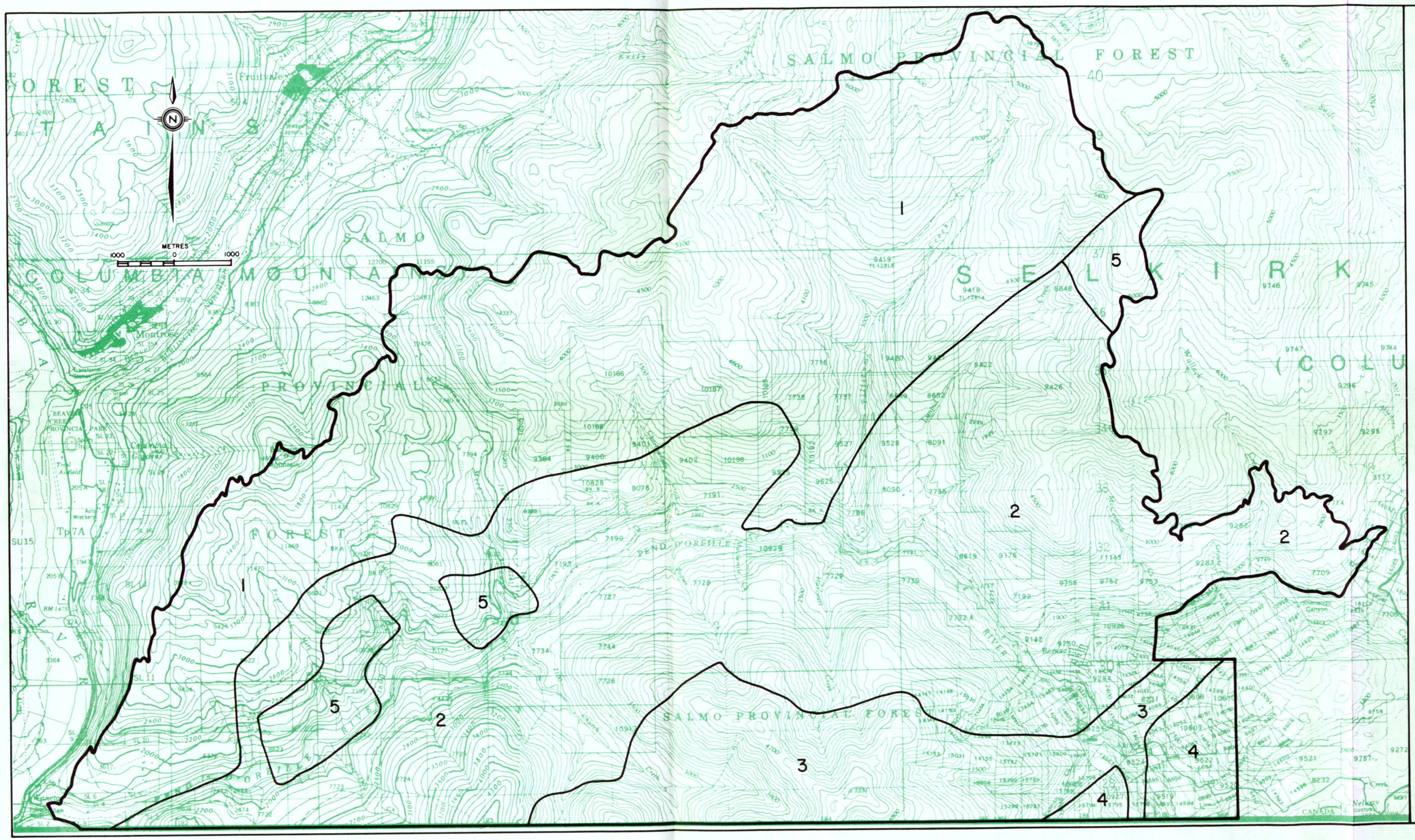
Fyles and Hewlett (1959) divided the Salmo lead-zinc area into four areas or belts (Figure 1.2). These are, from west to east: (1) the Mesozoic volcanic area, (2) the lead and zinc Mine belt, (3) the Black Argillite belt, and (4) the Eastern belt. The belts are intruded irregularly by several granitic stocks. The four belts were named for descriptive purposes, but are also geologically significant because they are separated by three eastward and southward dipping regional thrust faults. The Mesozoic volcanic rocks lie mainly west of the Salmo and north of the Pend-d'Oreille Rivers. The Mine belt bounds the volcanic area on the east and south. It is a curved belt 3 to 8 km wide and includes all of the area's known major lead-zinc deposits. The Black Argillite belt includes an area up to about 3 km wide, underlain mainly by black argillite and lying east and south of the Mine belt. The Eastern belt is located east of the Pend-d'Oreille River and extends northward from the international boundary (Fyles and Hewlett, 1959).

The Mesozoic volcanic area was not studied in detail by Fyles and Hewlett (1959). They examined these extrusive rocks (solidified at the earth's surface) only near the Waneta fault, and mapped the area as being chiefly underlain by "greenstone" with minor argillite. Blocky green agglomerates (pyroclastic rocks containing rounded fragments greater than 32 mm in diameter) were also mentioned in their report. "Pyroclastic" rocks are composed of material explosively ejected from a volcanic vent. After examining nine of our samples collected from various locations in this zone, Fyles (pers. comm., 4 August 1978) found that all were slightly calcareous and had andesitic composition. While some were thought to be volcanic rocks solidified in a marine environment, others appeared to be sedimentary rocks formed in a marine environment from material of volcanic origin.

Little's (1960) geological map indicates that this Mesozoic volcanic area lies within the extensive "Rossland" formation, a heterogeneous assemblage of lava flows and pyroclastic rocks with minor marine sediments. One interpretation (Little, 1960) is that deposition of this volcanic and sedimentary material occurred in a volcanic-island environment during the Jurassic Period (190-136 million years before present), hence the interesting combination of calcareous volcanic and sedimentary rocks.

The Mine belt consists of sedimentary rocks of unknown correlation, and three named formations - the Quartzite Range, Reno, and Laib - of the Cambrian Period (570-500 million years before present). These rocks comprise a thick sedimentary sequence which has been highly deformed and in places has been greatly changed by thermal metamorphism, sometimes obscuring the sedimentary characteristics. The Quartzite Range and Reno formations are dominantly quartzitic, the Laib is an argillaceous (having a notable proportion of clay) formation containing prominent limestone members, along with phyllite (both calcareous and non-calcareous types), schist, quartzite, and minor dolomite. As a matter of interest, Little (1960) interprets this combination of fine-grained, argillaceous, calcareous, and arenaceous (derived from sand) rocks as being indicative of probable deposition in a shallow, oscillating sea, far from the shore, and suggesting relatively low relief of the adjacent landmass.

The unnamed sedimentary rocks of the Mine belt, located in the lower part of the Pend-d'Oreille Valley roughly west of Tillicum Creek, include black and calcareous argillites, slate, several phyllites, grey limestone, and minor chert and quartzite. Except for the quartzite,



BEDROCK GEOLOGY

LEGEND

1	Mesozoic volcanic rocks
2	Mine belt
3	Black argillite belt
4	Eastern belt
5	Intrusive rocks

- Adapted from Fyles and Hewlett (1959) and Little (1960).
- See text for discussion of bedrock map units

Figure 1.2. BEDROCK GEOLOGY OF THE PEND-D'OREILLE VALLEY, B.C.

these sedimentary rocks are fine grained, and include both calcareous and non-calcareous rock types (Fyles and Hewlett, 1959).

The ore-bearing "Reeves limestone" is in the lower part of the Laib formation. All the lead-zinc orebodies are in the dolomitized zones in the Reeves limestone, and consist of replacements by the sulphide minerals sphalerite (an ore of zinc), galena (an ore of lead), and pyrite. Little mineralization has been found in limestone that has not been dolomitized. These and other components of the Mine belt have been mapped and described in detail by Fyles and Hewlett (1959).

The Black Argillite belt is underlain exclusively by the Active formation. The Active formation is dominantly black argillite (both limy and non-limy types), but includes minor amounts of slate, phyllite, argillaceous limestone, and dolomite. Almost all of the rocks are characteristically black or dark gray, and are mainly of the Ordovician Period (500-430 million years before present) (Fyles and Hewlett, 1959).

South of the Pend-d'Oreille River, the Active formation is only well exposed along the west fork of Russian Creek and near the heads of Harcourt, Church and Fraser Creeks. In this area it ranges from soft friable phyllite to hard siliceous argillite. Relatively soft black (carbonaceous) argillite, generally non-limy, is the most common rock type in the Active formation south of the Pend-d'Oreille River (Fyles and Hewlett, 1959).

The Eastern belt is underlain in the Study Area by the Nelway formation. The term "Nelway" was introduced by Little (1950) as a Canadian name for the Metaline limestone of northern Washington State. In the Study Area, the Nelway formation consists of calcareous rocks, gray limestone and gray dolomite. As a matter of interest, according to Little (1960), the abundance of calcareous material and the lack of discernible lateral gradation in any direction suggest that the sedimentary materials accumulated in a sea-basin far from any landmass. Although the corresponding "Metaline limestone" to the south has yielded abundant fossils (including numerous trilobite species), no diagnostic fossils have been obtained from the Nelway formation (Little, 1960).

While not occurring in regular belts, a fifth general group of rocks mapped by Fyles and Hewlett (1959) are the granitic intrusive rocks, rocks that originate as magma that pushes its way into older rock and solidifies before reaching the surface. Though not distinguished on the generalized geology map (Figure 1.2), two types of granitic intrusive rocks occur in the Study Area. The older type is found in the vicinity of Wallack Creek and is composed of granite and minor granitized sedimentary rocks. The granite is a representation of the "Nelson" intrusions, generally of the Cretaceous Period (136-65 million years before present). The Nelson batholith and its satellites are described in detail by Little (1960).

The younger granitic intrusive rocks are found in small masses along the lower Pend-d'Oreille River, and are similar to the "Sheppard" intrusions described by Little (1960). These rocks are leucocratic (light-coloured) granites and syenites which intruded black argillite as sills (parallel to the bedding of the host rock), dykes (cut across the bedding), or irregular masses. They are thought to have been formed during the Tertiary Period (65-2.5 million years before present) (Fyles and Hewlett, 1959).

As a final note it must be emphasized that the generalized geological map (Figure 1.2) does not reflect the complex occurrence of rock types in the area, rocks that vary greatly in such characteristics as origin, occurrence, composition, calcareousness, texture, and hardness or resistance to weathering.

1.4.2. Glacial History and Surficial Materials

The glacial history of the Pend-d'Oreille Valley in B.C. has never been interpreted in detail, and it was not within the scope of this study to initiate the research required for such an analysis. Nevertheless, general information is available in regional reports and examination of local landforms reveals much about the past environments which existed during their formation.

The last major glaciation in British Columbia, named the Fraser Glaciation, began to cover the lowlands of the southern interior about 19 000 years ago. At the onset, ice build-up is believed to have been initiated in the Coast and Columbia Mountains, with ice tongues from these areas coalescing as an ice sheet on the Interior Plateau. At the southern end of the Plateau, this ice sheet moved south over the international boundary to a terminus on the Columbia Plateau in northern Washington State (Fulton, 1971).

During the Fraser Glaciation, the entire Study Area was covered by ice. Elsewhere in the region, only mountain peaks above about 2200 m were thought to have projected through the ice sheet (Little, 1960). Observations of the striae occurring on the ridges and peaks in the Bonnington Range show that the general movement of the ice was in the direction S. 10° E. (Daly, 1912).

According to Fulton and Smith (1978), deglaciation was underway throughout south-central British Columbia 11 000 years ago, and the ice had probably completely retreated from this part of the province by at least 9510 ± 160 years ago (Fulton, 1971).

Because many of the landforms present in the Study Area originated during deglaciation, a description of this relatively brief period should be of interest. Ice sheet recession was accomplished by rapid downwasting, with a frontal retreat beginning in the southern Columbia Mountains. On a local scale, individual mountains and uplands appeared through the ice cover first, while "dead" ice remained in the adjacent valleys (Fulton, 1971). This rapid downwasting generated huge quantities of meltwater. Streams flowing down side valleys and off the ice masses deposited sand and gravel between the stagnant ice and the main valley wall to form kame terraces. These stratified ice-contact deposits are common in the Study Area (below an elevation of approximately 760 m), on the sides of the Pend-d'Oreille and Salmo Valleys and in their tributary valleys. Kame terraces have rolling and uneven surfaces caused by melting out of blocks of ice and slumping.

In places, this pattern of downmelting caused the formation of temporary lakes when meltwater backed up behind plugs of stagnant ice damming valley bottoms (Fulton, 1971). Sediment deposited in ponded water tends to be composed of bedded clays, silts, and fine sands. Pockets and small terraces of these lake (lacustrine) deposits occur in the Study Area. Due to their fine texture, these deposits are potentially unstable and susceptible to erosion when disturbed.

Except on steep slopes where it was removed by erosion or buried by colluvial material (product of mass wastage), morainal (glacial till) deposits are found on most slopes throughout the Study Area. The texture of glacial till in the Study Area ranges from silty clay loam to sandy loam, and its coarse fragment content may lie in either the gravelly or non-gravelly class. Till characteristics such as texture and calcareousness are discussed in Chapter Two (see section 2.3.1.).

It is interesting to note that the deglaciation period is thought to have influenced the Pend-d'Oreille Valley in yet another way. Most soils were found to have a surface capping of eolian (wind blown) material containing a variable amount of volcanic ash (especially in the "fine sand" fraction). These eolian deposits (considered to be "loess" due to their relatively fine texture) vary in thickness from about 10 cm to over 30 cm, and are unstratified, generally free of coarse fragments, and composed of material mainly in the fine sand to coarse silt particle size range. It is speculated that the loess originated on the expansive glacial outwash and floodplains of the Columbia River Valley to the southwest of the Study Area in Washington State. Across these plains flowed heavily silt-laden glacial meltwater streams which flooded in spring and summer, and shrank later in the year to expose broad expanses of unvegetated sediment. Strong winds blowing off the ice masses helped to dry out these sediments, and swept the fine-grained material into the air as great clouds of dust (Embleton and King, 1968). Prevailing winds carried this loess to the northeast where much settled in the Pend-d'Oreille Valley after deglaciation as a veneer over glacial till and deposits of lacustrine, fluvial, and colluvial origin.

The volcanic ash found within the loess capping was confirmed (Valentine, pers. comm.) as such by use of a petrographic microscope, but further analysis, such as quantification of its presence in the loess or its origin(s), was not within the scope of this study. The ash was thought to have been incorporated in the loess either during loess deposition or as a result of subsequent mixing by geomorphic and biologic processes (King and Brewster, 1976).

The volcanic ash is probably from the eruption of Mt. Mazama at Crater Lake, Oregon, 6,600 years ago (Fryxell, 1965), but could have originated from the eruption of Glacier Peak in the northern Cascades of Washington about 12 000 years ago, or from one of the many eruptions of Mt. St. Helens in the Cascades of southern Washington, which occurred between about 200 years ago and more than 12 000 years ago (Snedden, 1973). No thin bands of light-gray to white volcanic ash, such as that described by Westgate and Fulton (1975) were recognizable in surficial deposits of any type examined in the Study Area.

1.5. Climate

1.5.1. Regional Overview

The nature and orientation of regional physiographic features, and those of areas to the west, greatly influence the climatological characteristics of the Study Area. Weather systems, occurring within the predominant Polar air mass, develop over the north Pacific Ocean and are drawn into the region with the prevailing westerly winds. The cool, moist Polar air is lifted over successive ranges of the Coast, Cascade, Monashee and Selkirk Mountains, precipitating moisture on the west slopes and warming during its descent down the eastern slopes. When reaching the Columbia River valley, the air associated with these weather systems is relatively dry and as a result more thermally responsive to the temperature of the underlying ground surface.

During the winter and early spring, occasional outbreaks of Arctic air bring clear skies and very low temperatures to the region. Since the invading cold, dry air flows from the north down the Columbia and Kootenay River Valleys, the Pend-d'Oreille and lower Columbia River Valleys are often one of the last areas in the British Columbia interior to be affected by such outbreaks.

Climatically, the region is characterized by relatively low precipitation, warm sunny summers, and cool, cloudy winters. At Waneta, an elevation of 573 m, long term climatological data indicate average daily maximum and minimum temperatures in July of 29.0°C and 10.3°C respectively. Similarly, average maximum and minimum temperatures in January are -1.6°C and -7.9°C. Extreme temperatures of 42.8°C and -35°C have been recorded (Environment Canada, 1975).

Climatological records at Waneta indicate an average freeze free period of 136 days, with the average last and first freezes being May 13 and September 27 respectively. With the exception of lower valley slopes, freeze free periods decrease with increasing elevation. West of Trail at 2347 m the average freeze free period is 20 days, the average last spring freeze occurring on July 6 and the first fall freeze on July 27 (Environment Canada, 1975). In the Study Area, low elevation freeze free periods decrease slightly west to east at comparable elevations. Freeze free periods are reduced from those generally characteristic of any particular elevation where topographic depressions occur or where surface features obstruct the drainage of nighttime, radiationally cooled air.

At Waneta, which typifies the area between the Columbia River and Seven Mile Creek, the average total annual precipitation is 630 mm, of which 450 mm or 72% occurs as rain, and 28% occurs as snow. April, July, August and September are the driest months, each averaging 32 to 34 mm of precipitation. Conversely, the greatest monthly precipitation takes place in both December and January when an average equivalent of 80 mm of water is precipitated. During the period of May to September inclusive, the average total rainfall is 222 mm, which represents only 35% of the average annual precipitation (Environment Canada, 1975).

In the Pend-d'Oreille River Valley precipitation totals generally increase from west to east and with increasing elevation. As a generalization, it was estimated that the areas between Seven Mile Creek and Limpid Creek receive 8% more precipitation than the Waneta area at a comparable elevation, while areas between Limpid and Lomond Creeks are subject to a 12% increase.

At lower elevations, rainfall can be expected in any month of the year, the least occurring in January when an average of 18 mm is recorded. Between April and October, snowfall at these elevations does not significantly contribute to annual precipitation totals, and between May and September the occurrence of fresh snow is unusual.

Although the prevailing winds aloft are from the west, low level wind speed and direction are greatly influenced by the nature and orientation of the regional topography. In the Pend-d'Oreille Valley, winds will generally be channelled east and west. Although there are no substantiating wind data available for this area, winds are likely to blow most frequently from the west.

According to long term regional wind data, windspeeds tend to increase with increasing elevation. The mean January and June windspeed in Trail, at an elevation of 579 m, is 8.5 km/h and 8.4 km/h respectively. Immediately to the west at an elevation of 2347 m corresponding windspeeds are 34.8 km/h and 18.9 km/h (Environment Canada, 1975). Windspeeds in the Pend-d'Oreille Valley are not expected to be greatly different from those in the lower Columbia River Valley at comparable elevations.

On a local scale, topography and terrain characteristics commonly modify the prevailing direction and speed of regional winds, creating a wide variety of local wind climates. The uneven daytime heating of valley slopes creates convective currents and wind eddies which add further variability to local wind patterns. This is particularly true in the Pend-d'Oreille where steeply inclined south facing slopes are conducive to strong heating while the more shaded north facing slopes are not.

Effects of Topographic Setting

Local terrain and surface characteristics greatly affect the local thermal regime. At night, radiationally cooled air will flow from higher elevations towards lower elevations. Where local terrain features such as surface depressions and extensive areas of flat relief inhibit this flow, the cold air stagnates, creating lower minimum temperatures, shorter growing seasons and a reduced period free from freezing temperatures. Thermal inversions are characteristic of these areas.

Where the site location is inclined and air drainage unimpeded by surface features, the shedding of cold air will be accentuated. This cold air flow mixes with warmer layers above and as a result such sites are less subject to thermal inversions and accentuated minimum temperatures.

In the Pend-d'Oreille, valley bottom temperatures are depressed due to cold air pooling. Under clear, calm conditions nighttime inversions to a depth of 100 to 150 metres are expected to occur. Hence, from valley bottom to 150 metres minimum temperatures will commonly increase and, above 150 metres, will decrease with increasing elevation.

Shading of direct solar radiation by surrounding topography decreases both daily temperatures and total daily potential evapotranspiration. The areas of the Pend-d'Oreille Valley most affected are southeast of the confluence of the Salmo and Pend-d'Oreille Rivers and along the lower east and west facing slopes of Tillicum, Nine Mile, Seven Mile, Four Mile, Church and Harcourt Creeks.

Areas leeward of larger physical features may be subject to reduced precipitation. Such 'rainshadow' effects occur within the region at all scales of study but, due to a lack of empirical data, are not documented within the Pend-d'Oreille Valley.

The orientation of the Pend-d'Oreille Valley parallel to the prevailing winds has resulted in low precipitation totals in the western portion of the valley with a gradual increase west to east. In the Remac area the valley is oriented north and south resulting in a significant increase in seasonal and annual precipitation.

1.5.2. Climate of the Study Area

Survey methods used to assess the climate of the Study Area are discussed in Appendix C.1.

Temperature

Although there is much local variation, maximum and minimum temperatures generally decrease with increasing elevation. Commonly, the highest maximums occur at the lowest elevations and the highest minimums on the lower slopes above the valley bottom. Mean minimum, mean maximum and mean monthly temperatures are indicated, for selected elevations and months, in Tables C.1a, C.1b, and C.2 respectively. Using these data, estimates of growing season (Table C.3) and freeze free periods (Table C.4) were prepared. These tables and others mentioned later on the climate of the Study Area are presented in Appendix C.2.

Precipitation

Rainfall and snowfall increase with increasing elevation. Rainfall occurring between May and September increases at an approximate rate of 17 mm/100m. At some undetermined elevation between 1370 m and 1830 m precipitation totals begin to decrease with increasing elevation. Estimates of seasonal precipitation are presented in Tables C.5a to C.5i (Appendix C.2). At high elevations snow cover is likely to exist from late October to mid-June, and at low elevations in the main valley from mid-December to early March. Although there is much local variation, snowdepth generally increases with increasing elevation.

Potential Evapotranspiration

Potential evapotranspiration (PET) may be loosely defined as the amount of moisture which, if available, would be removed from a given land area by both plant transpiration and evaporation. As PET is dependent upon the amount of incident solar radiation, air temperature, water vapour pressure deficit and wind, PET rates are greatest on inclined, sunny sites which are subject to warmer temperatures, high water vapour pressure deficits, and which are exposed to local winds. In the Pend-d'Oreille Valley such sites are the exposed, south to southwest facing, low-to-mid-elevation slopes with site inclinations from fifteen to forty-five degrees. Annual PET totals generally decrease with increasing elevation and with a change in aspect towards the north. At Waneta seasonal PET totals are estimated to be 454 - 489 mm. Seasonal totals for various slope and aspect combinations at different elevations are indicated in Tables C.5 to C.7 (Appendix C.2).

Steep, south facing, sheltered slopes may be subject to significant PET rates during sunny winter days. If the soil at rooting depth remains frozen during these conditions, coniferous vegetation may be subject to winter kill by desiccation.

Climatic Moisture Balance

The determination of climatic moisture deficit (CMD) and/or climatic moisture surplus (CMS) provides a good indicator of the combined influence of local thermal and moisture regimes. A CMD occurs when the total seasonal PET exceeds the total seasonal precipitation; a CMS occurs when the converse is true.

Where a climatic moisture deficit occurs, the energy potentially available for evapotranspiration will instead increase soil and surface air temperatures. Whether or not a soil moisture deficit will occur at such sites will depend upon the available water storage capacity of the soil as well as the degree to which the soils are recharged in the spring. Similarly, where a CMS exists, the available water storage capacity of the soil and runoff characteristics will ultimately determine the soil moisture balance.

In the western portion of the Pend-d'Oreille Valley, CMD's will commonly occur on south facing slopes to elevations of 1520 m, on north facing slopes to elevations of 1060 m, and on other aspects to elevations within this range (Tables C.5 to C.7, Appendix C.2). As CMD and CMS are mutually exclusive, a CMS will be found at all other sites. In the eastern portion of this valley a CMS will occur at lower elevations on all aspects due to the local increase in precipitation.

Monthly Soil Temperatures

A prediction of monthly soil temperatures was made from climatic data for a wide range of elevations in the Waneta area. Although these predictions were made using relatively experimental and locally untested techniques, documentation of both techniques and results is presented in Appendix C.1. Soil temperatures were assessed because of their importance to soil classification.

Chapter Two

SOIL RESOURCES AND SELECTED LAND USE INTERPRETATIONS

Chapter Two

SOIL RESOURCES AND SELECTED LAND USE INTERPRETATIONS

2.1. Introduction

2.1.1. Objectives

The soil resource inventory of the Pend-d'Oreille Valley was undertaken to provide basic soil and surficial material (landform) information, and interpretations for land use planning. Soil is an important resource to consider for several reasons. All renewable resources are in some way dependent upon soil, which is itself essentially non-renewable due to the very slow rate in which it develops. This fact necessitates conservation of this basic resource in order to produce high-level sustained yields of timber, wildlife, water, recreation, forage, and agricultural crops. Soils are also useful in predicting the natural productivity of these renewable resources, and their response to management.

The engineering interpretations of soils and surficial materials are another important application of the survey. The survey depicts limitations for roads, dwellings, septic tanks and other uses which are important for urban and transportation planning. This information is useful since considerable financial savings can result if the most appropriate materials are used for land use developments.

The specific objectives of the soil resource inventory were:

1. To describe soils, surficial materials, and associated soil climate and vegetation characteristics.
2. To map soils on 1:20 000 scale maps.
3. To predict soil and surficial material behaviour when subjected to specific management activities through map unit interpretations for a number of land uses.

The soil resource inventory was by design an intermediate level survey. The map unit delineations typically vary in size from 10 to 100 hectares (25 to 250 acres). Information at the scale presented on the soil maps is of sufficient detail to help develop resource management policies and plan land management procedures. Due to the intermediate nature of this survey, it lacks detail for use in site-specific projects. These projects require additional on-site investigation.

Two common misunderstandings regarding the use of soils for land use planning need to be cleared up. Although soil refers to the unconsolidated material immediately below the earth's surface, it directly influences the kinds of plants that grow on a site, and the rate at which these plants grow. Thus, the identification of relatively homogeneous soil types provides a framework for the identification of vegetation types, potential habitats for wildlife, and the growth characteristics (productivity) of commercial forests.

Secondly, inherent in the characterization of soils is a description of parent material (i.e. the unweathered surficial material where soil development has not occurred). It is the soil's unweathered parent (surficial) material, generally located below one metre in depth, which is evaluated for most engineering interpretations.

2.1.2. Soils and Soil Forming Factors

Soil refers to the naturally occurring unconsolidated mineral or organic material, at least 10 cm thick, which is capable of supporting plant growth. Interaction of the five principle factors of soil formation - topography (relief), parent material (surficial material), climate, organisms, and time - cause differences in soils.

No attempt is made in this report to discuss soil forming factors, soil processes, and soil classification since background references such as Valentine et al. (1978) and Canada Soil Survey Committee (1978) are available.

2.2. Survey Methods

2.2.1. Survey Procedures

Prior to fieldwork, aerial photographs were used to depict different landforms, slopes, aspects, and vegetation conditions. Colour photographs at an approximate scale of 1:15 000 were used. Since Jungen's (in progress) reconnaissance-level soil report and maps were available, a preliminary soil legend could be prepared. The reconnaissance 1:50 000 scale maps were referred to as a valuable aid to air-photo interpretation.

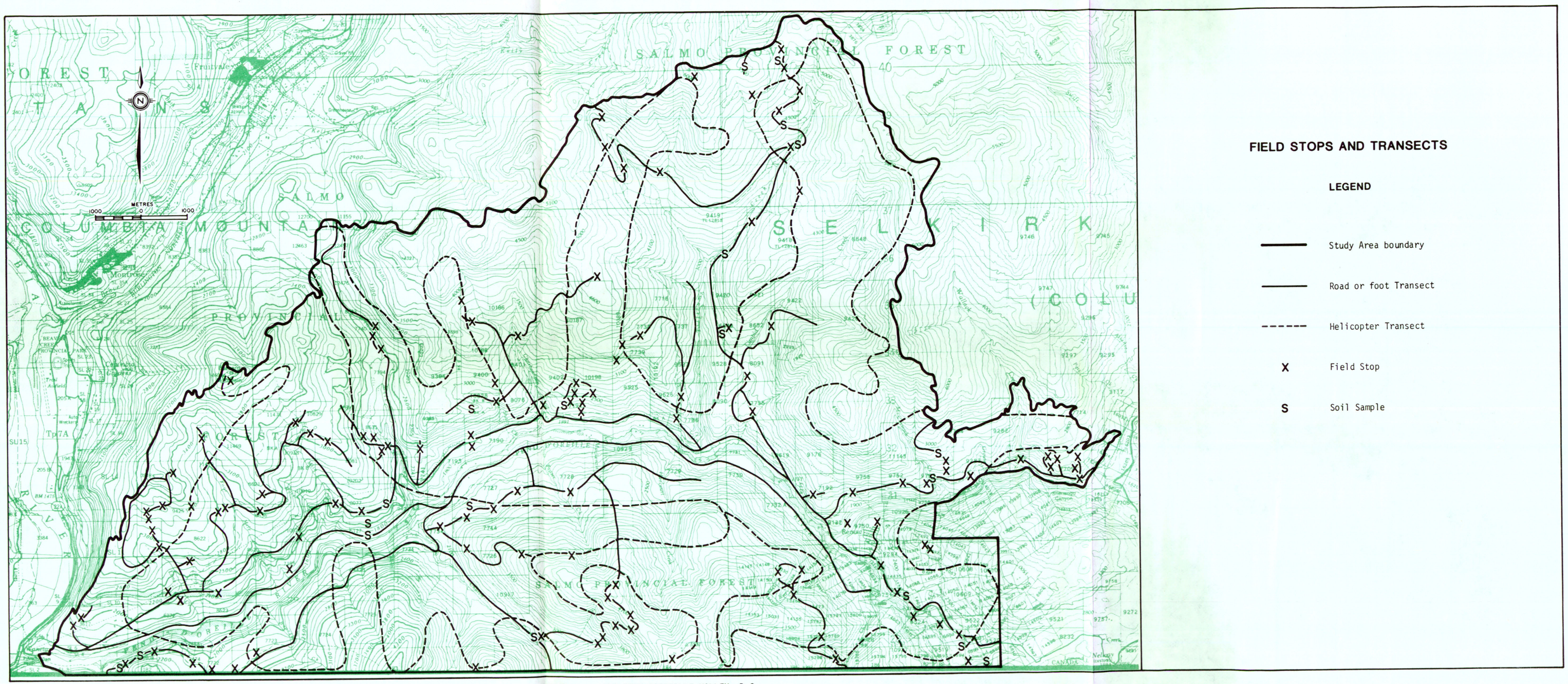


Figure 2.1. FIELD STOPS AND TRANSECTS IN THE PEND-D'OREILLE VALLEY, B.C.

Field survey by truck on existing roads, foot transects and a two-day helicopter survey of inaccessible areas provided field checking of airphoto interpretation. Soils were examined at each stop and field descriptions were recorded on internal soil characteristics such as horizonation, depth, structure, colours, textures, pH, drainage and parent (surficial) materials. External soil characteristics such as slope, elevation, rockiness, aspect, and associated vegetation were also noted on field cards. Soils were classified at both the soil subgroup and soil family levels using The Canadian System of Soil Classification (Canada Soil Survey Committee, 1978).

Soils were inspected and described on nearly 200 sites, for an average of approximately one field check per square kilometre (100 hectares or 250 acres). Approximately one-third of the map delineations were field checked (field stops are shown on Figure 2.1). All map delineation boundaries were inferred from air-photo interpretation. It is believed that at least 75% of the area outlined within a map delineation is represented by the labelled soils (see Appendix A.4).

The initial soil legend for the Study Area was modified and updated throughout the field season as field examinations progressed. The final legend is presented in the next section and on the soil maps.

Representative soil types were morphologically described and sampled in detail. Samples underwent laboratory analyses to determine physical and chemical properties. Laboratory analyses included pH, % Carbon, % Nitrogen, exchangeable bases (me/100g) for Calcium, Magnesium, Potassium, and Sodium, cation exchange capacity, base saturation, pyrophosphate-extractable Iron and Aluminum, and particle size distribution of sand, silt, and clay. Additional tests were conducted for selected soil horizons when needed. Detailed profile descriptions and laboratory analyses are available for each soil type by contacting the Resource Analysis Branch (Attention: B.C. Soil Data File), B.C. Ministry of Environment, Legislative Buildings, Victoria, B.C., V8V 1X4.

Field checking resulted in modification of initial air-photo interpretation with final soil unit boundary lines being plotted on the aerial photographs. These boundaries were then transferred to 1:20 000 scale base maps for compilation. The 1:20 000 scale base maps were prepared by enlarging 1:50 000 scale topographic maps and by adding updated land use information such as new roads, trails and transmission lines.

2.2.2. Mapping Scheme

Soils of the Study Area were first differentiated by major surficial deposits at the genetic materials level as defined in the Resource Analysis Branch's (1976) Terrain Classification System. The major surficial materials differentiated were: morainal, colluvial, fluvial, lacustrine, and organic.

The soil map legend was then developed by further differentiating these surficial materials by dominant soil family (see Figure 2.2). The soil family is a taxonomic level within The Canadian System of Soil Classification (Canada Soil Survey Committee, 1978) which differentiates soil by subgroup development, particle size class, mineralogy, depth-to-bedrock, reaction (pH) class, and soil climate including soil temperature and soil moisture.

The use of the soil family was contemplated for the Study Area for two main reasons. First, project constraints necessitated an intermediate level survey in which the Study Area had to be mapped and sampled in one field season. This level of intensity was considered too detailed for reconnaissance surveys where soil associations have been used (e.g. Jungen, in progress), and too general for detailed surveys using soil series where greater field checking is required. Secondly, the steeply sloping terrain in the valley results in a wide fluctuation of soil characteristics over relatively short distances. Soil series criteria were considered too rigid for this mountainous area where mass-wasting and soil creep processes actively modify the soils. Thus, the soil family level criteria seemed to better fit the characteristics of the landscape and still meet the objectives of the survey.

The application of the soil family resulted in a request for a climate analysis utilizing all available data to determine soil climate characteristics for the Study Area (see section 1.5.2.). Since soil climate cannot be seen in the field, soil characteristics and climax vegetation were related to soil temperature classes and soil moisture subclasses. This permitted extrapolation of climatic data to observable and mappable features in the landscape (see Appendix A.6 on Soil Climate for more details).

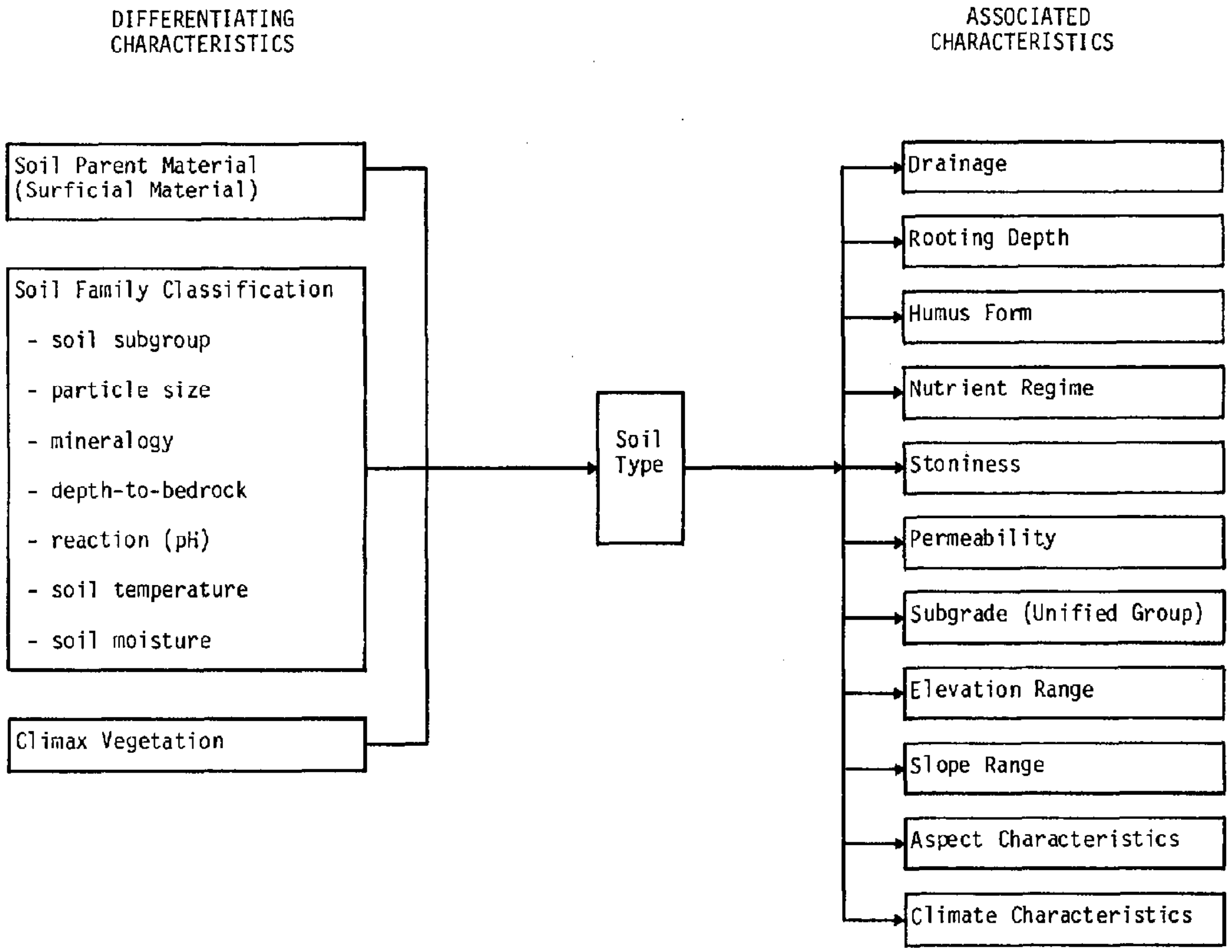


Figure 2.2. SCHEME FOR IDENTIFYING AND DESCRIBING SOIL TYPES

2.2.3. Soil Symbols

Soil types are identified on the soil maps using symbols such as:

General Convention	Example of a Map Unit Symbol		
Soil types in numerator	more abundant soil type	<u>M1/C2</u>	less abundant soil type
		78	
Slope classes in denominator	more abundant slope class		less abundant slope class

The capital letter of the soil symbol indicates the kind of surficial deposit as follows:

M	Morainal	C	Colluvial
F	Fluvial	O	Organic
L	Lacustrine	R	Bedrock

The number following the letter further differentiates the surficial deposit by soil family and climax vegetation. See Table 2.1 (soil legend) for more details.

Extremely shallow soils in which depth-to-bedrock is less than 50 cm were highlighted by adding "s" to the appropriate soil type (e.g. C2s or M1/C2s).

The soil symbol convention operates under the following assumptions:

M1 > 75% "M1" soils
< 25% other soils

M1/C2 50-80% "M1" soils
20-50% "C2" soils
< 25% other soils

A slash (/) differentiates those soils which are most abundant on the left, and those which are less abundant on the right. A slash is not used where one soil is very dominant. "Other soils" refer to inclusions of unmapped soils due to scale of mapping.

The slope class numbers in the denominator are defined by the Canada Soil Survey Committee (1978) and are presented on the legend for the soil maps (see back pocket). Each number represents a slope range, for example, slope class 7 is used for land on 31% to 45% slope.

2.3. Soil Resources

This section describes the soil resources of the Study Area by discussing the general characteristics of the Pend-d'Oreille's soil parent materials (surficial deposits) and soil subgroup classification. The utilization of climax vegetation and soil characteristics as indicators of soil climate is discussed in Appendix A.6 since this affects soil family classification and map unit delineations.

Each soil type is described in Appendix A.2 with representative photographs of the soil landscape and soil profile provided. The differentiating and associated characteristics shown in Figure 2.2 are given for each soil. Additional information on the detailed morphological characteristics and physical and chemical properties of sampled modal (average) soils are also available on request, as mentioned previously, by contacting the Resource Analysis Branch.

2.3.1. Soil Parent Materials (Surficial Deposits)

Five major types of soil parent materials (surficial deposits) were identified in the Study Area: morainal, colluvial, fluvial, lacustrine, and organic. In addition, eolian sediments often overlie these major materials. These parent materials represent the first level differentiation of soil types. Figure 2.3 shows the general distribution of these materials throughout the Study Area, their distribution is shown in more detail on the 1:20 000 scale soil maps.

The general characteristics of the parent materials are described below. An overview discussion of glacial history was provided in section 1.4. Definitions used for these surficial deposits are from the Terrain Classification System (Resource Analysis Branch 1976), textural and

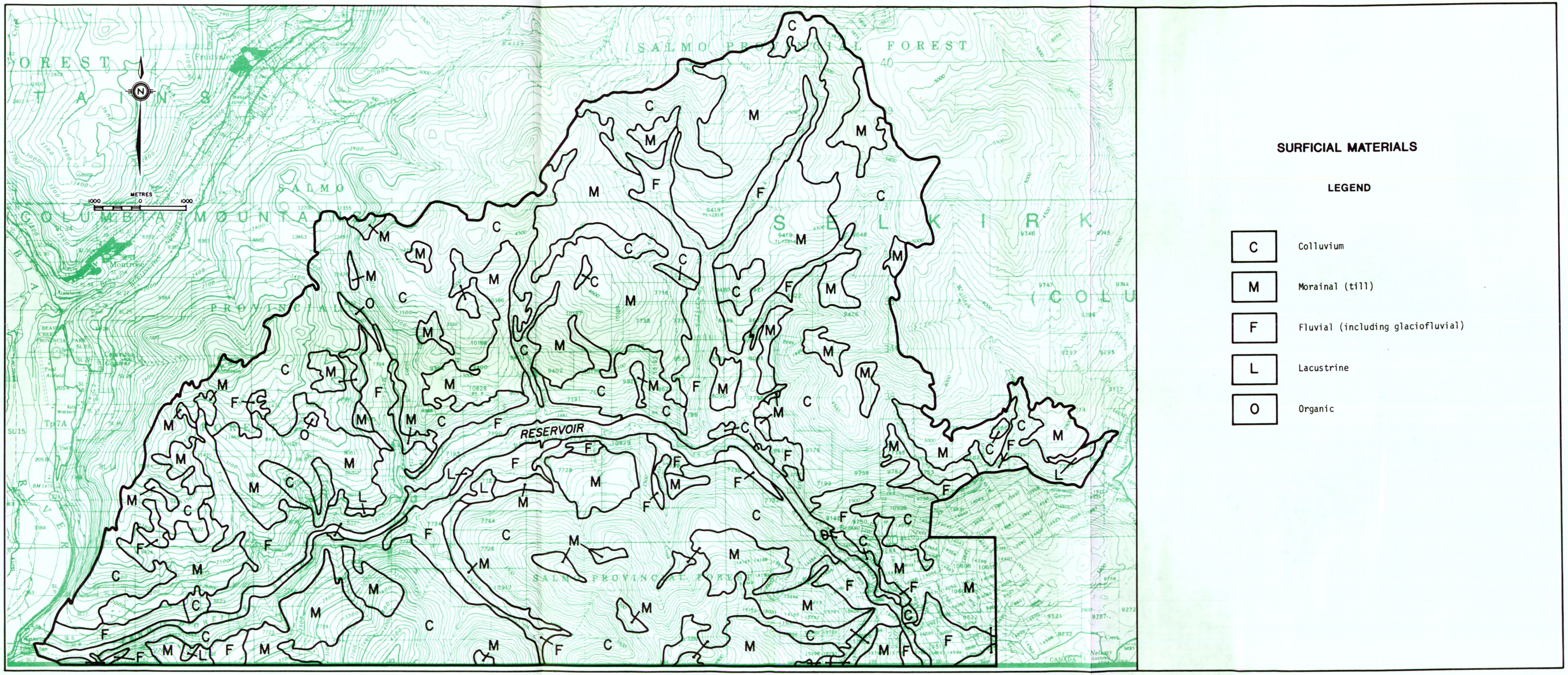


Figure 2.3. SURFICIAL MATERIALS OF THE PEND-D'OREILLE VALLEY, B.C.

topographic (slope) terms are from The Canadian System of Soil Classification (Canada Soil Survey Committee, 1978). Many of the terms employed here are described in Appendix A.2.

Morainal (till) materials are sediments deposited directly from glaciers. Morainal deposits cover approximately one-third of the Study Area, occurring at all elevations on gentle to very strong slopes. Typically, a loose 20-50 cm eolian and volcanic ash capping overlies these deposits. Glacial till occurs as a blanket (greater than one metre thick), or a veneer (less than one metre thick) that fails to mask the gross topographic forms of the underlying bedrock.

In general, two groups of till were recognized in the Pend-d'Oreille Valley. The general characteristics of these tills in their relatively unweathered state are shown below. One till group is calcareous and one is non-calcareous.

Dominant Characteristics	Calcareous Till	Non-calcareous Till
Texture (<2 mm)	Loam to clay loam	Loam to sandy loam
Coarse Fragment % (>2 mm)	10 - 35%	35 - 50%
Particle Size Class	Loamy	Loamy - skeletal
Reaction (pH)	7.5 - 8.0	4.5 - 5.5
Base saturation %	100%	5 - 30%
Colour (Munsell)	olive brown	olive brown
Elevation	<1200 m	>1100 m

The calcareous till has probably been influenced by the limestone and dolomite outcroppings in the lower elevations of the valley, whereas the non-calcareous till appears to be more influenced by the localized volcanic and meta-sedimentary bedrock found in the higher elevations. A number of intergrades also occur between these two tills which show variations in depth, texture, calcareousness, reaction, and coarse fragment content. For example, for the calcareous till, depth to carbonates is generally 1.0 to 1.5 m, but in certain areas, the depth is only 0.5 m.

Colluvial materials are products of mass wastage and have reached their present position by direct, gravity-induced movement. Colluvial deposits are the most dominant parent material in the valley, occurring at all elevations on strong to steep slopes. The upper 50 cm of most colluvial deposits generally consists of a loose mixture of materials containing some volcanic ash and eolian deposits with incorporated bedrock fragments due to soil creep.

Since several kinds of bedrock types outcrop in the Pend-d'Oreille (see section 1.4. on geology), most colluvial deposits are influenced by more than one kind of bedrock outcropping and also contain till fragments which have been dislocated by mass wastage. Consequently, most colluvial deposits are of mixed mineralogy and thus no attempt was made to separate them on the basis of bedrock geology.

Textures of the colluvial deposits vary from loam, sandy loam, to sandy clay loam. Coarse fragment content is generally 35-70%. Particle size class is nearly always loamy-skeletal.

Fluvial materials were transported and deposited by streams and rivers. The mappable fluvial and glaciofluvial deposits in the Pend-d'Oreille Valley occur above contemporary floodplains and stream channels. Due to the steeply sloping nature of the valley, the Pend-d'Oreille River and its tributaries are nearly always confined to narrow, incised stream channels. The extent of these active channels cannot be mapped at 1:20 000, therefore, no map unit recognition is given to active fluvial deposits. Users should keep in mind that all tributary streams do contain a narrow channel that is of consequence for land use planning and on-site management.

Inactive fluvial and glaciofluvial deposits are confined to the lower elevations of the main valley and to the lower elevations of the tributary valleys. Some fluvial deposits are well sorted sands and/or gravels which commonly occur on nearly level to gentle slopes. The poorly sorted glaciofluvial (kame) deposits are generally on strong to very strong slopes. Soils developed on fluvial deposits were separated on the basis of texture, with primarily sandy deposits distinguished from gravelly deposits.

Lacustrine materials are sediments that have settled from suspension in lakes. In the Study Area, lacustrine materials are generally silty, with very few coarse fragments, and calcareous at depth. Although not covering a large area in the valley, they are occasionally exposed on stratigraphic sections cut by roads and are of consequence as desired mineral licks by ungulates and as a potential source of slope instability.

Organic materials are deposits which have resulted from vegetative growth, accumulation, and decay, and occur when the rate of accumulation exceeds decay. In the Study Area, only two small poorly drained organic units have been mapped.

Eolian materials have been transported and deposited by wind action. In the Pend-d'Oreille Valley, these deposits generally overlie the aforementioned materials on gentle to very strong slopes where they occur as a silt loam veneer, being approximately 20 to 50 cm in thickness. Particles of volcanic ash are incorporated with the eolian deposits (see section 1.4.2).

2.3.2. Soil Classification

Soil classification is discussed here at the subgroup level for the major soil orders found in the Pend-d'Oreille. Seven soil orders occur in the Study Area, only five of which are mappable in extent. Figure 2.4 shows the general distribution of the major soil subgroups. Soil orders and subgroups are defined and described in The Canadian System of Soil Classification (Canada Soil Survey Committee, 1978).

Brunisolic soils have weakly expressed soil horizonation. These soils are dominant in the lower elevations of the Study Area below 1200 metres where they occur on morainal, fluvial, and colluvial parent materials. In the Pend-d'Oreille Valley, soils are either Orthic Eutric Brunisols or Orthic Dystric Brunisols. Both of these subgroups lack an eluvial horizon. Eutric and Dystric Brunisols are differentiated on the basis of pH, with the latter soils being more acidic. Dystric Brunisols are transitional to Podzolic soils in higher elevations. Dystric Brunisols, compared to Eutric Brunisols, often occur in a wetter, colder environment and are more likely to be associated with a coniferous forest containing western hemlock and western red cedar. Eutric Brunisols, on the other hand, are more likely to be found where Douglas-fir, grand fir, and western red cedar represent the climax forest tree species.

Podzolic soils are characterized, in the Study Area, by the accumulation of iron and aluminum in soil horizons through leaching. Podzolic soils occur on morainal, fluvial, and colluvial parent materials in higher elevations, usually above 1200 m, where greater precipitation

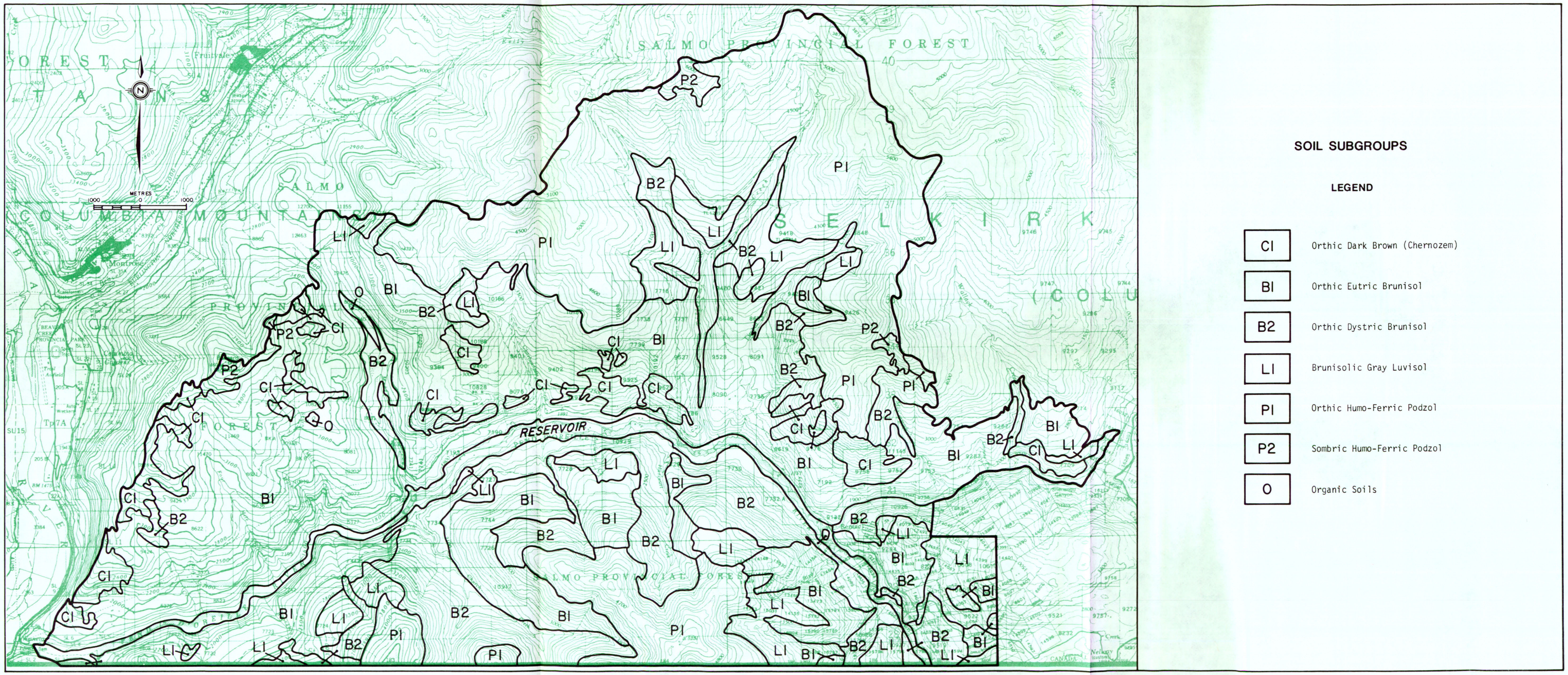


Figure 2.4. SOIL SUBGROUPS OF THE PEND-D'OREILLE VALLEY, B.C.

is experienced. Orthic Humo-Ferric Podzol is the dominant subgroup. However, on steeply sloping and south-facing open slopes at these high elevations, some Sombric Humo-Ferric Podzols also occur. These soils have a thick, dark Ah horizon which contains both mineral and organic material. Wherever alpine fir and Engelmann spruce are found in the valley, Podzolic soils almost always occur.

Luvisolic soils are characterized by a horizon of clay accumulation. This horizon may inhibit downward water movement and root penetration in the soil, although in the valley it is usually weakly expressed. In the Study Area, Luvisolic development occurs on lacustrine and morainal materials and Brunisolic Gray Luvisols are the main subgroup.

Chernozemic soils in the Study Area, are restricted to south-facing slopes below 1200 m where open grass and shrubland vegetation is dominant. Due to high summer temperatures and high evapotranspiration rates, tree growth is inhibited and soil leaching is limited. This leads to the accumulation of the decomposition products of grasses in the topsoil, resulting in a thick Ah horizon. Frequent fires in the past have probably also played a role in maintaining open grass and shrubland conditions. These open areas are prime winter forage areas for white-tailed deer. Chernozemic soils are Orthic Dark Browns in the Pend-d'Oreille and occur primarily on colluvium, and occasionally on till.

Organic soils are restricted to development on organic deposits which are at least 40 cm thick. As mentioned previously, only two small mappable units of organics occur in the Study Area.

Gleysolic soils are saturated with water and exist under reducing conditions for much of the year, as indicated by grayish (gleyed) colours or distinct mottling. These soils are poorly drained, and are generally adjacent to tributary stream channels feeding the main Pend-d'Oreille River. As mentioned previously, these channels were not mapped due to scale, but nevertheless do exist and are of concern to land managers. The vegetation commonly associated with these soils includes western red cedar and common lady fern.

Regosolic soils either lack or have only very weak soil development, they do not have a B horizon. They are restricted to areas that are periodically disturbed, in the Pend-d'Oreille Valley they usually occur on very steep colluvial slopes experiencing active mass wasting. Regosolic soils exist as unmapped inclusions within the Study Area.

2.3.3. Soil Types

Soil types were differentiated in the Pend-d'Oreille Valley (see Figure 2.2) by utilizing soil parent materials (surficial deposits), soil family criteria including subgroup soil development and soil climate, and climax vegetation. Climax vegetation was incorporated in the soil legend due to its usefulness as an indicator of soil climate (see Appendix A.6). Each soil type is composed of primarily one soil family, which in turn is a grouping of soil profiles. Therefore, each soil type has a range of inherent characteristics.

The generalized soil legend for the Pend-d'Oreille Valley (see Table 2.1) summarizes the major factors that differentiate the soil types. Each soil type is described in Appendix A.2 with its range of soil characteristics also discussed. A key to the soils is also contained in Appendix A.1.

One photograph is provided in Appendix A.2 depicting the landscape in which the soil occurs, including the vegetation commonly associated with the soil, and another photograph illustrates a typical soil profile. Fold-outs attached to the first and last soil types provide brief definitions of soil terms and may be used with any of the soil descriptions in Appendix A.2.

Correlation of soil types with Jungen's (in progress) soil association components and with established U.S. Soil Series are provided in Appendix A.3. The primary benefit of soil correlation is improved communication. By knowing how soils in the Study Area relate to soils mapped in the adjacent areas in the United States, soil scientists can compare notes on the use characteristics and interpretations provided for similar soil types. Planners also benefit by being aware of how one soil report relates to another.

2.4. Land Use Interpretations

2.4.1. Introduction

Soils are interpreted in this section for a variety of land uses. Soil capability ratings for agriculture and forestry, and soil limitation ratings for recreation sites and engineering uses such as roads, dwellings and septic tanks are provided. Ratings are also provided in the

Table 2.1.

GENERALIZED SOIL LEGEND FOR THE PEND-D'OREILLE VALLEY, B.C.*

Soil** Type	Parent Material	Particle Size Class	Soil Development (Subgroup)	Soil Temperature Class	Soil Moisture Subclass	Climax Trees
M1	Morainal	Loamy	Orthic Eutric Brunisol	Mild	Semiarid	Douglas-fir
M2	Morainal	Loamy	Orthic Eutric Brunisol	Cool	Subhumid	Grand fir and/or western red cedar
M3	Morainal	Loamy	Brunisolic Gray Luvisol	Cool	Humid	Western hemlock
M4	Morainal	Loamy-skeletal	Orthic Humo-Ferric Podzol	Cold	Perhumid	Western hemlock, with alpine fir
M5	Morainal	Loamy-skeletal	Orthic Humo-Ferric Podzol	Very Cold	Perhumid	Alpine fir, Engelman spruce
F1	Fluvial	Loamy-skeletal	Orthic Eutric Brunisol	Mild	Semiarid	Douglas-fir
F2	Fluvial	Coarse-loamy	Orthic Eutric Brunisol	Cool	Subhumid	Grand fir and/or western red cedar
F3	Fluvial	Loamy-skeletal	Orthic Eutric Brunisol	Cool	Subhumid	Grand fir and/or western red cedar
F4	Fluvial	Coarse-loamy	Orthic Dystric Brunisol	Cool	Humid	Western hemlock
F5	Fluvial	Loamy-skeletal	Orthic Dystric Brunisol	Cool	Humid	Western hemlock
L1	Lacustrine	Coarse-silty	Brunisolic Gray Luvisol	Cool	Humid	Western hemlock or western red cedar
C1	Colluvium	Loamy-skeletal	Orthic Dark Brown	Mild to Cool	Semiarid	Non-forest
C2	Colluvium	Loamy-skeletal	Orthic Eutric Brunisol	Mild to Cool	Semiarid	Douglas-fir
C3	Colluvium	Loamy-skeletal	Orthic Eutric Brunisol	Cool	Subhumid	Grand fir and/or western red cedar
C4	Colluvium	Loamy-skeletal	Orthic Dystric Brunisol	Cool	Humid	Western hemlock
C5	Colluvium	Loamy-skeletal	Orthic Humo-Ferric Podzol	Cold	Subhumid	Douglas-fir and/or grand fir
C6	Colluvium	Loamy-skeletal	Orthic Humo-Ferric Podzol	Cold	Perhumid	Western hemlock, with alpine fir
C7	Colluvium	Loamy-skeletal	Orthic Humo-Ferric Podzol	Very Cold	Perhumid	Alpine fir, Engelmann spruce
C8	Colluvium	Loamy-skeletal	Sombric Humo-Ferric Podzol	Cold to Very Cold	Subhumid	Non-forest
O	Organic	-	-	-	-	Variable
R	Bedrock	-	-	-	-	Non-forest

* This generalized legend indicates the most common characteristics for each soil; please refer to the soil description in Appendix A.2 for other associated characteristics.

** An "s" is added for soils which are extremely shallow, i.e., soils in which depth-to-bedrock is less than 50 cm (e.g., C2s or M1/C1s).

engineering section on soil erosion potential. Interpretations are value judgements based on soil characteristics observed in the field and on soil samples tested in the laboratory. Wildlife interpretations are presented in Chapter 4 since they are based on both the soil and vegetation information and utilize data collected by the B.C. Fish and Wildlife Branch.

2.4.1.1. Soil Interpretations and Land Uses

Soil interpretations are intended to provide resource information necessary for better land use planning and management. The interpretations provide a relative prediction of soil performance. Soil interpretations are intended to serve as input into the planning process and are not intended as recommendations for land use.

The predictive value of the soil interpretations depends largely on the methods used to develop the interpretations. Users are encouraged to modify or change the methods used in this report when further experience warrants it, it is recommended that this be done with a soil scientist. The main value of the soil map is that it provides a geographical framework for organizing and extending available knowledge about soils to specific locations. New discoveries and relationships derived from research and in-the-field testing can be extended to other areas of similar soils.

The reliability of soil interpretations also depends on the homogeneity of the soils delineated within the map unit. Some landscapes are naturally more complex than others. Also, some areas received more intensive field checking which generally improves map reliability (see Figure 2.1). It is believed that at least 75 percent of the area outlined within a map delineation is represented by the labelled soils (see Appendix A.4). Thus, up to 25 percent of a map area may contain localized pockets of unlike soils which are too small to be shown at the scale of mapping. These inclusions of soils not represented by a map unit symbol are usually no larger than 4 hectares (10 acres), but may be as large as 10 hectares (25 acres). Therefore the interpretations are not intended to be used to replace on-site investigations when specific information is needed for operations or design purposes.

Twenty soil types have been recognized in the Pend-d'Oreille Valley. Each of them has a unique combination of profile characteristics, texture, moisture retention, mineralogical and chemical composition, and each of them is found in a unique landscape setting as determined by climate, vegetation, slope, relief, and moisture regime. All of them, to a varying degree, have different use capabilities and yield potential. Soil interpretations are employed to synthesize the diversity of soil resource data. Internal and external soil characteristics are evaluated for specified land uses and an interpretive rating is provided.

Soil interpretations apply to modal characteristics of each soil (i.e. the most typical conditions found). Soil type characteristics, however, are broader than those expressed by the modal soil. Therefore, when applying soil interpretations to actual map delineations, users must also be aware of the possible range of soil characteristics associated with the soil map units which, in some instances, can modify the interpretation provided.

2.4.1.2. Soil Interpretive Classes

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

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

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

(iii) severe limitations: recognized in soils that are poorly suited for the use being considered because of one or more unfavourable soil properties. Limitations are difficult and costly to overcome, requiring special design, major soil reclamation, or intense maintenance.

(iv) very severe limitations: recognized in soils that are very poorly suited for the specific use because of several unfavourable soil properties. Limitations are believed to be too difficult to overcome for most uses.

Again, it should be emphasized that 'severe' soil ratings do not necessarily imply that a site cannot be changed to remove, correct, or modify the soil limitations. The use of soils rated 'severe' depends on the kind of limitations, whether or not the soil limitations can be altered successfully and economically, and the scarcity of good sites.

Soil capability ratings for agriculture and forestry employ the seven class system defined by the Canada Land Inventory (1970). These ratings are defined for each resource in sections 2.4.4. and 2.4.5.

2.4.2. Soil Interpretations for Recreation

2.4.2.1. Methods

Interpretations are provided for campgrounds and picnic sites and are expressed in terms of the degree and kind of soil limitations which affect use. The interpretations are based on soil characteristics only and do not include such factors as recreation features which may attract use or existing roads which improve access. Thus, the interpretations are just one input into the recreation planning process.

The interpretive method for determining soil limitations for campgrounds and picnic sites is outlined on Table A.9 in Appendix A.5. This table has been adapted from previous guides provided by Montgomery and Edminster (1966) and Coen et al. (1977). The table evaluates the following soil characteristics in terms of their relative limitations for use: soil drainage, flooding hazard, slope, texture, stoniness, depth to bedrock, and rockiness. The importance of these soil properties to recreational use are briefly discussed. .

Soil drainage evaluates the rapidity and extent of removal of water from soils in relation to additions. Wet soils with imperfect to very poor drainage are a limitation to use since the soils are subject to compaction due to the lubricating effect of water. Soil compaction reduces soil pore space, thereby reducing infiltration and percolation, increasing surface runoff and encouraging erosion. Wet soils are also unpleasant sites for recreationists since they become muddy when trampled.

Soils subject to flooding are generally not suitable for recreation facilities that require relatively elaborate structures. These sites are also a hazard for recreationists as sudden heavy rains may cause flash flooding of creeks and streams.

Steep slopes are less physically suitable for campgrounds and picnic sites since they are uncomfortable for recreationists. In addition, steep slopes are more unstable or erodible due to the influence of gravity and running water. Meeuwig (1971) concluded that erosion rates double for each 10% increase in slope when the vegetation and litter cover of the soil is less than 50% - conditions not uncommon for most campground and picnic sites.

Soils with a relatively high clay and silt content are especially susceptible to erosion as fine grained particles are easily suspended in running water. Also, when dry, they can become dusty when exposed. Excessively sandy soils, without the necessary clays and silts to bind the particles together, are undesirable because they are loose and unstable. Soils with a mixture of clay, silt, and sand - such as a loam or sandy loam - are considered best suited for most recreational uses. Loamy soils are also considered best for plant growth; thus vegetation cover maintenance is likely to be more feasible on intensively used sites.

Excessive stoniness is a limitation in that surface stones present obstacles to recreationists unless they are removed. Surface stoniness also influences the difficulty of construction of recreational facilities.

Soils with a shallow depth to bedrock are a limitation if recreation facilities are envisioned requiring some excavation work. Encountering bedrock increases the cost of this work. Shallow soils also tend to be sensitive to use and difficult to vegetate.

Excessive rockiness is an obstacle to campground and picnic site construction as site layout must negotiate around bedrock outcrops. Bedrock outcrops can also present a safety hazard, especially on steep slopes, where rockfalls are more likely to occur.

These aforementioned properties were all evaluated before rating each soil mapping unit and slope class combination into one of four categories (see Table 2.2). These categories, based on soil limitations for campgrounds and picnic sites, are slight, moderate, severe, and very severe. An interpretive map can be prepared from the soil map of the Pend-d'Oreille by colouring units according to their limitations for use.

Table 2.2.

SOIL INTERPRETATIONS FOR CAMPGROUNDS AND PICNIC SITES[1]

Soil Type	Slope Class 1, 2, 3, 4 (0-9%)	5 (10-15%)	6 (16-30%)	7, 8, 9, 10 (> 30%)
M1, M2, M3, F2, F4	Slight	Moderate: slope	Severe: slope	Very severe: slope
M4, M5, F1, F3, F5	Slight: stony	Moderate: slope, stony	Severe: slope, stony	Very severe: slope, stony
L1	Moderate: texture	Severe: texture, slope	Very severe: texture, slope	Very severe: slope, texture
C1, C2, C3, C4, C5, C6, C7, C8	--	Severe:[2] depth, slope, stony	Severe:[2] depth, slope, stony	Very severe: slope, depth, stony
0	Very severe: wet, texture	--	--	--

[1]See Table A.9 in Appendix A.5 for outline of criteria used to develop these interpretations.

[2]If depth to bedrock is less than 0.5 m as indicated by an "s" following the map unit symbol on the soils map (e.g. C2s), or if the map unit contains a bedrock outcrop symbol (e.g. R), reduce rating to very severe.

-- indicates that no soils exist for these slope classes

Several of the engineering interpretations provided in the next section (2.4.3.) such as those for septic tanks and roads, also influence the suitability of sites for intensive forms of recreational use and should be consulted.

2.4.2.2. Results

Table 2.2 indicates the degree and kind of limitations for campgrounds and picnic sites for each soil type and slope class. The main limiting factor in the Study Area is steep slopes which result in severe to very severe limitations for most of the valley.

Most of the mappable soils in the area are rapidly to moderately well drained and are not subject to flooding. Thus, no important soil limitations exist for these two characteristics. Unmapped inclusions of wetter soils and small tributary channels containing a confined floodplain are, however, subject to these limitations. As mentioned previously, on-site investigations are necessary before an area is determined suitable for use to ensure that unmapped conditions with unfavourable soil properties do not exist.

Loamy soils developed on morainal and fluvial deposits on level to gentle slopes have no significant limitations for use. Unfortunately, most of these soils occur on steeper topography where slope does limit use. When these soils are adjacent to the reservoir, shoreline instability may be an additional hazard limiting use. Loamy-skeletal soils on these parent materials are also affected by stoniness limitations.

Soils developed on colluvium are generally ill-suited for campgrounds and picnic sites due to steep slopes, rockiness and shallow depth to bedrock may also prove problematic.

Lacustrine deposits are moderately limited by silty textures causing low shear strength, high compaction and erosion potential. This texture limitation is increasingly more severe on steeper slopes, on sites receiving seepage, and on reservoir banks.

Organic deposits have very severe limitation to use due to poor drainage and texture characteristics resulting in low shear strength.

2.4.3. Soil Interpretations for Engineering Uses

2.4.3.1. Engineering Uses of the Soils

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are regional planners, engineers and local land owners and managers.

Among the properties of soils highly important in engineering are permeability, shear strength, compaction characteristics, soil drainage condition, shrink-swell potential, frost action (heaving) potential and erosion hazard potential. Also important are depth to water table, depth to bedrock and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, foundations for small buildings, shallow excavations and septic tanks.

Information in this section can be helpful to those who:

1. Select potential residential, industrial, commercial and recreational areas.
2. Evaluate alternative routes for roads, underground cables and pipelines, and power lines.
3. Seek to minimize soil losses due to erosion.
4. Seek sources of sand and gravel, or topsoil.
5. Develop preliminary estimates pertinent to construction in a particular area.

Selected engineering interpretations for each soil type are presented in Table 2.4. As emphasized previously, this information does not eliminate the need for further investigation at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than 1-2 metres. Also, inspection of sites is needed because a given soil map unit may contain small areas of other kinds of soil that have strongly contrasting properties and different limitations for engineering uses.

2.4.3.2. Engineering Soil Classification Systems

The two systems most commonly used in classifying soils for engineering are the Unified system used by most engineers and the American Association of State Highway Officials (AASHO) system adopted by some highway officials. The relatively unweathered parent materials for each soil were sampled at approximately 1 metre depth to determine Unified and AASHO classes.

Table 2.3.

ENGINEERING CHARACTERISTICS OF UNIFIED SOIL GROUPS[1]

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

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

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit and organic matter. Fifteen soil classes are recognized: there are eight classes for coarse-grained soils, identified as GW, GP, GM, and GC for gravelly materials and SW, SP, SM, and SC for sandy materials, six classes for fine-grained soils, identified as ML, CL, OL, MH, CH and OH, and one class of highly organic soils identified as Pt.

By knowing the Unified soil class, many engineering characteristics can be inferred, including value as subgrade, shear strength, compressibility and expansion characteristics, compaction characteristics and frost action potential. These inferred engineering characteristics are presented in Table 2.3 for each Unified soil class. Unified soil classes were determined for each soil type in Table 2.4.

The AASHO system is used in classifying soils according to those properties that affect use in road construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A-1 to A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest mineral soils for subgrade. AASHO soil classes are indicated for each soil type in Table 2.4. For more detail on both the AASHO and Unified Systems, refer to Asphalt Institute (1969) and U.S.D.A. Soil Conservation Service (1971).

2.4.3.3. Methods

All interpretations in this section have been modified from guidelines prepared by the U.S.D.A. Soil Conservation Service (1971). That agency provides guide sheets and text which explain in detail each engineering interpretation. Therefore, only a relatively brief discussion of each interpretation is provided here. Guide sheets for each interpretation are presented in Appendix A.5.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 0.5 to 2 metres is evaluated. Ratings are based on the ability of the soil to filter and absorb sewage effluent and the effect soil has on the construction and operation of the system. Properties that affect absorption are permeability, drainage, depth to bedrock and susceptibility to flooding.

Table 2.4.

SOIL INTERPRETATIONS FOR SELECTED ENGINEERING USES

Soil Type	Slope Class	Textural Classifications			Value as Subgrade	Potential Frost Action	Degree and Kind of Limitation for:				Suitability as Source of:		Potential Erosion Hazard
			AASHO	UNIFIED			Septic Tank Absorption Fields	Shallow Excavations	Buildings	Roads	Sand and Gravel	Topsoil	
M1 M2 M3	1-4 (0-9%)	l-cl	A-4, A-6	ML,CL	Fair to poor	Moderate to high	Slight to Moderate: perm.	Slight to Moderate: text, wet	Moderate: subgrade	Moderate: subgrade; frost	Unsuited	Good to fair: stony	Moderate text, perm.
	5 (10-15%)						Moderate: slope,perm.	Moderate: slope	Moderate: slope, subgrade	Moderate: slope, subgrade	Unsuited	Fair: slope, stony	Moderate: text,slope
	6 (16-30%)						Severe: slope	Severe: slope	Moderate: slope	Moderate: slope, subgrade	Unsuited	Poor: slope	Moderate: text,slope
	7 (31-45%)						Very Severe: slope	Very Severe: slope	Severe: slope	Severe: slope	Unsuited	Very Poor: slope	Moderate: slope,text
M4 M5	1-4 (0-9%)	gl-gsl	A-2-4, A-4	ML,CL SM,SC	Fair	Moderate to high	Moderate: stony, depth	Moderate: text, depth	Moderate: depth	Moderate: subgrade	Poor to unsuited	Poor: stony	Moderate: text,depth
	5 (10-15%)						Moderate to Severe: depth,slope	Moderate to Severe: depth,slope	Moderate to Severe: depth,slope	Moderate: slope, subgrade	Poor to unsuited	Poor: stony	Moderate: text, depth
	6 (16-30%)						Severe: slope,depth	Severe: slope,depth	Moderate to Severe: slope,depth	Moderate: slope, subgrade	Poor to unsuited	Poor: stony, slope	Moderate to High: depth, slope
	7 (31-45%)						Very Severe: slope,depth	Very Severe: slope,depth	Severe: slope, depth	Severe: slope	Poor to unsuited	Very Poor: slope	Moderate to High: depth, slope
F1 F3 F5	1-4 (0-9%)	gsl-gl	A-1, A-2	GM,GC	Good to excellent	Low to moderate	Moderate: stony	Moderate: text	Slight:	Slight:	Good to poor	Poor: stony	Low
	5 (10-15%)						Moderate: slope,stony	Moderate: slope,text	Moderate: slope	Moderate: slope	Fair to poor	Poor: stony,slope	Low
	6 (16-30%)						Severe: slope	Severe: slope	Moderate: slope	Moderate: slope	Fair to poor	Poor: stony,slope	Moderate: slope
	7,8 (31-70%)						Very Severe: slope	Very Severe: slope	Severe to Very Severe slope	Severe to Very Severe slope	Fair to poor	Very Poor: slope,stony	Moderate to High: slope, litter
F2 F4	1-4 (0-9%)	sl-ls	A-2-4	SM,SC	Fair to good	Moderate	Slight	Slight to Moderate: text	Slight:	Slight: frost	Poor to fair	Good to fair	Low: text
	5 (10-15%)						Moderate: slope	Moderate: slope,text	Moderate: slope	Moderate: slope	Poor to fair	Fair: slope, text	Low to Moderate: text
	6 (16-30%)						Severe: slope	Severe: slope	Moderate: slope	Moderate: slope	Poor to fair	Poor: slope	Moderate: slope, text
	7,8 (31-70%)						Very Severe: slope	Very Severe: slope	Severe to Very Severe: slope	Severe to Very Severe: slope	Poor to fair	Very Poor slope	Moderate to High: slope, text

Table 2.4. (Continued)

L1	1-4 (0-9%)	sil-sicl	A-4,A-7	ML,CL,MH, CH	Poor	High	Moderate: perm.	Moderate: text,wet	Moderate: subgrade	Moderate to Severe: subgrade, frost	Unsuited	Good to Fair: text	Moderate: text, perm.
	5 (10-15%)						Moderate: perm., slope	Moderate: slope,text	Moderate to Severe: subgrade slope	Moderate to Severe: subgrade, frost	Unsuited	Fair: slope, text	Moderate to High: text
	6 (16-30%)						Severe: slope, perm.	Severe: slope	Severe: slope, subgrade	Severe: subgrade, slope	Unsuited	Poor: slope	High: text, perm. slope
C1 C8	7 (31-34%)	gsl-gl	A-2-4 A-6	SM,SC ML,CL	Fair to poor	Low to moderate	Very Severe: slope,depth	Very Severe: slope,depth	Severe: slope	Severe: frost	Poor to unsuited	Very Poor: slope, stony	Moderate to High: slope,litter
	8,9 (46-100%)						Very Severe: slope,depth	Very Severe: slope,depth	Very Severe: slope	Severe to Very Severe: slope	Poor to unsuited	Very Poor slope, stony	High: slope, litter
C5	7 (31-45%)	vgsl-gsil	A-2-4 A-6	SM,SC ML,CL	Fair to poor	Low to moderate	Very Severe: slope,depth	Very Severe: slope,depth	Severe: slope	Severe: slope	Poor to unsuited	Very Poor: slope, stony	Moderate to High: slope, litter
	8,9 (46-100%)						Very Severe: slope,depth	Very Severe: slope,depth	Very Severe: slope	Severe to Very Severe: slope	Poor to unsuited	Very Poor: slope, stony	High: slope, depth
C2 C3 C4 C6 C7	6 (16-30%)	gsl-gl	A-2-4 A-6	SM,SC ML,CL	Fair to poor	Low to moderate	Severe: slope	Severe: slope	Severe: slope	Moderate: slope	Poor to unsuited	Poor: stony, slope	Low to Moderate: slope, depth
	7 (31-45%)						Very Severe: slope	Very Severe: slope	Severe: slope	Severe: slope	Poor to unsuited	Very Poor: slope, stony	Moderate: slope, depth
	8,9 (46-100%)						Very Severe: slope	Very Severe: slope	Very Severe: slope	Severe to Very Severe: slope	Poor to unsuited	Very Poor: slope, stony	High: slope, depth
O Organic	-	-	-	Pt	Unsuitable	Moderate	Very Severe: wet	Very Severe: wet	Very Severe: wet	Very Severe: wet	Unsuited	Very Poor: wet	High: wet, perm.
R Bedrock	-	-	-	-	Unsuitable	-	Very Severe: depth	Very Severe: depth	Very Severe: depth	Very Severe: depth	-	-	-

Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage and downslope flow of effluent. Large stones increase construction costs and decrease absorption capability. See Table A.1, Appendix A.5 for guide sheet.

Shallow excavations are those that require digging or trenching to a depth of less than 2 metres, for example, excavations for pipelines, sewer lines, phone and power transmission lines, basements and open ditches. Desirable soil properties are good workability, resistance to sloughing, gentle slopes, absence of rock outcrops, deep materials and freedom from flooding. See Table A.2, Appendix A.5 for guide sheet.

Buildings or dwellings, for which soils are given limitation ratings in Table 2.4, are those not more than three stories high and that are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for such dwellings are those that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load are drainage and shear strength, plasticity, texture and shrink-swell potential as inferred from subgrade assessments using the Unified soil classification. Those that affect excavation are drainage, slope, depth to bedrock and rockiness. See Table A.3, Appendix A.5 for guide sheet.

Roads, for which soils are also given a limitation rating in Table 2.4, are assumed to have a subgrade of underlying soil parent material and ordinary provisions for drainage. They are built mainly from soil at hand and most cuts and fills are less than 2 metres. Soil properties that most affect design and construction of roads are load-supporting ability and quantity of cut-and-fill material available.

The AASHO and Unified classifications of the soil material and inferred shrink-swell potential indicate traffic-supporting capacity of the material. Soil drainage, and flooding affect stability of the material. Slope, depth to hard rock, rockiness and drainage affect ease of excavation and amount of cut and fill needed to reach an even grade. Susceptibility to frost heaving affects road maintenance. See Table A.4, Appendix A.5 for guide sheet.

Sand and gravel are used in many kinds of construction. The ratings provided in Table 2.4 provide guidance on where to look for probable sources. A soil rated as a good or fair source of sand or gravel generally has a layer at least 1 metre thick. See Table A.6, Appendix A.5 for guide sheet.

Topsoil describes material used to cover barren surfaces exposed during construction so as to improve soil conditions for the re-establishment and maintenance of vegetation and also to improve conditions where vegetation is already established. The soils are rated in terms of characteristics which are favourable to plant growth and the ease of working and spreading the soil material. Texture of the soil material, stoniness and drainage are characteristics that affect suitability. Also considered in the ratings is the damage that will result at the area from which the topsoil is taken. Thus, steep slopes are an unfavourable characteristic due to increased soil erosion potential. See Table A.7, Appendix A.5 for guide sheet.

Soil erosion is the detachment and subsequent transport of soil particles by wind, gravity, and/or flowing water. Criteria considered in determining surface erosion potential include slope, drainage, permeability, depth to impermeable layer, Unified soil group, and forest floor thickness. See Table A.8, Appendix A.5 for guide sheet.

Surface soil erosion potential is an important consideration, not only for engineering uses of land, but also for all other land uses. The relatively steep slopes in the Pend-d'Oreille Valley make many soils particularly susceptible to erosion when disturbed. Soil erosion can decrease site productivity, damage roads and structures, affect the quality of water and fish habitat and is aesthetically unattractive.

Interpretations are provided in Table 2.4 for the engineering characteristics of each soil type in the Pend-d'Oreille. The interpretations relate to modal (average) soil characteristics, thus, as mentioned, on-site investigations are necessary if development is envisioned for an area. Geotechnical expertise is generally needed for large developments.

2.4.4. Soil Capability for Agriculture

2.4.4.1. Methods

Soil capability classes for agriculture are provided for each soil type in Table 2.5. The Canada Land Inventory's (1972) manual on Soil Capability for Agriculture, Jungen's (1972) broad scale capability map, and Jungen's (in progress) soil association ratings for agricultural capability were utilized in refining capability ratings for the Study Area. Due to the apparently high climatic capability for agriculture in the valley bottoms, some of the ratings are higher than previously indicated by Jungen.

LEGEND FOR SOIL CAPABILITY FOR AGRICULTURE (Table 2.5)

The capability classes used for the Pend-d'Oreille Valley are as follows:

Class 1: Soils in this class have no significant limitations in use for crops. The soils are deep, well to imperfectly drained, hold moisture well, and are well supplied with plant nutrients. They can be managed and cropped without difficulty. Under good management they are moderately high to high in productivity for a wide range of field crops.

Class 2: Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The soils are deep and hold moisture well. The limitations are moderate and the soils can be managed and cropped with little difficulty. Under good management they are moderately high to high in productivity for a fairly wide range of crops.

Class 3: Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices. The limitations are more severe than for Class 2 soils. They affect one or more of the following practices: timing and ease of tillage; planting and harvesting; choice of crops; and methods of conservation. Under good management they are fair to moderately high in productivity for a fair range of crops.

Class 4: Soils in this class have severe limitations that restrict the range of crops or require special conservation practices or both. The limitations seriously affect one or more of the following practices: timing and ease of tillage; planting and harvesting; choice of crops; and methods of conservation. The soils are low to fair in productivity for a fair range of crops but may have high productivity for a specially adapted crop.

Class 5: Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. The limitations are so severe that the soils are most capable of use for sustained production of annual field crops. The soils are capable of producing native or tame species of perennial forage plants, and may be improved by use of farm machinery. The improvement practices may include clearing of bush, cultivation, seeding, fertilizing or water control.

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

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

0 Organic soils (not placed in capability classes).

The capability subclasses express the kinds of limitations that affect the agricultural use of land. The subclasses used for the Pend-d'Oreille are:

Subclass C adverse climate - The main limitation is low temperature or low or poor distribution of rainfall during the cropping season or a combination of these.

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

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

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

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

Example of how the class symbols operate:

Capability class $\longrightarrow 4^{T \longleftarrow \text{Most limiting subclass}}_{P \longleftarrow \text{Other limiting subclass}}$

An area of Class 4 land with topography and stoniness limitations.

Table 2.5.

SOIL CAPABILITY FOR AGRICULTURE[1]

Soil Type	Capability Class and Subclass						
	Slope Class						
	1, 2 (0-2%)	3 (2-5%)	4 (6-9%)	5 (10-15%)	6 (16-30%)	7, 8 (31-70%)	9, 10 (> 70%)
M1, M2	--	--	$3^T_P - 4^P_C$	4^T_P	5^T_P	6^T_P	--
M3	--	--	$5^C_P - 6^C_P$	$5^C_P - 6^C_P$	$5^C_T - 6^C_T$	$6^T_C - 7^C_T$	--
M4, M5	--	--	7^C	7^C	7^C	7^C	--
F1	--	--	--	4^T_P	5^T_P	6^T_P	--
F2	--	$*3^M_T$	3^T_M	4^T_M	5^T	6^T	--
F3	--	4^P_M	4^P_M	4^T_P	5^T_P	6^T	
F4	--	$4^C_M - 5^C$	$4^C_M - 5^C$	$4^T_C - 5^C$	5^T_C	6^T	
F5	--	$5^C_P - 6^C_P$	$5^C_P - 6^C_P$	$5^C_P - 6^C_P$	$5^C_T - 6^C_T$	6^T_C	--
L1	--	2^T	3^T	4^T	5^T	--	--
C1	--	--	--	--	--	6^T_R	7^T_R
C2, C3, C4, C5	--	--	--	--	6^R_T	6^T_R	7^T_R
C6, C7	--	--	--	--	7^C	7^C_T	7^T_C
C8	--	--	--	--	$6^R_T - 7^C$	$6^R_T - 7^C_T$	7^T_C

*With irrigation, these soils should improve to class 2^T

-- indicates that no soils exist for these slope classes

[1]Note: See opposite page for legend explaining capability class and subclass symbols.

Although the relationships between soil characteristics and agricultural capability were otherwise generally not changed from Jungen's work, the capability ratings are now assigned to a more detailed scale of mapping. For more information on the methods associated with agricultural capability assessment, refer to Runka (1973).

2.4.4.2. Capability Classification

The capability classes used for the Pend-d'Oreille are described on the legend opposite Table 2.5. A given capability class is a grouping of soils that have the same relative degree of limitation for agricultural use. The limitations become progressively greater from Class 1 to Class 7.

In this classification, mineral soils are grouped into seven classes on the basis of soil survey information. Soils in classes 1, 2, 3, and 4 are considered capable of sustained use for cultivated field crops, those in classes 5 and 6 only for perennial forage crops and those in class 7 for neither.

Some of the important factors on which the classification is based are:

-The soils will be cropped under a largely mechanized system.

-Land requiring improvements, including clearing, that can be made economically by the farmer himself, is classed according to its limitations after the improvements have been made. Land requiring improvements beyond the means of the individual farmer is classed according to its present condition.

-The following are not considered: distances to market, kind of roads, location, size of farms, type of ownership, cultural patterns, skill or resources of individual operators, and hazard of crop damage by storms.

The classes are based on the magnitude of their limitations for agriculture. Each class includes many kinds of soil and many of the soils in any class require different management and treatment. Subclass ratings indicate the nature of the limitation(s).

2.4.4.3. Results

The capability for agriculture in the Pend-d'Oreille Valley is summarized on Table 2.5. Although Class 1 climate capability for agriculture has been mapped for portions of the valley

(Resource Analysis Branch, 1974), no Class 1 lands exist due to soil and topographic limitations. Most of the Study Area occurs on moderate to steep slopes which places the lands in Classes 4 to 7 due to topographic limitations alone.

Morainal, colluvial, and fluvial materials are dominant in the valley, most of these deposits are limited for agricultural use due to stoniness. Low moisture holding capacity is also a limitation on fluvial and colluvial deposits.

Areas of gently sloping lacustrine and sandy fluvial deposits have the highest capability for agriculture. These small localized sites, located on valley bottom slopes mainly below 750 metres elevation, have Classes 2 and 3 capability for agriculture. Irrigation would improve the capability for the sandy fluvial materials which are limited by a relatively low moisture holding capacity.

2.4.5. Land Capability for Forestry

2.4.5.1. Methods

Land capability for forestry ratings for each soil type are presented in Table 2.6. The Canada Land Inventory (McCormack, 1967) classification framework was used. No additional forest capability plots, as described by Kowall (1971), were measured in the Study Area during the course of the inventory. Capability assessments, however, have been prepared for similar soils by Jungen (in progress) and 1:50 000 forest capability maps are available for the Study Area fron the Resource Analysis Branch.

In addition, the B.C. Forest Service has productivity plots in the valley and has assigned relative productivity ratings for each forest cover unit. Forest productivity ratings have been assigned to "habitat types" (Pfister et al, 1977) which relate to the climax vegetation conditions identified for each soil map unit.

The forest capability ratings for the Study Area's soils were determined using the aforementioned available data, additional plot data, if collected, will improve the reliability of these ratings and may result in modification of the ratings.

LEGEND FOR LAND CAPABILITY FOR FORESTRY (Table 2.6.)

The capability classes used for the Pend-d'Oreille Valley are described below. Forest productivity estimates are based on a rotation age of 100 years.

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

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

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

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

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

Class 6: Lands having severe limitations to the growth of commercial forests. Soils are frequently shallow, stony and rapid to well drained. A large percentage of the land in this class is composed of open, steep, south-facing colluvial slopes. The most common limitations (frequently in combination) are shallowness to bedrock, deficiency of soil moisture, and adverse exposure. Productivity will usually be from 0.8 to 2.1 cubic metres per hectare per year.

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

The capability subclasses express the kinds of limitations that affect the forest capability rating. The subclasses used for the Pend-d'Oreille Valley are:

Subclass A - drought or aridity as a result of climate. Water deficits exist during the growing season due to relatively low seasonal precipitation.

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

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

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

Subclass U - exposure to sun associated with steep, south-facing slopes which results in increased water deficits during the growing season due to significant evapotranspirational losses.

Subclass W - soil moisture excess used for poorly drained organic soils.

Table 2.6.

LAND CAPABILITY FOR FORESTRY[1]

Soil Type	Dominant Capability Classes	Dominant Capability Subclasses
M1	3-4	A, U
M2	3-4	A
M3	2-3	A
M4	2-1	H
M5	2	H
F1	3-4	U, A
F2	3	A, M
F3	4-5	M, A
F4	3	A, M
F5	3-4	M, A
L1	3	A
C1	6	U, R
C2	4-5	U, R
C3	4-5	A, R
C4	3-4	A, R
C5	5	U, R, H
C6	3-4	F, H
C7	3-4	R, H
C8	6-7	U, H, R
D	7	W

[1]Note: See opposite page for legend explaining capability class and subclass symbols.

2.4.5.2. Capability Classification

The capability classes used for the Pend-d'Oreille are defined in the legend for Table 2.6. A given capability class is a grouping of soils that have a similar inherent ability to grow commercial timber. The classes are defined in terms of the inherent limitations to the growth of commercial forests and on productivity. The best lands for commercial tree growth will be found in Class 1 and, at the other extreme, those in Class 7 cannot be expected to yield timber in commercial quantities. Subclass ratings indicate the nature of the limitation(s).

Some of the important factors on which the classification is based are:

-All known or inferred information about the unit including soil, depth, moisture, fertility, landform, climate and vegetation.

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

-The following are not considered: location, access, distance to markets, size of units, ownership, present state of special crops such as Christmas trees.

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

2.4.5.3. Results

Land capability for forestry in the Pend-d'Oreille is summarized in Table 2.6. A complex forest capability pattern occurs in this mountainous area because of the interaction of highly variable climatic, edaphic, and topographic factors.

At lower elevations, low seasonal precipitation results in droughty summer conditions which limit forest growth. Moderately high forest capabilities are experienced on deep, loamy soils in those areas where grand fir and western red cedar are considered climax tree species. Moderate to low capabilities occur on sites with edaphic limitations such as shallow-to-bedrock colluvium or coarse-textured fluvial materials, and on steep southern exposures where evapotranspirational stresses result in increased water deficits.

High forest capabilities occur at higher elevations (usually above 1100 m) where western hemlock occurs. Droughtiness or low temperatures are only slight limitations affecting forest growth. Again, edaphic sites may have moderate or low capabilities depending on the severity of the soil-related limitations.

A small portion of the Study Area occurs above 1700 metres in subalpine forests dominated by alpine fir and Engelmann spruce. These areas have slight to moderate limitations due to low temperatures which shorten the growing season and relatively shallow soils.

Chapter Three

VEGETATION RESOURCES

Chapter Three

VEGETATION RESOURCES

3.1. Introduction

The objectives of the vegetation study were:

1. To identify and map the vegetation (see back pocket) of the Pend-d'Oreille by using the vegetation types described and classified in "Vegetation of the Nelson (NTS 82F) Area" (van Barneveld, in progress).
2. To describe the vegetation patterns of the Pend-d'Oreille Valley (section 3.3, and Appendices B.1 and B.2).
3. To establish the relationship of the vegetation types to terrain, soils and climate, and to establish successional trends (Appendix B.3).
4. To develop various interpretations for white-tailed deer winter range management (Appendices B.4 and B.5).

The vegetation data in this chapter has been extracted from "Vegetation of the Nelson Area" (van Barneveld, in progress). Although vegetation types are described in Appendix B.2, more detailed information for each type is contained in van Barneveld's report.

3.2. Survey Methods

Vegetation types for the Pend-d'Oreille Valley were defined in the context of the reconnaissance survey of the Nelson (NTS 82F) Area (van Barneveld, in progress). Homogeneous units of vegetation were identified by use of a key for vegetation types developed from the reconnaissance survey.

The vegetation types were mapped at a 1:20 000 scale. Vegetation type names and numbers are used in this chapter, the numbers are bracketed after the vegetation type names. The procedure for vegetation type mapping can be obtained from "Manual for Vegetation Mapping Methodology" (Resource Analysis Branch, Vegetation Unit, in progress). The plant names used in this chapter are listed in Appendix B.7.

3.3. Vegetation Patterns

In the Pend-d'Oreille Valley, three forest zones (Figure 3.1) are present:

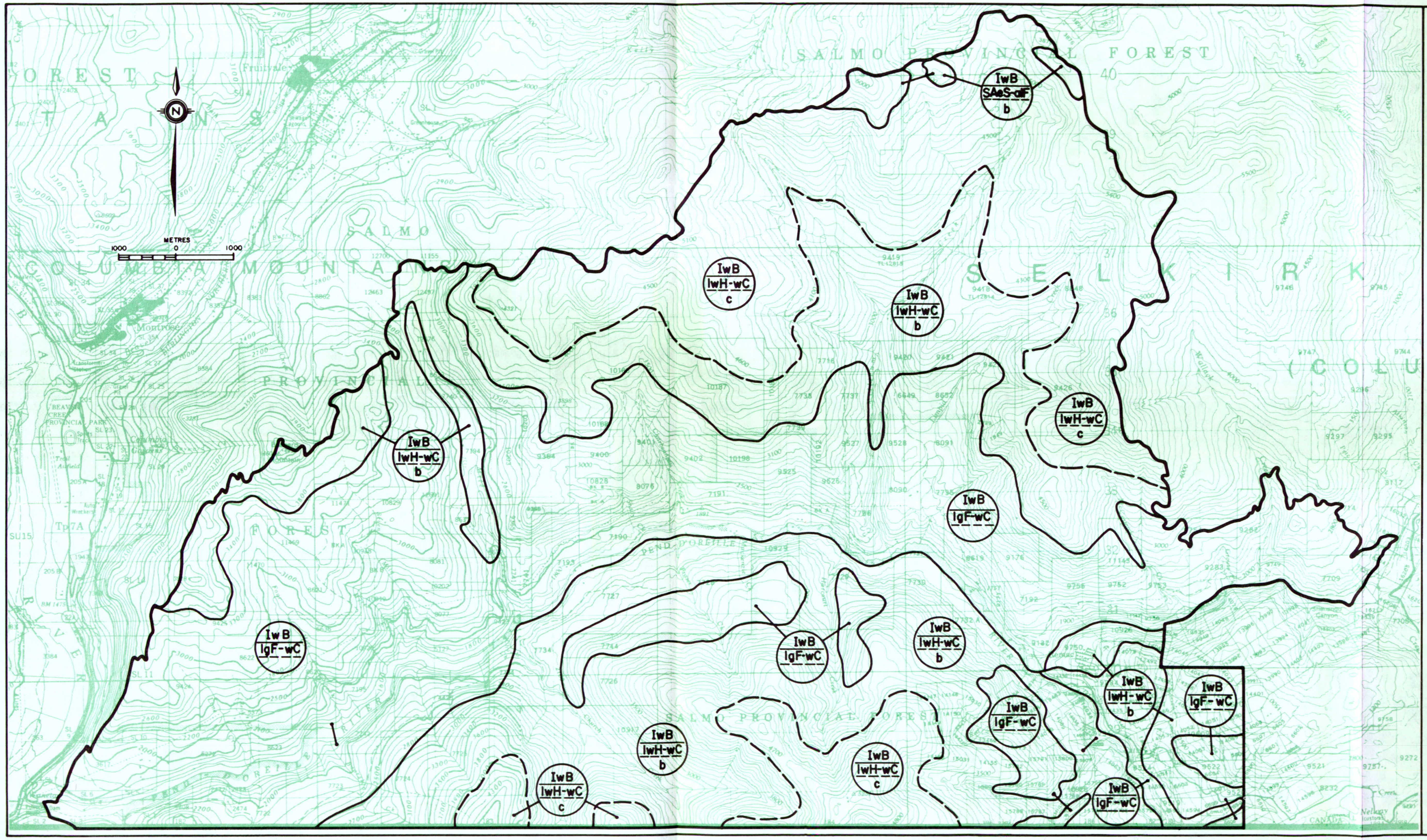
Forest Zone	Elevation(m)
Interior Grand Fir - Western Red Cedar	550 - (725)* 1150
Interior Western Hemlock - Western Red Cedar	(725) 1150 - 1700
Subalpine Engelmann Spruce - Alpine Fir	> 1700
*Brackets indicate elevational limits due to aspect changes	

The Pend-d'Oreille Valley lies within the Interior Wet Belt Region as indicated by the presence of the characteristic zone, the Interior Western Hemlock - Western Red Cedar Zone.

Climax stands of grand fir and western red cedar are not present in the Pend-d'Oreille Valley because of frequent fires around the turn of the century and fires in the mid-thirties and mid-sixties.

The north side of the Pend-d'Oreille River, below 1150 metres, contains seral forest stands of western white pine, Rocky Mountain Douglas-fir, lodgepole pine, common paper birch, trembling aspen, western red cedar and grand fir. Western white pine, Rocky Mountain Douglas-fir and common paper birch are usually the dominant species. The vegetation type Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26) is representative of this area. In the gulleys and on north to northeast aspects where there is less evapotranspiration, western hemlock can also be present with the previously mentioned tree species. The Western red cedar - Utah honeysuckle - western yew - blue-bead clintonia (20) vegetation type is characteristic of these areas. Examples of this situation occur at Nine Mile Creek and Tillicum Creeks.

From the Columbia River east to Lime Creek, toxic fumes from the smelter in Trail have affected the vegetation. Fires and soil erosion have retarded the re-establishment of the tree



BIOPHYSICAL FOREST REGION, ZONES AND SUBZONES

LEGEND

Example

Biophysical Forest Region, Zone and Subzone symbol

IwB ← Biophysical Forest Region
IwH-wC ← Biophysical Forest Zone
c ← Biophysical Forest Subzone

Map Unit Boundaries

Solid line: Biophysical Forest Zone
Dashed line: Biophysical Forest Subzone

Biophysical Forest Region, Zones and Subzones [1]

Forest Region	Map Symbol	Zone and Subzone	General Environmental Description
INTERIOR WET BELT REGION (IWB)	IwB / IgF-wC	Interior grand fir-western red cedar zone (IgF-wC)	A relatively dry and warm climate; warm to hot summers; an extended growing season; soils are moderately leached and subject to significant moisture deficiencies.
		Interior western hemlock-western red cedar zone (IwH-wC)	moderate to high amounts of precipitation (upwards of 600 mm) which falls mostly as snow; climatic environment results in leaching of soils; good moisture availibility and relatively mild temperatures are reflected in the generally good tree growth.
	IwB / IwH-wC / b	b) Rocky Mountain Douglas-fir-Lodgepole pine-western larch subzone. (lacks ponderosa pine, Engelmann spruce and alpine fir as potential seral species)	moderately cool temperatures and moderately high annual precipitation (greater than 750 mm) are reflected in the absence of ponderosa pine as a seral species; alpine fir and Engelmann spruce are lacking reflecting a milder climate than that of subzone c.
	IwB / IwH-wC / c	c) Lodgepole pine-Engelmann spruce-alpine fir subzone (Engelmann spruce and alpine fir are potential seral species)	cooler environment than subzone b. Soils are not as deeply weathered; moss layer remains relatively thin.
		Subalpine Engelmann spruce -alpine fir zone (SAeS-alF)	moderate to high precipitation; short growing season; severe minimum temperatures; at higher elevations harsh climate restricts tree growth.
	IwB / SAeS-alF / b	b) Lodgepole pine subzone. (lacks Rocky Mountain Douglas-fir as potential seral species)	moderate to high precipitation; climatic limitations are reflected in the limited height growth and "conical" shape of the stems of the trees, particularly towards the upper limits of this subzone.

[1] van Barneveld, J.W. Vegetation of the Nelson Area (82F), (in preparation), Resource Analysis Branch, Ministry of Environment, Kelowna, B.C.

Figure 3.1. BIOPHYSICAL FOREST REGION, ZONES AND SUBZONES OF THE PEND-D'OREILLE VALLEY, B.C.

species. This area is presently in a young seral stage that can eventually reach the climatic climax of grand fir - western red cedar. On south aspects with steep slopes and shallow soils within this area, an edaphic climax of Rocky Mountain Douglas-fir is expected to re-establish.

Between Lime Creek and Tillicum Creek, stands of Rocky Mountain Douglas-fir and open grassy areas with scatterings of ponderosa pine and Rocky Mountain Douglas-fir are present. The Rocky Mountain Douglas-fir - common saskatoon - pine grass - western fescue complex (15) is characteristic of the grassy areas and the Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13) is characteristic of the stands of Rocky Mountain Douglas-fir that occupy these areas. On these sites higher rates of evapotranspiration and higher soil temperatures occur than in the rest of the valley. Sun exposure, increased soil temperatures and drought occur because of the south aspects and shallow soils. Due to the insolation, plant materials dry faster and become flammable fuels for fires. After a fire, the soil surface is exposed directly to the rays of the sun and ponderosa pine and Rocky Mountain Douglas-fir are the only trees able to establish. Ponderosa pine is seral to Rocky Mountain Douglas-fir and with time an edaphic climax of Rocky Mountain Douglas-fir may be anticipated. Similar areas occur to the west of Tillicum Creek as well, but most of these topo-edaphic sites occur between Lime Creek and Tillicum Creek.

At the eastern end of the Pend-d'Oreille Valley, western hemlock is common due to increased precipitation and changes in aspect. One seral vegetation type, Western larch - western red cedar - western thimbleberry - northern twinflower (32) is characteristic of this area. On the more exposed shallow colluviated soils with steep slopes, the seral vegetation type Rocky Mountain Douglas-fir - common snowberry - pine grass - bluebunch wheat grass (11) occurs, these sites revegetate slowly.

On the north side of the Pend-d'Oreille River climax stands of western hemlock and western red cedar are present. They occur above 1150 metres and in areas which have not been burned for some time. Areas within the Tillicum Creek Drainage are representative of these stands. The Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner (2) vegetation type is characteristic of these areas. In areas where seepage or an excess of moisture is present, the above vegetation type is replaced by Western hemlock - western yew - devil's club - oak fern (4).

Seral stands occur more frequently than climax stands because of past fire in the Pend-d'Oreille Valley. In the upper Tillicum Creek Drainage, Limpid Creek Drainage and other drainages where Engelmann spruce and alpine fir are seral to western hemlock and western red cedar, vegetation type Western hemlock - alpine fir - black blueberry - evergreen yellow violet (40) is present. Lower in elevation, where Engelmann spruce and alpine fir do not occur as seral species, the seral vegetation types are Western larch - western red cedar - western thimbleberry - northern twinflower (32) and Western red cedar - Utah honeysuckle - western yew - blue-bead clintonia (20).

Three vegetation types are present at the upper elevations in the Tillicum Creek Drainage. The Alpine fir - western hemlock - white-flowered rhododendron - unifoliate-leaved foamflower (1) vegetation type represents areas with somewhat open to closed tree canopies, a dense shrub layer and few herbs. Two vegetation types are characteristic of areas with variable tree canopies, open shrub layers and an abundance of herbs. These types are Engelmann spruce - black swamp gooseberry - western meadow-rue - unifoliate-leaved foamflower (10a) and Engelmann spruce - black blueberry - common lady fern - Canada violet (10b). These three vegetation types can occur in the Interior Western Hemlock - Western Red Cedar forest zone or the Subalpine Engelmann Spruce - Alpine Fir forest zone depending on the regenerating species potential.

Along the ridge tops around Tillicum Creek are areas with a krummholz - like appearance. These areas may often lie above the dense cloud layers and may consequently receive less precipitation than areas at somewhat lower elevations. These dry areas are more susceptible to fires than lower elevation forests. Reinvasion by trees is slow, due to adverse climate conditions and competition with grasses. The scattered establishment of tree regeneration and the wind effect on their growth results in a stunted (krummholz-like) appearance. It is expected that these areas can form a closed tree canopy, however, such development will be extremely slow because of the cumulative effect of repetitive burns and the harsh climatic conditions. The White-flowered rhododendron - alpine fir - Merten's cassiope - red mountain-heater (5) vegetation type is representative of these areas.

The vegetation patterns on the south side of the Pend-d'Oreille River are slightly different than those on the north side. The two vegetation types (10a and 10b) which are representative of areas with variable tree canopies, open shrub layers and an abundance of herbs are present, however vegetation type (5) with krummholz-like vegetation, and vegetation type Alpine fir

- western hemlock - white-flowered rhododendron - unifoliate-leaved foamflower (1) are not present. This is because the mountains to the south of the river are lower than the mountains to the north.

Aspect also strongly influences the vegetation patterns at lower elevations. Edaphic stands of Rocky Mountain Douglas-fir and open grassy areas common to the north of the river are seldom present to the south. The Western red cedar - Utah honeysuckle - western yew - blue-bead clintonia (20) vegetation type, which is confined below 1150 metres to gulleys and north to northeast aspects on the north side of the valley, occurs throughout the south side of the valley east of Church Creek. In the Church Creek and Harcourt Creek Drainages, climax stands of western hemlock and western red cedar occur at lower elevations. In the gulleys and seepage sites on the south side of the valley, Western hemlock - devil's club - blue-bead clintonia - unifoliate-leaved foamflower (17) is found.

To the west of Church Creek stands of western white pine, Rocky Mountain Douglas-fir, common paper birch, trembling aspen, western red cedar and grand fir are present. In the Church Creek Drainage and eastwards where precipitation is higher, western hemlock is also present. Three seral vegetation types characterize this area. The vegetation types are:

i) Western larch - western red cedar - western thimbleberry - northern twinflower (32)
ii) Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)
iii) Western red cedar - Utah honeysuckle - western yew - blue-bead clintonia (20)

On both sides of the Pend-d'Oreille Valley, stands of lodgepole pine are present. These stands represent young to mature seral stages characteristic of fire-caused succession. The Lodgepole pine - Engelmann spruce - Oregon boxwood - common western pipsissewa (39) vegetation type characterizes fire succession above 1300 metres in elevation. Two vegetation types represent mid-elevation fire succession, they are Rocky Mountain Douglas-fir - birch-leaved spirea - pine grass - heart-leaved arnica (33a) and Lodgepole pine - rose spp. - few-flowered one-sided wintergreen - pine grass (33b). Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38) represents fire succession below 1150 metres. This type is usually present on fluvial material on the south side of the Pend-d'Oreille River and in the Pend-d'Oreille Valley, east of the Salmo River.

The vegetation types of the Pend-d'Oreille Valley are further described in Appendix B.2. Keys to the vegetation types are provided in Appendix B.1. Appendix B.3 indicates the major succession trends of the vegetation types and their relation to soils, aspect, and causal factors. Appendix B.6 correlates the climax vegetation types with other vegetation reports which relate to the Study Area.

Chapter Four

BIOPHYSICAL INTERPRETATIONS FOR WHITE-TAILED DEER

4.1. Introduction

Elk, mule deer, and white-tailed deer are found in the Pend-d'Oreille Valley. The white-tailed deer is the most abundant of these species, however, and will likely remain so under the existing natural and man-made conditions that prevail. For this reason the objective of this chapter is to provide biophysical interpretations for the management of white-tailed deer winter range. Winter range is considered to be the most important component of white-tailed deer habitat in the Study Area, and the one most in need of protection and enhancement. Interpretations of biophysical data for other ungulates and wildlife species such as upland game birds may be made at some future time, but are not dealt with in this report. The term "deer" refers specifically to white-tailed deer throughout this chapter.

The soil and vegetation resources described previously (Chapters Two and Three) provide the basis for biophysical interpretations discussed in this chapter. In addition, a considerable amount of data on the white-tailed deer population in the Study Area has been obtained by the Fish and Wildlife Branch. This information offers a substantial empirical basis for determining the value of various soil and vegetation types as winter range.

Biophysical conditions that influence white-tailed deer habitat are summarized in Table 4.2, and are interpreted in three management-related perspectives discussed in this chapter. The three major sections are: (1) soil implications for white-tailed deer management, (2) vegetation implications for white-tailed deer management, and (3) the rating of mapped soil and vegetation types as winter range for white-tailed deer. White-tailed deer habitat selection during the critical winter season is also discussed in the last section. For convenience in discussing the interpretations, each column in the interpretive table (4.2) is numbered to correspond with the headings in sections 4.2 and 4.3.

4.2. Soil Implications for White-tailed Deer

Land units having similar soils tend to resemble each other in their capability to support white-tailed deer, despite changes in vegetative conditions that have been brought about through various natural and human influences. The capability of similar soil types to provide white-tailed deer habitat can be exploited through appropriate vegetation control techniques, and this relationship between soils and vegetation serves as a basis for the interpretations given in Table 4.2.

Soil fertility has been subjectively rated in column 2 for each soil unit in Table 4.2 on the basis of cation exchange capacity, water holding capacity, reaction (pH), and general nutrient conditions. Rich, medium, and poor ratings are given. Generally, soils with a relatively high clay content have good cation exchange and water holding capacity and are considered rich. Excessively gravelly and sandy soils with low clay content are considered poor due to low cation exchange and water holding capacity.

A 20 - 50 cm capping of eolian and ash material occurs in most soils on level to strong slopes (0 to 45% slope). This silty-textured capping generally enhances fertility on coarse-textured soils through its water holding and cation exchange capacity, but the capping is highly erodible on steeper slopes if vegetative cover is removed.

Soil fertility is an important consideration for wildlife management. Soils not only affect the kinds of plants that can grow on a site but many studies have shown that plants of the same species grown in different soils often differ in chemical composition and consequently in palatability (Heady, 1964). Midgely (1937) also concluded that an abundance of available plant nutrients in soil is reflected in the chemical composition of plants. Soil texture has an influence on the chemical composition of plants since finer textured soils with relatively high amounts of clay had a higher cation exchange capacity and water holding capacity (Midgely 1937).

McEwan and Dietz (1965) found that plants growing on soils derived from limestone had a higher protein content during vegetative growth than similar plants growing on soils derived from metamorphic rocks. In the West Kootenay region, coarse-textured granitic rocks are dominant. The generally acidic soils derived from these rocks are likely to be relatively nutrient poor in comparison to soils formed by the limestone outcrops in the Pend-d'Oreille Valley. Thus, these limestone-influenced soils are regionally important in terms of soil fertility and, quite likely also, in terms of plant nutrition for white-tailed deer.

Biomass productivity is an important feature of soils that affects the production of forage plants, vegetation management methods and the feasibility of managing vegetative cover for various needs of wildlife. Ratings of forest capability are considered to be a reasonably accurate indicator of the total biological productivity of an ecosystem or a soil type (Kimmins, pers. comm.).

Biomass productivity ratings that have been derived from coniferous forest capability classes in the Study Area are given in column 3 of the interpretive table, and are discussed in more detail in chapter two. Three arbitrary ratings are used in this report: high for forest capability classes 1 - 2, moderate for classes 3 - 4, and low for classes 5 - 7.

Although soil fertility is a principal factor governing biomass productivity, climatic conditions such as aridity and short growing season are important modifiers which occur in the Study Area, particularly on lower south and west-facing slopes which comprise much of the white-tailed deer winter range.

In general, soils with a high biomass productivity rating have the potential to grow a greater amount of forage and cover for wildlife. For the most part these soils occur in the Study Area above elevations which provide winter range for white-tailed deer. Nevertheless, some soils within the winter range area have a higher productivity potential than others, and managers may wish to select these for various habitat enhancement measures.

Soils with higher biomass productivity ratings produce a more rapid rate of plant succession, and may be best adapted for production of cover compared to those with lower ratings, since the former would require more frequent treatment in order to supply seral forage.

Soil erosion potential ratings are given in column 4 on the table for each soil type. The ratings are described in Chapter Two with more detailed ratings given for each soil by slope class. Whenever a dual rating is given, for example moderate to high, the areas with higher erosion potential are invariably on the steeper slopes.

Soil erosion potential is an important consideration whenever managers contemplate removing protective vegetative cover. Prescribed burning, for example, may result in significant erosion on soils with a high erosion potential. Whenever erosion occurs, loss of soil nutrients results and soil productivity declines. Although soil erosion may occasionally result in short-term benefits, for example the establishment of pioneer seral vegetation communities with abundant forage, long-term implications are generally negative. Resource management options for deteriorating soils become more restrictive and forage species may become less nutritious.

Soil erosion potential ratings are not predictions of damage, but only subjective assessments of the relative susceptibility of soils to erosion. Soils with high erosion potential should be monitored carefully if management activities such as burning are prescribed. In this way, the response of similar soils in other areas can be better predicted.

<u>Snow depth limitations without vegetation cover</u> (without considering the influence of a tree canopy) are assessed for each soil in column 5. Unfortunately, little data exists for quantitatively assessing average winter snow depths of various areas in the Pend-d'Oreille Valley as was done for the Creston Wildlife Pilot Project (Luckhurst et al., 1973). Nevertheless, experience in the valley by the B.C. Fish and Wildlife Branch justifies at least a relative assessment of snow depth limitations. In general, snow depth without vegetation cover is a function of snowfall and aspect. Increased solar radiation on steep south to west facing slopes helps to decrease snowpacks on these aspects.

In order to provide each soil with a rating, snow depth limitations without vegetation were assigned for each soil moisture subclass as follows: semiarid soils generally have moderate limitations with 30-45 cm of average mid-winter snowpack expected, subhumid soils generally have moderate to severe limitations with 30-75 cm of snowpack expected depending on elevation and aspect, humid soils generally have severe limitations with 46-75 cm snowpack expected, and perhumid soils are believed to have very severe snow depth limitations with greater than 75 cm of snowpack expected. Soil moisture subclasses are discussed in Chapter Two. For the most part, critical white-tailed deer winter range is restricted to semiarid and subhumid soils below 900 metres (3000 feet) in elevation due to snowpack limitations.

Snow depth limitations with protective vegetative cover are assessed later in the table. A recent wildlife study conducted for Envirocon et al. (1975) concluded that deer in the

Pend-d'Oreille Valley avoid snow depths exceeding 30 cm (12 inches). Luckhurst et al. (1973) felt that snowpacks exceeding 75 cm (30 inches) are severely limiting for most ungulates in the Creston area, limiting snow depths for white-tailed deer are likely to be much less than that. In eastern Canada, Kelsall and Prescott (1971) concluded in a study on deer behavior in snow that when snow depths exceed 20 cm, deer were found to move downhill to low elevation winter ranges. Deer were restricted severely in their movement when snow depths exceeded 40 cm.

4.3. Vegetation Implications for White-tailed Deer

Vegetation types mapped in association with soil types are indicated in column 6. These vegetation types are described in Chapter Three and Appendix B.2, with successional relationships for each soil indicated in Appendix B.3.

The rate of succession is subjectively provided for each vegetation type in column 7. In this context, it refers to the speed with which a given vegetation type normally changes to another, more successionally advanced, vegetation type. Vegetation types with a rapid rate of succession are difficult to maintain in their present condition. If it is desirable to manage for these types, then intensive management is usually necessary to maintain desired conditions.

Conversely, vegetation types with a slow rate of succession are easier to maintain. However, if succession is very slow, and optimum habitat conditions are destroyed, habitats may be ruined for years, whereas sites with a rapid rate of succession can be improved in a matter of a few years with sufficient management.

Snow interception by tree canopy is assessed in column 8. Ratings are based on evergreen forest cover where low interception is anticipated for vegetation types with less than 40% cover, moderate interception where 40-60% cover exists, and high interception where greater than 60% cover occurs.

This column and column 5 are ultimately both considered before arriving at overall snow depth limitations with vegetation cover for white-tailed deer in column 12. Although snow interception by tree canopy is high in many higher elevation forests in the Pend-d'Oreille, snowfall is so great that severe limitations nevertheless exist for white-tailed deer during the critical winter months.

Table 4.1.

WHITE-TAILED DEER FOOD PREFERENCE IN THE PEND-D'OREILLE VALLEY, B.C.[1]

Species	Remarks
High Use	
redstem ceanothus	
western choke cherry (Prunus virginiana)	
common saskatoon	
oregon-grape	-available only when snow depths are low
snowbrush ceanothus	
black cottonwood (Populus trichocarpa)	-seedlings
western red cedar	
Douglas-fir	-mature branches broken from trees by snow load are the most heavily used
grasses (bunchgrasses and bluegrasses)	-when available in spring
arboreal lichens	-on broken branches and logging slash
Medium Use	
willows	-often over 2 metres tall
rose	
raspberry	
Oregon boxwood	-often buried in snow
bitter cherry (Prunus emarginata)	
great mullein (Verbascum thapsus)	-leaves
kinnikinnick	-often buried in snow
western red-osier dogwood	
poison-ivy (Rhus radicans)	-often buried in snow
Low to Nil Use	
California filbert	
common paper birch	
grand fir	
creambush oceanspray	
Lewis' mock-orange	
mallow ninebark	
soopolallie	
black hawthorn (Crataegus douglasii)	
common snowberry	
blue-berry elder (Sambucus cerulea)	

[1]Common plant names according to Taylor and MacBryde (1977), see Appendix B.7 for botanical names not listed here.

Shrub cover is rated in column 9 for average conditions found within each vegetation type. Shrub cover is important both from the point of view of providing forage and adequate protective hiding cover.

Herb cover is also rated in column 10 for average conditions found within each vegetation type. Herb cover is a food source for white-tailed deer, its value to deer depends on the kinds of species present and their palatability.

Presence of forage species evaluations are provided in column 11 for average conditions found within each vegetation type. A white-tailed deer food preference list was prepared for the Pend-d'Oreille Valley based on observations made by the Fish and Wildlife Branch (see Table 4.1). The presence and constancy of these species for each vegetation type were assessed in order to develop "high", "moderate", and "low" ratings.

Snow depth limitations with vegetation cover (considering the influence of tree canopy) are evaluated in column 12 by assessing snow depth without vegetation cover (column 5) and snow interception by tree canopy (column 8). This rating provides a general assessment of the value of each soil/vegetation type for providing thermal cover with reduced snow depths for white-tailed deer during the winter months.

Some vegetation types have a range of limitations due either to the variability in evergreen forest cover or to aspect and elevation differences which affect snowpack.

4.4. White-tailed Deer Winter Range Management

4.4.1. Introduction

White-tailed deer (*Odocoileus virginianus*) in the West Kootenay region are migratory in response to great differences in winter snow depth, summer forage production, and food availability from area to area. Accumulation of greater than 1 metre of snow creates adverse conditions for deer, and some mountain valleys commonly experience snow accumulations of more than 2 metres in mid-winter. Major low elevation valleys normally experience less than 75 centimetres of snow accumulation and therefore are critical for deer survival in winter. During summer, forage production in mountain valleys is high, providing an ample supply for deer. Migration between winter and summer ranges permits the maintenance of much larger deer populations in the West Kootenays than would be possible with a non-migratory population. The land base available for winter range use in the Pend-d'Oreille Valley is estimated to be about 5% of the summer range available. The adequacy of the winter range is considered to be the principal factor controlling the white-tailed deer population surrounding the Pend-d'Oreille Valley.

Ongoing research by the B.C. Fish and Wildlife Branch provided a data base for interpretation of deer winter habitat selection. At the present time, data analysis is incomplete, however, and the interpretations which follow may be revised.

4.4.2. Habitat Selection by Season of Use

Winter starts in the mountains in October and begins to influence deer distribution on the summer ranges in November and December. Deer migration is initiated by the accumulation of about 20 cm of snow, and is typically a rapid movement from summer range to winter range. Movements of 30 km in two weeks have been recorded. In years of gradual snow accumulation, deer trickle onto the winter range slowly over a period of as long as two months (such as in 1976), while in years of rapid snow accumulation (such as in 1977) the deer arrive in a span of as little as three weeks. Once on the winter range, deer habitat selection is influenced by snow hazard, a combination of snow depth and snow hardness, which is modified in turn by cover, slope, elevation, and aspect. Four periods have been identified through the winter between migration onto the winter range and migration back to summer ranges.

Early Winter

This period is characterized by snow hazard insufficient to hinder deer movement. Deer are seriously hindered by snow depths of 30 cm, when the snow is heavy and dense, or weakly crusted, and by depths up to 50 cm when the snow is very light and dry. The early winter period begins with deer migration onto the winter range, and ends when deer are unable to move about freely in open areas. The duration of this period has been as little as two weeks in 1977-78 and as long as two months in 1976-77, when it phased directly into late winter. Habitat selection during this period is primarily a search for areas of high shrub forage production since herbaceous food sources are generally buried by snow. Coniferous cover is used for hiding and some degree of thermal protection, but is not absolutely necessary. Movement patterns show distribution of deer on all aspects and slopes up to elevations as high as 1500 m, where snow depths increase to the point of hindering movement.

Mid-Winter

This period is characterized by snow hazard in all open areas sufficient to restrict deer movements. The period begins as snow depths exceed the limits defined for early winter, and ends when snow melts off the steep south and west aspects sufficiently to again allow deer free movement in open areas. Habitat selection is for areas with adequate cover to reduce snow accumulation through interception. However, because food supplies within such cover areas are limited, the deer must move short distances out of cover areas into shrub forage areas which provide additional food. This period of the winter is sometimes called the "critical" period since during severe winters, when snow depths amount to as much as 1.5 m, this is the longest period of winter use.

Late Winter

This period is characterized by reduced snow depths due to insolation. The period begins as snow depths on steep south aspects drop below 20 cm, and ends with the disappearance of snow from most low elevation sites. As spring approaches, steep, sparsely treed southeast to west aspects clear of snow much more rapidly than other areas because of the action of the warm sun on these slopes. During some winters this action may be sufficient to prevent the accumulation of excessive snow on many of the exposed sites. Most winters, early snow melt limits this period to the two to three weeks when the snow hazard on all open sites is excessive for deer use (except those sites strongly affected by insolation). During this period white-tailed deer select snow-free slopes and adjacent cover. The openings provide an abundance of shrub forage and low-growing herbaceous forage, some of which begins spring growth as soon as the snow is gone. Hiding cover at the edges of the openings, especially the top edge, is well used for bedding areas.

Early Spring

This period is characterized by lack of snow on most low elevation sites, including most open fields. It is initiated as the snow disappears and concludes with the migration of deer to summer ranges. Snow still restricts deer movements during the early spring period in the areas adjacent to the winter ranges and at higher elevations in the valley. During years when a distinct snow depth gradient exists between low elevations and high elevations, deer concentration at the lower elevations is quite evident. Deer habits during the early spring period become more nocturnal, and a preference for cultivated fields is observed as the grasses begin to sprout. Cover areas adjacent to cultivated fields are used during the daylight period for hiding.

Summer and Fall

Migration to summer range areas takes place when most of the snow is gone from the summer range areas, and usually occurs about mid-April. Most shrubs have sprouted by this time, and food supplies are abundant. The migration is rapid and deer move about 3 km per day to their summer ranges (Woods and Woods, 1979).

Summer and fall habitat preference is for valley bottoms and south aspects outside the Study Area in areas with abundant forage available (Woods and Woods, 1979). Summer ranges of between 370 ha and 930 ha were recorded and are larger than the winter range used by individual deer.

4.4.3. Management Prescriptions by Season of Use

Diversity of habitat types and the maintenance of adequate "edge" are accepted principles in management of white-tailed deer (Leopold, 1933, Dasmann, 1971). Historical evidence in much of the eastern United States suggests that with the cutting of mature forests and the development of farms and "edge", white-tailed deer populations rose from low levels to very high numbers (Taylor, 1956). Deer population levels in the West Kootenays are believed to have been much higher in the 1930's and 1940's because of the seral regrowth of forests from many large forest fires in the 1890's and 1930's, and the diversity of habitat types created by the fires. Continued fire suppression and management of forests for mature trees suitable for logging have created a situation where less and less diversity and edge exists both on and off the winter range.

Maintenance of diversity and edge, and development of appropriate habitat for all parts of the winter in close proximity should ensure that deer thrive and increase on the remaining Pend-d'Oreille winter range. Habitat treatment methods must be tailored to the slope, aspect, elevation, climate, soil, and vegetation potential of the site, and to the part of the winter in which use takes place. General management prescriptions for each winter period of use are given below.

Early Winter Use Areas

The whole valley is suitable for early winter use, but high elevation sites, benches at the valley's wetter eastern end, and most low elevation north aspects are suitable only for early winter use. Management of these areas for forage production following logging will ensure that deer do not concentrate heavily on more critical parts of the winter range early in the winter and deplete food reserves in those areas. Cover must be maintained for hiding, and for movement corridors with reduced snow depths which increase the area available to deer. Management for timber production is generally compatible with wildlife management objectives. Maintenance of most of these areas at a ratio of 60% forage production to 40% cover is desirable. Burning following logging in many areas will promote growth of desirable forage species, and repeated burning at intervals of about 15-20 years would help to maintain shrub species within reach of deer. Eventual rotation to forest cover would help to ensure protection of the soil. In areas where tree establishment is difficult, prescribed burning may not be desirable.

Mid-Winter Use Areas

The sites most suitable for use during mid-winter are the low elevation sites capable of supporting dense stands of conifers. Typically these are gently sloping sites with deep soils on west and east aspects. Douglas-fir stands provide the best snow interception, as well as providing a source of food as self-thinning takes place or limbs break off due to snow loading. Management to preserve a canopy of conifers over at least 60% of the suitable sites is most desirable. Twenty percent of these sites should be in the early seral shrub/forage production stage, and a further 20% in the early seral conifer stage. Canopy density must be at least 60% to ensure adequate snow interception. Openings cut for forage production should be small, preferably less than 1 hectare, and narrow rather than square or round to increase the edge. Rotation of all stands through a 100 year cycle of logging to encourage forage production, planting after 20 years where necessary, and regrowth to 80 to 100 years would maintain the desired proportions of food and shelter.

In some areas it is possible to produce adequate mid-winter cover on steep south aspects, which is also suitable for late winter use. In many instances it may not be desirable to log mature stands which provide cover on these south-facing slopes. The relative scarcity of cover on these slopes and slower rates of tree growth would necessitate longer rotations. Ground fires within these stands may be necessary to revitalize forage species.

Late Winter Use Areas

Areas of steep southeast to west aspects at low elevation are valued for late winter use. These sites must be managed for forage production to aid deer in recovery from the difficult mid-winter period. Most of these sites can be managed with little or no provision of cover stands as adjacent cover areas will be sufficient to supply this need. It is necessary to ensure that

LEGEND FOR TABLE 4.2.

Sections 4.2 to 4.4 serve as an expanded, explanatory legend for Table 4.2. This legend is abbreviated for easy reference purposes only.

Column 1: Soil Types

Soil types are described in Chapter Two and Appendix A.2. Only soil types with potential winter range value are listed.

Column 2: Soil Fertility

- P Poor
- M Medium
- R Rich

Column 3: Biomass Productivity

- L Low (Forest Capability Classes 5-7)
- M Moderate (Forest Capability Classes 3-4)
- H High (Forest Capability Classes 1-2)

Column 4: Soil Erosion Potential

- L Low
- M Moderate
- H High

Column 5: Snowdepth Limitations without Vegetation

- M Moderate (30-45 cm)
- Se Severe (46-75 cm)

Column 6: Vegetation Types

Vegetation Types are described in Chapter Three and Appendix B.2. Only those vegetation types with potential winter range value are listed. The vegetation type numerical map symbols relate to the following descriptive vegetation type names:

- 11 Pseudotsuga menziesii - Symphoricarpus albus - Calamagrostis rubescens - Agropyron spicatum
- 13 Pseudotsuga menziesii - Symphoricarpus albus - Disporum hookeri - Calamagrostis rubescens complex
- 15 Pseudotsuga menziesii - Calamagrostis rubescens - Festuca occidentalis complex
- 20 Thuja plicata - Lonicera utahensis - Taxus brevifolia - Clintonia uniflora
- 24 Populus tremuloides - Betula papyrifera - Rubus parviflorus - Pteridium aquilium
- 26 Pseudotsuga menziesii - Symphoricarpus albus - Disporum hookeria - Osmorhiza chilensis
- 32 Larix occidentalis - Thuja plicata - Rubus parviflorus - Linnaea borealis
- 33 Pinus contorta - Pseudotsuga menziesii - Calamagrostis rubescens
- 38 Pinus contorta - Shepherdia canadensis - Pteridium aquilium - Rhytidiadelphus triquetrus

Column 7: Rate of Succession

- VS Very slow
- S Slow
- N Normal
- R Rapid

Column 8: Snow Interception by Tree Canopy

- L Low (less than 40% cover)
- M Moderate (40-60%)
- H High (greater than 60%)

Column 9: Shrub Cover

- L Low (less than 20% cover)
- M Moderate (20-40%)
- H High (greater than 40%)

Column 10: Herbaceous Cover

- L Low (less than 33% cover)
- M Moderate (33-66% cover)
- H High (greater than 66% cover)

Column 11: Presence of Forage Species

- L Low
- M Moderate
- H High
- VH Very High

Column 12: Snow Depth Limitations with Vegetation

- S Slight (less than 30 cm)
- M Moderate (30-45 cm)
- Se Severe (46-75 cm)

Column 13: Season of Use

- EW Early Winter (Snow depths do not hinder deer movements)
- MW Mid Winter (Snow depths hinder deer movements in all open areas)
- LW Late Winter (Snow depths decreased on south to west aspects sufficiently to no longer hinder deer movements)
- ES Early Spring (No snow in low elevation areas of the winter range)
- All All Winter
- S Summer Use only, no winter use

Column 14: Value as Winter Range

			Factors Contributing to Value
VL	Very low		
L	Low		
M	Moderate	c	cover
H	High	f	food
VH	Very High	a	aspect (insolation slope)

Column 15: Management Comments

Comments a to p immediately follow interpretative table in text.

Table 4.2

INTERPRETATIONS FOR WHITE-TAILED DEER WINTER RANGE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SOIL TYPE	SOIL FERTILITY	BIOMASS PRODUCTIVITY	SOIL EROSION POTENTIAL	SNOWDEPTH LIMITATIONS WITHOUT VEGETATION	VEGETATION TYPE	RATE OF SUCCESSION	SNOW INTERCEPTION BY TREE CANOPY	SHRUB COVER	HERB COVER	PRESENCE OF FORAGE SPECIES	SNOWDEPTH LIMITATIONS WITH VEGETATION	SEASON OF USE	VALUE AS WINTER RANGE	†MANAGEMENT COMMENTS
M1	M	M	M	M	13	N	L-M	H	M	M-H	S-M	All	VHf$^{c}_{a}$ - Hf^{a}	See a
F1	M-P	M	M-H		24	N	L	H	M	H	M	EW, ES	M^{f}	See b
M2	M	M	M	M-Se	26	N	M-H	H	M	H	M	All	Hf^{c} - Lc^{f}	See C
F2	M-P	M	L-M		32	N	M	H	M	M	M-Se	EW, ES	Lf^{c}	See d
F3	P-M	M-L	L-H		38	N	M-L	M	M-H	M	M-Se	EW, ES	Lf^{c}	See e
L1	M-R	M	M-H		24	N	L	H	M	H	M-Se	EW, ES	M^{f} - L	See f
C3	M-P	M-L	M-H		cultivated fields	-	L	L	H	H	M-Se	ES	H^{f}	See q
M3	M	H-M	M	Se	20	N	H	H	M	H	M-Se	EW, ES	L^{f} - VL	
F4	M-P	M	L-M		32	N	M	H	M	M	Se	EW	L^{f} - VL	See h
F5	P-M	M	L-M		38	N	M-L	M	M-H	M	Se	S	VL	
C4	M-P	M	M-H		33	N	L	L	L-H	L-M	Se	S	VL	
C1*	M-P	L	M-H	M	15	VS	L	M	H	H-VH	M	EW, LW, ES	VHf^{a} - Mf^{a}	See i
C2*	M-P	M-L	M-H		11	S-N	L	H	H	VH	M	EW, LW, ES	Hf^{a} - L	See j
					13	S-N	L-M	H	M	M-H	S-M	All	VHf$^{a}_{c}$ - Hf^{a}	See u
					24	N	L	H	M	H	M	EW, ES	M^{f} - L	See 1
C1**	P-M	L	H-M	Se	15	VS	L	M	H	H-VH	Se	EW	La^{f}	See m
C2**	P-M	M-L	H-M		11	S-N	L	H	H	VH	Se	EW	VL	See n
					13	S-N	L-M	H	M	M-H	Se-M	EW-MW	Ma^{c} - L^{a}	See o
					24	N	L	H	M	H	Se	EW. ES	L^{f}	See o

NOTES:
1. Soil and vegetation types that do not have potential winter range value are not listed.
2. Vegetation types occurring between double lines can occur in any of the soils also listed between the double lines. For example, vegetation types 13 and 24 both occur in areas where soil M1 and F1 have been mapped.
3. Management comments a to p immediately follow this table in text.

* Low elevations, generally below 900 m.

** High elevations, generally above 900 m.

†MANAGEMENT COMMENTS FOR WHITE-TAILED DEER WINTER RANGE

a Ideal white-tailed deer cover conditions exist in some areas where dense stands of Douglas-fir provide deer with the shelter required during the mid-winter period when deep snow cover occurs in all areas of the valley. Maintenance of adequate cover (>60% in even-aged stands) is required to achieve the snow interception quality desired. Forage production is potentially high and should be maintained by management of the sites for both shelter and food production. This should be done by cutting small (less than one hectare) openings in the canopy, and treating the sites for maximum food production by employing methods such as prescribed burning. Canopy should be maintained adjacent to permanent openings for hiding and snow interception.

b Deciduous stands of aspen, birch, and larch provide little snow interception and forage production is generally lower than the site potential. Conversion of these stands to forage production or to snow interception cover is desirable in most instances. More adequate cover would be provided by forming stands of Douglas-fir.

c Important mid-winter cover in some areas of the valley. Grand fir and western red cedar provide poorer snow interception than Douglas-fir, and are therefore of less benefit in providing cover during deep snow periods. Stand conversion to Douglas-fir would be beneficial in many areas. These stands are often too dense to allow forage production in the understory as well, and a decrease in stand density with provision of small (less than one hectare) openings would increase food production. Large clearings should be avoided unless south to west aspects on greater than 25% slopes are encountered. Slopes like these should be considered more carefully for forage production, as opening the canopy would promote late winter use in areas previously shaded by the cover present.

d Excessive snow accumulation limits deer use of these sites to early winter and early spring on suitable sites adjacent to better winter range areas. Inadequate snow interception quality in this forest type causes excessive snow accumulation within the cover. Forage production is inadequate in these stands and further limits the winter range quality. Establishment of a dense canopy of Douglas-fir where possible would enhance the value of the sites for mid-winter use. Treatment of openings created for forage production would also be beneficial to deer. Sites close to steep, southaspects should be concentrated on as they may be needed to provide a winter long combination of appropriate habitats.

e Marginal winter range sites which generally experience excessive snow accumulation for deer use during mid-winter. These units should be treated to provide adequate snow interception cover. Establishment of Douglas-fir would convert the sites to a more suitable vegetation type, which would enhance their value as winter range. Forage production in small openings would increase early winter, mid-winter, and early spring value. Openings should be treated to encourage the growth of preferred forage species. Rotation of stands for production of forage and cover would be most beneficial, and mid-winter use might be achieved.

f Deciduous stands of aspen, birch, and larch provide little snow interception and forage production is generally lower than the site potential. Conversion of these stands to forage production or to snow interception cover is desirable in most instances. More adequate cover would be provided by forming stands of Douglas-fir.

g Cultivated fields are valued for herbaceous forage production in the early spring. These sites should be maintained as cultivated fields to aid the recovery of deer from the winter months. Where large areas of this type are present, management for conversion to dense forest will increase movement between more suitable late winter habitats and provide more adequate cover where needed.

h Excessive snow accumulation will normally limit utilization of these sites to early winter. Management for forage production in small openings and establishment of dense cover stands of Douglas-fir in proximity to openings will encourage use of the sites later into the mid-winter period. Early spring use will normally be restricted as snow melt on the sites will be much later than on similar low elevation types. Forest management should ensure that large openings are avoided, or that sufficient trees are maintained in selective logging to reestablish a snow interception canopy of greater than 60% cover after a recovery period of about 40 years.

i Management of these sites for forage production is most important as they are the first areas to clear of snow in later winter. Deer move onto the area as soon as snow depths are less than approximately 20 cm and make heavy use of low growing shrub and herbaceous food sources. Maintenance of cover at the top of these units, and occasional veteran trees on the open slopes will increase use of the sites as well as promoting the reduction of snow depths in spring.

j Management of these sites for forage production is most important as they are the earliest to clear of snow in later winter due to insolation. Deer move onto the area as soon as snow depths are less than approximately 20 cm and make heavy use of the low growing shrub and herbaceous food sources. Maintenance of adequate available food species on these units will aid in the recovery of the deer from the low food intake period of mid-winter just experienced.
Normal succession rates will cause browse species to grow out of reach of deer in a shorter period than on drier sites, and special attention may be required to maintain a food source which deer can reach. Maintenance of cover at the boundaries of the sites is necessary, and occasional veteran trees on these sites will promote the reduction of snow depths and will provide cover for deer.

k Dense stands of Douglas-fir on these units provide deer with shelter required during the mid-winter period. Maintenance or development of adequate stand density (>60% in even stands) is required to achieve the snow interception quality desired. This vegetation type on colluvium tends to have less dense stands than those on morainal (M1) or fluvial (F1) soils, and care must be taken to ensure that the cover is either dense enough to intercept the snow, or that it is open enough to provide forage areas for later winter use. Forage production is potentially high and should be encouraged by management practices aimed at rotating suitable sites through forage production and shelter cycles. Canopy should be maintained adjacent to permanent openings for hiding and snow interception.

l Deciduous cover on these sites is of little benefit to deer. Conversion of all units of this vegetation type to either forage production or coniferous cover would increase the winter value for deer.

m Severe snow accumulations on these higher elevation sites limit winter range use to the earliest part of the winter. Management for high forage production will aid in reducing the demands placed on more important low elevation forage production areas. Sites should be treated to maintain desirable food species and to reduce forage height to levels useable by deer. Cover must be maintained adjacent to this type, especially at the top of slopes, and occasional veteran Douglas-fir trees on the slopes are desirable.

n Severe snow accumulation on these high elevation sites limit winter range use to the earliest part of the winter. Management for high forage production will aid in reducing the demands placed on more important lower elevation forage production areas. Sites should be treated to maintain desirable food species and to reduce forage height to levels useable to deer. Normal successional rates and a moister climate regime cause shrubs to exceed the height useful to deer more rapidly than on the previous vegetation type. Cover must be maintained adjacent to this type, especially at the tops of slopes, and occasional veteran Douglas-firs on the slopes are desirable.

o Dense stands of Douglas-fir on these units provide deer with shelter required during the mid-winter period. Maintenance of adequate stand densities (>70% cover in even stands) is absolutely necessary to achieve the snow interception quality desired. Mid-winter use will occur only in areas of appropriate snow interception quality. Forage production should be maintained in small openings managed for desirable forage species and reduction of shrub height. Rotation of the forest through all stand ages will ensure maintenance of forage and cover areas.

p Deciduous cover on these sites is of little benefit to deer. Conversion of all units of this type to either forage production or coniferous cover would increase the winter value to deer.

cover areas are preserved at the edges of these steep slopes, and, most importantly, at the top edge. Provision of individual trees spaced about on the slopes will encourage use of the sites by supplying hiding cover and bedding sites, and by promoting the melting of snow in spring.

Early Spring Use Areas

All low elevation sites are suitable for early spring use. Specific management is required only on the cultivated fields, where promotion of desirable species may be needed. Fertilization and even plowing and planting of some fields might increase their value to deer in spring. Maintenance of cover adjacent to fields will promote use, but is not critical. In areas with large fields (greater than 5 ha), it would be beneficial to convert some of the area to mid-winter cover. This would increase the overall value of the sites, and would provide movement corridors between better developed cover sites.

Interpretations for White-tailed Deer Winter Range

Table 4.2 has been developed to identify the soil and vegetation types available at the present time, and to provide an insight into the management practices which best suit the sites. Each type found within the winter range area is dealt with, and detailed management prescriptions can be developed based on the identified potentials and problems. Management interpretations are based on the best use which the area is capable of, as judged by the period of winter use. If a site is suitable for early winter, mid-winter, and early spring use, then mid-winter use would be assessed, as there is less mid-winter range than early winter or early spring range. If a site is good for "all" periods of winter use, then the mid-winter and late winter time periods would need to be balanced, and the one which was most lacking in that area would be stressed.

4.5. General Management Alternatives

Management interpretations were discussed briefly in column 15 of the white-tailed deer winter range interpretive table (4.2). Management alternatives for a particular soil/vegetation type cannot be fully assessed unless the juxtaposition of that type with surrounding types is considered. The interpretive table does not consider juxtaposition, therefore management options are listed and no detailed prescriptions provided. A wildlife management plan is envisioned for the Pend-d'Oreille Valley. This document, which will be prepared by the Fish and Wildlife Branch, can however utilize the interpretive table as a general guide for making more detailed on-site management decisions.

Management alternatives include the manipulation of vegetation by logging and controlled (prescribed) burning. More intensive forms of management may also include options such as fertilization, seeding or planting, and shrub-cutting. There are other more experimental options available to the wildlife manager who wishes to improve winter range conditions for white-tailed deer in the Pend-d'Oreille Valley. Management alternatives are discussed briefly below.

Logging is one form of habitat manipulation. As mentioned previously, loss of thermal cover areas due to the new reservoir means that management options in winter range areas will focus on (1) balancing the amount of shelter area available in all parts of the valley, and (2) enhancement of forage production on the remaining winter range. Logging, which reduces shelter in areas already lacking adequate cover, is generally undesirable. Nevertheless, some small selected areas within the winter range may have surplus cover where additional openings are advantageous. Selective patch logging in these areas may be beneficial.

Prescribed burning is another form of habitat manipulation, its chief aim is to improve forage quantity and quality. The main advantages of burning are (1) reduction of undesirable species, (2) provision of a suitable seed bed for desirable species, (3) to release nutrients for improved forage quality, (4) encouragement of resprouting, and (5) reduction of shrubs to a height which deer can reach to feed. The main disadvantage of burning is soil erosion losses due to removal of protective vegetation.

Schmautz (1970), in studies in northern Idaho on habitat types (habitat types according to Daubenmire and Daubenmire, 1968) similar to those found in the Pend-d'Oreille Valley, concluded that fire, under certain circumstances, can be used to change the composition of shrub stands. A palatable species may be virtually absent in a shrub stand, but its seeds may be present and viable in the duff or mineral soil. Fire may induce germination, this frequently occurs with ceanothus in the Pseudotsuga menziesii - Physocarpus malvaceus habitat type.

Gratkowski (1962) and Lyon (1966) have shown that seeds of Ceanothus velutinus remain viable in the duff for many decades. For example, two years after a controlled August burn on a 50 hectare (120 acre) stand of mature Douglas-fir, Lyon (1966) recorded 30-50 well distributed seedlings per square metre. Prior to the burn, despite an intensive search, only one ceanothus plant was found in the area.

Orme and Leege (1976) assessed the emergence and survival of redstem ceanothus (Ceanothus sanguineus) following prescribed burning. Although their area of study was north-central Idaho on nonglaciated igneous parent materials, which are much different than in the Pend-d'Oreille Valley, the habitat types are similar. The experimental burns occurred on Pseudotsuga menziesii - Physocarpus malvaceus, Abies grandis - Paxistima myrsinites, and Thuja plicata - Paxistima myrsinites habitat types.

Orme and Leege concluded that the ultimate number of new redstem ceanothus seedlings that appear after a prescribed burn depends on the quantity of seeds stored in the duff and soil, and the intensity of the heat applied to that seed. In this regard they concluded that fall burns were generally more successful than spring burns for producing an even distribution of seedlings. Spring burns, due to higher soil moistures, did not raise soil temperatures as high as fall burns, consequently fewer seedlings germinated. Also, the more consumptive fall burns more effectively eliminated competition, which is significant for redstem since it has a low tolerance for shade.

Orme and Leege (1976) also concluded for their area that east and west aspects provided better seedling survival than south aspects. Apparently seedling survival was very poor on south and southwest aspects due to excessive droughtiness.

Evidence of redstem ceanothus seed sprouting following summer and fall burns in the Pend-d'Oreille Valley has been recorded.

As already mentioned, a major concern regarding the use of fire for wildlife management is the effect that burns have on soil erosion. Although soil erosion potential ratings are provided for each soil type, these ratings are not predictions for actual erosion damage, but merely indicate the relative susceptibility of soils to erosion problems. Whether a soil erodes significantly or not must be assessed in relation to management activities. Burning which removes protective vegetation has often been considered an initiator of soil erosion, especially on steep slopes.

Packer and Williams (1976) investigated the effects of burning on soil stability in western Montana. None of the unlogged-unburned (control) plots produced any soil erosion due to overland flow from snowmelt. This lack of soil erosion, even though overland flow occurred, attests to the protective influence of vegetative cover on the unburned plots. Soil erosion from logged-burned plots averaged 63 kg/ha the first year, jumped to 188 kg/ha the second year, dropped to 18 kg/ha for the third and fourth years, and was essentially zero by the seventh year. Summer storms produced the most amount of erosion since they provided a much more efficient eroding force than snowmelt because of higher rates of overland flow and splash erosion from raindrop impact.

Packer and Williams (1976) concluded that for most moderate slopes in their Study Area, burning was not significantly damaging since soil erosion losses were a relatively small and temporary impact following burning. However, they stressed that south-facing aspects, especially on steep slopes, could experience significant soil erosion losses. Being the driest, south aspects suffered the most intensive burns, experienced the most adverse impacts on soil and vegetative characteristics as a result of burning, and showed less improvement of these characteristics during the seven years following burning. They believed that the south aspects still remained in a more delicate runoff and erosional balance than other aspects.

Schmautz (1970) noted that no significant damage to soils and watersheds was observed subsequent to controlled spring burns in northern Idaho, even on slopes as steep as 40 to 50 percent. Shrub species present apparently sprouted quickly and the slopes were revegetated in a few weeks. Logging and burning are likely to disturb existing soil and vegetation characteristics more than burning by itself, which may have accounted, in part, for the apparent greater soil losses in Packer and Williams' (1976) study than by Schmautz (1970). Schmautz (1970) concluded that soil erodibility is important to consider, but does not preclude the use of fire. Instead, areas with a high soil erosion potential will dictate that greater care in both planning and burning is needed.

Fertilization is a more intensive form of wildlife management which may also be worth considering. Nitrogen fertilization has been most commonly applied to improve wildlife habitat. According to Duncan and Hylton (1970), nitrogen fertilization in most areas has resulted in increased crude protein, increased succulence, and increased leaf-to-stem ratios. Even in semiarid areas, nitrogen fertilization has improved forage quality, although forage yields in these areas may not have been increased.

Carpenter and Williams (1972) provide an excellent review of the role of mineral fertilizers in big-game range improvement. Their review resulted in the following observations: nitrogen fertilization can increase biomass growth of shrub seedlings and increase production of shrubs, non-vigorous plants on relatively infertile sites appear to respond best, nitrogen and phosphorus fertilization tends to improve shrub growth over grasses, different plants respond differently to fertilization, therefore experimentation is necessary, forage yields increase for around five years subsequent to fertilizer application, although benefits decline rapidly each year, seral species generally respond better to fertilization than do more shade tolerant or climax species, fall and spring applications appear to provide better results than summer applications, and improved protein content of forage as a result of fertilization increases palatability of forbs for wildlife.

Experiments by Brown and Mandery (1962) have revealed the management potential of fertilization both to attract deer away from forest plantations and to improve palatability of other forage for deer.

Other forms of intensive management which may be considered include seeding and planting, and shrub-cutting. Lyon (1966) found that the major limitation with seeding and/or planting is lack of a suitable and inexpensive source of seed for plants most suitable for wildlife. Mutilation of desired basal-sprouting shrubs by shrub-cutting or crushing may be successful in some areas (Lyon, 1966). Shrub-cutting is labour intensive, but may be more desirable than burning on steep, south-facing slopes in light of their potential for soil erosion.

In conclusion, most management options or alternatives should first be treated experimentally to determine benefits and costs. The ability to extrapolate results to other areas in the Pend-d'Oreille Valley should be greatly improved when wildlife managers evaluate findings in light of this soil and vegetation survey. The results of habitat management on a specific soil/vegetation (habitat) type should be similar for other parts of in the valley with the same soil and vegetation type.

Chapter Five

SUMMARY OF LAND USE INTERPRETATIONS

Chapter Four

BIOPHYSICAL INTERPRETATIONS FOR WHITE-TAILED DEER

REFERENCES

Chapter Five

SUMMARY OF LAND USE INTERPRETATIONS

Generalized land capability of soil types for agriculture, forestry, engineering, and white-tailed deer winter range are shown on Table 5.1. This table summarizes the more detailed interpretations provided in previous chapters. These generalized interpretations may be useful for broad resource planning and conceptualization of major land capability values in the Pend-d'Oreille Valley. The more detailed interpretations in Tables 2.2 to 2.6, and 4.2 provide more information useful as a guide to resource management.

The general land capabilities indicated in Table 5.1 are broad averages for the soil type, individual sites where these soil types have been mapped may deviate from the capabilities indicated due to variations such as slope.

Table 5.1.

GENERALIZED LAND CAPABILITY OF SOIL TYPES[1]

Soil Type	Agriculture[2]	Forestry[2]	Engineering[3]	White-tailed Deer Winter Range[4]
M1	M-L	M	M	VH
M2	M-L	M	M	H
M3	L	H-M	M	L
M4	L	H	M	-
M5	L	H	M	-
F1	L	M	M	VH
F2	M-L	M	M-H	H
F3	M-L	M-L	M-H	H
F4	M-L	M	M-H	L
F5	L	M	M-H	L
L1	H-M	M	M	H
C1	L	L	L	VH-M
C2	L	M-L	L	VH-M
C3	L	M-L	L	H
C4	L	M	L	L
C5	L	L	L	-
C6	L	M	L	-
C7	L	M	L	-
C8	L	L	L	-

1 VH - Very high, H - High, M - Moderate, L - Low, - = not winter range
2 High = C.L.I. classes 1 and 2, Moderate = C.L.I. classes 3 and 4, Low = C.L.I. classes 5-7 (generalized from Tables 2.5 and 2.6)
3 High = slight limitations dominant, Moderate = moderate limitations dominant, Low = severe and very severe limitations dominant (generalized from Table 2.4)
4 Winter range ratings from Table 4.2, assuming optimum vegetation type

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Appendix A

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A.1 Key to the Soils of the Pend-d'Oreille Valley, B.C.*

The following Key provides some general site characteristics useful to consider in determining the soils. Soil descriptions should be consulted for verification. Associated vegetation information is applicable to stands that have not been very seriously disturbed in recent years.

1. Soils developed on morainal (till) parent materials.
    2. Soil development is Brunisolic, western hemlock absent.
        3. Moder humus form class (Ah horizon present), Douglas-fir is climax tree. M1
        3. Mor humus form class (Ah horizon absent), grand fir or western red cedar present ... M2
    2. Soil development is Luvisolic, western hemlock present, alpine fir and Engelmann spruce absent M3
    2. Soil development is Podzolic, alpine fir and Engelmann spruce present.
        4. Bfh horizon usually absent, western hemlock present M4
        4. Bfh horizon usually present, western hemlock absent M5

1. Soils developed on fluvial or glaciofluvial parent materials.
    5. Soil development is Eutric Brunisol, western hemlock absent.
        6. Moder humus form class (Ah horizon present), Douglas-fir is climax tree F1
        6. Mor humus form class (Ah horizon absent), grand fir or western red cedar present
            7. Soil parent material contains less than 35% coarse fragments F2
            7. Soil parent material contains more than 35% coarse fragments F3
    5. Soil development is Dystric Brunisol, western hemlock present.
        8. Soil parent material contains less than 35% coarse fragments F4
        8. Soil parent material contains more than 35% coarse fragments F5

1. Soils developed on lacustrine parent materials, soil development is Luvisolic; soil texture is silt loam or silt L1

1. Soils developed on colluvial parent materials.
    9. Soil development is Chernozemic (Orthic Dark Brown), trees usually absent or sparse C1
    9. Soil development is Brunisolic, alpine fir and Engelmann spruce absent.
        10. Soil development is Eutric Brunisol, western hemlock is also absent.
            11. Moder humus form class (Ah horizon present), Douglas-fir is climax tree C2
            11. Mor humus form class (Ah horizon absent), grand fir or western red cedar present C3
        10. Soil development is Dystric Brunisol, western hemlock is present C4
    9. Soil development is Podzolic.
        12. Moder humus form class (Ah horizon present), Douglas-fir or grand fir is climax tree C5
        12. Mor humus form class (Ah horizon absent), alpine fir and Engelmann spruce present.
            13. Bfh horizon usually absent, western hemlock present C6
            13. Bfh horizon usually present, western hemlock absent C7
        12. Mull humus form class (thick Ah horizon present), trees usually absent or sparse .. C8

* Note: Soils that do not "key" out represent unmapped inclusions or map unit exceptions (non-modal soils)

A.2 Description of the Soils of the Pend-d'Oreille Valley, B.C.

Each soil type is described in relative detail. Fold-outs attached to the first and last soil types provide a brief explanation of the terms and can be used with any of the soil descriptions.

Each soil type is composed of primarily one soil family, which in turn is a grouping of soil profiles. Therefore, each soil has a range of inherent characteristics. The soil profile shown is only one typical example.

One photograph is provided depicting the landscape in which the soil occurs, including the vegetation commonly associated with the soil, and another photograph is generally provided illustrating a typical soil profile.

DESCRIPTION OF TERMS

SOIL FAMILY

Soil family descriptions are arranged as follows:

		Example:
1st line:	soil subgroup classification..	Orthic Eutric Brunisol
2nd line:	particle size, mineralogy, soil depth*, reaction class*, calcareous class*	loamy, mixed
3rd line:	soil temperature class, soil moisture subclass	mild, semi-arid

* if applicable

Soil Subgroup

For a definition of each subgroup, refer to The Canadian System of Soil Classification (Canada Soil Survey Committee, 1978). Some discussion provided in Section 2.3.2. of text.

Particle Size

The term "particle size" refers to the grain size distribution of the whole soil including the coarse fraction. It differs from texture, which refers to the fine earth (< 2 mm) fraction only. The particle-size classes were assigned for the relatively unweathered (BC or CB horizon) soil parent materials. Although an ash and eolian capping commonly overlies many parent materials, the change in particle size was not strongly contrasting enough to be recognized here. The particle size classes for family groupings are as follows:

Fragmental. Stones, cobbles and gravel, with too little fine earth to fill interstices larger than 1 mm.

Sandy-skeletal. Particles coarser than 2 mm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the sandy particle-size class.

Clayey-skeletal. Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the clayey particle-size class.

Sandy. The texture of the fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures; particles 2 mm-25 cm occupy less than 35% by volume.

Loamy. The texture of the fine earth includes loamy very fine sand, very fine sand, and finer textures with less than 35% clay; particles 2 mm-25 cm occupy less than 35% by volume.

Coarse-loamy. A loamy particle-size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-loamy. A loamy particle-size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Coarse-silty. A loamy particle-size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Clayey. The fine earth contains 35% or more clay by weight and particles 2 mm-25 cm occupy less than 35% by volume.

Mineralogy

Mineralogy classes are based on the mineralogical composition of the soil. Since all of the study area's map units have mixed mineralogy, classes are not presented here. In localized areas associated with bedrock outcroppings of limestone, some carbonatic mineralogy exists.

Soil Depth

Depth classes are only used for soils having bedrock (lithic contact) within a depth of 1 m. The classes, based on depth to bedrock, are as follows:

extremely shallow	- 20 cm deep or less
very shallow	- 20 to 50 cm deep
shallow	- 50 to 100 cm deep

Reaction Classes

Family reaction classes apply to the relatively unweathered parent materials. Classes are based on the average pH in 0.01 M $CaCl_2$ of the C horizons. The classes are:

acid	pH of 5.5 or lower
neutral	pH of 5.5 to 7.4
alkaline	pH of 7.4 and higher

Since calcareous soils are alkaline, no reaction class is provided when a calcareous class is used.

Calcareous Classes

Family calcareous classes apply to the unweathered parent material or C horizon. They are used in all soils with Ck or Cca horizons. The classes are:

weakly calcareous	1 to 6% $CaCO_3$ equivalent
strongly calcareous	6 to 40% $CaCO_3$ equivalent
extremely calcareous	over 40% $CaCO_3$ equivalent

Soil Temperature Classes

	Description	MAST	MSST	Growing Season (Days >5°C)	Degree Days (>5°C)	Warm Thermal Period (Days >15°C)	Degree Days (>15°C)
Very Cold	soils frozen during the dormant season	-7-2°C	5-8°C	<120	<550	0	0
Cold	soils usually frozen in some part of the control section in part of the growing season	2-8°C	8-15°C	140-220	550-1250	0-50	30
Cool	soils may or may not be frozen in part of the control section for a short part of the dormant season	5-8°C	15-18°C	170-220	1250-1700	>60	30-220
Mild	soils are rarely frozen during the dormant season	8-15°C	15-22°C	200-365	1700-2800	90-180	170-670

MAST - mean annual soil temperature
MSST - mean summer soil temperature

Soil Moisture Subclasses

Perhumid	no significant water deficits in growing season (> 2.5 cm)
Humid	very slight deficits in growing season (2.5-6.5 cm)
Subhumid	significant deficits within growing season (6.5-13 cm)
Semiarid	moderately severe deficits in growing season (13-19 cm)
Subarid	severe deficits in growing season (19-38 cm - cool; 19-51 cm - mild)

CLIMAX TREES

The shade-tolerant tree species listed are representative of climax stand conditions. Since these conditions seldom exist, these species are more commonly found regenerating under seral forest stands. These species also relate directly to the vegetation work conducted for this study (see Chapter 3) and to Daubenmire and Daubenmire's (1968) and Pfister's et al. (1977) habitat types. For example:

Climax Trees	Daubenmire & Daubenmire's (1968) Habitat Type
Douglas-fir	Pseudotsuga menziesii - Physocarpus malvaceus
Grand fir	Abies grandis - Paxistima myrsinites
Western red cedar	Thuja plicata - Paxistima myrsinites
Western hemlock	Tsuga heterophylla - Paxistima myrsinites
Alpine fir, Engelmann Spruce	Abies lasiocarpa - Paxistima myrsinites or Abies lasiocarpa-Menziesia ferruginea
Non-forest	Other vegetation types

(Continued on page A23)

SOIL TYPE - M1

Parent Material: Morainal (till)

Soil Family: Orthic Eutric Brunisol, loamy, mixed calcareous, mild, semiarid

Climax Tree: Douglas-fir

Slope; Aspect: 16 - 45%; south

Elevation: 500 - 900 m (1700 - 3000 ft)

Drainage: Well to moderately well drained

Stoniness: Moderately to slightly stony

Depth of Bedrock: > 100 cm

Rooting Depth: > 100 cm

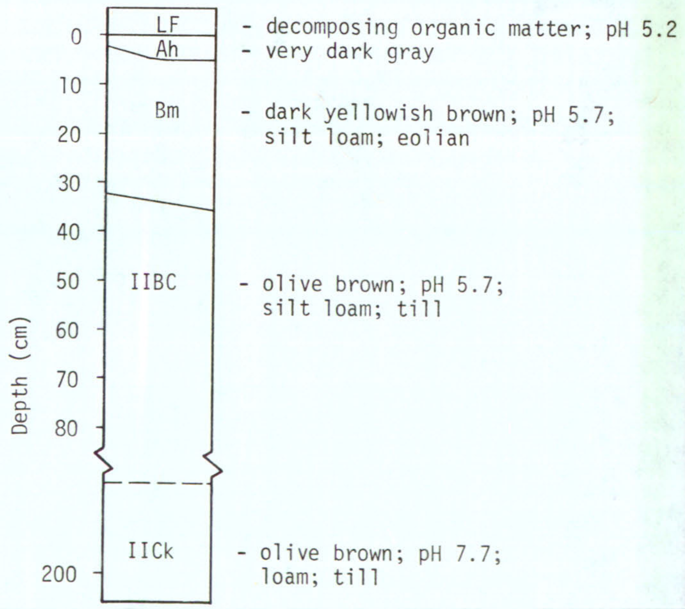
Humus Form Class: Moder

Moisture Regime: Submesic

Nutrient Regime: Medium to rich

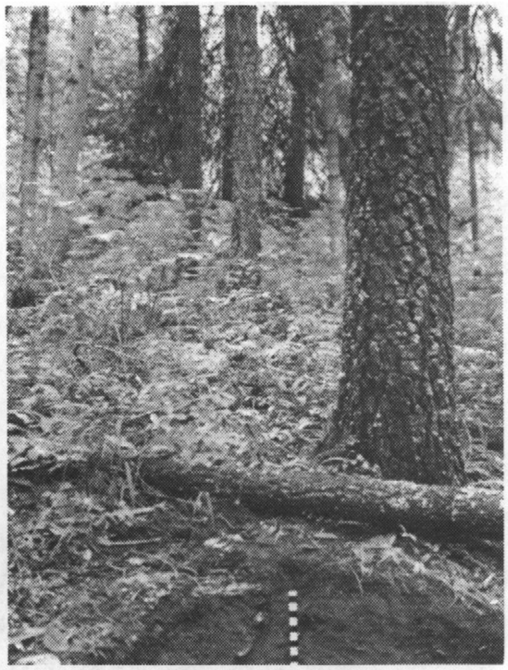
Discussion: Some Brunisolic Gray Luvisols occur. An eolian capping between 20 - 50 cm overlies till. Parent material textures vary from loam to clay loam.

Soil Profile



Common Vegetation: The tree canopy is generally a dense cover of Pseudotsuga menziesii; a scattering of Pinus ponderosa can occur. The usually dense shrub layer includes Physocarpus malvaceous, Holodiscus discolour, Symphoricarpus albus, Corylus californica, Rosa gymnocarpa, Amelanchier alnifolia, Mahonia repens, and Spiraea betulifolia. Grasses include Calamagrostis rubescens.

SOIL TYPE - M2



Parent Material: Morainal (till)

Soil Family: Orthic Eutric Brunisol, loamy, mixed, calcareous, cool, subhumid

Climax Trees: Grand fir and/or western red cedar

Slope; Aspect: 9 - 45%; variable

Elevation: 500 - 1100 m (1700 - 3600 ft)

Drainage: Well to moderately well drained

Stoniness: Moderate to slightly stony

Depth to Bedrock: > 100 cm

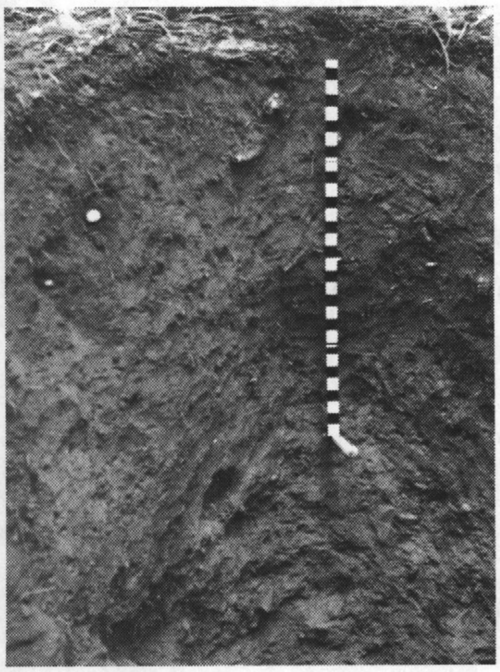
Rooting Depth: > 100 cm

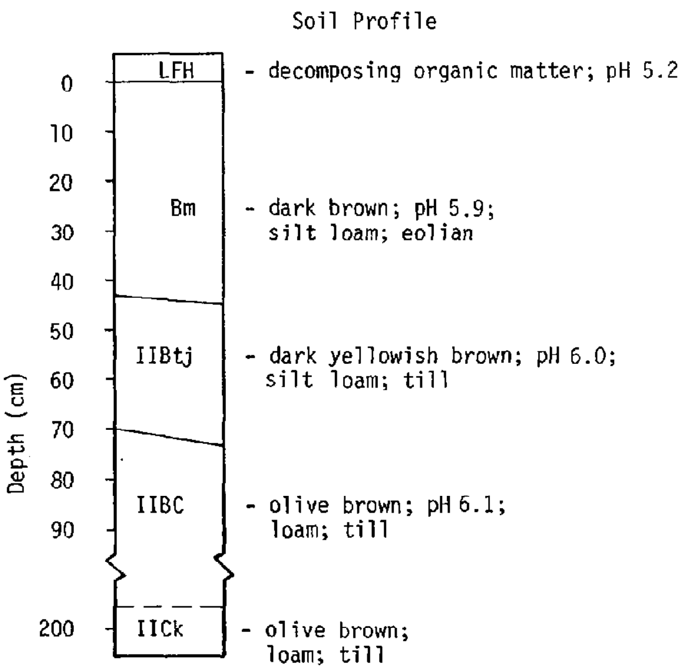
Humus Form Class: Mor

Moisture Regime: Mesic to submesic

Nutrient Regime: Medium

Discussion: Some Brunisolic Gray Luvisols occur. Parent material textures vary from loam to clay loam. An eolian capping between 20 - 50 cm overlies till.





Common Vegetation: Climax tree is Abies grandis or Thuja plicata. Typical seral tree species may include Pseudotsuga menziesii, Larix occidentalis, Pinus monticola, Pinus contorta, Betula papyrifera, and Populus tremuloides. The usually open shrub layer includes Acer glabrum, Rubus parviflorus, Amenlancier alnifolia, and Symphoricarpus albus. The herb layer includes Linnaea borealis, Clintonia uniflora, and Hieracium albiflorum.

SOIL TYPE - M3

Parent Material: Morainal (till)

Soil Family: Brunisolic Gray Luvisol, loamy, mixed, calcareous, cool, humid

Climax Tree: Western hemlock

Slope; Aspect: 9 - 45%; variable

Elevation: 700 - 1200 m (2300 - 4000 ft)

Drainage: Well to moderately well drained

Stoniness: Moderate to slightly stony

Depth to Bedrock: > 100 cm

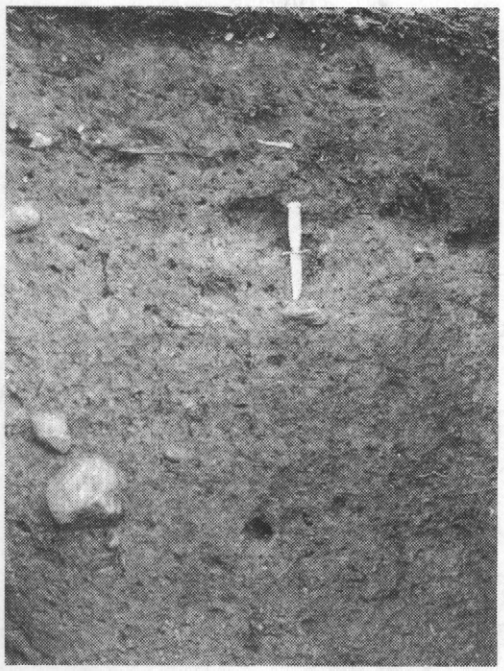
Rooting Depth: > 100 cm

Humus Form Class: Mor

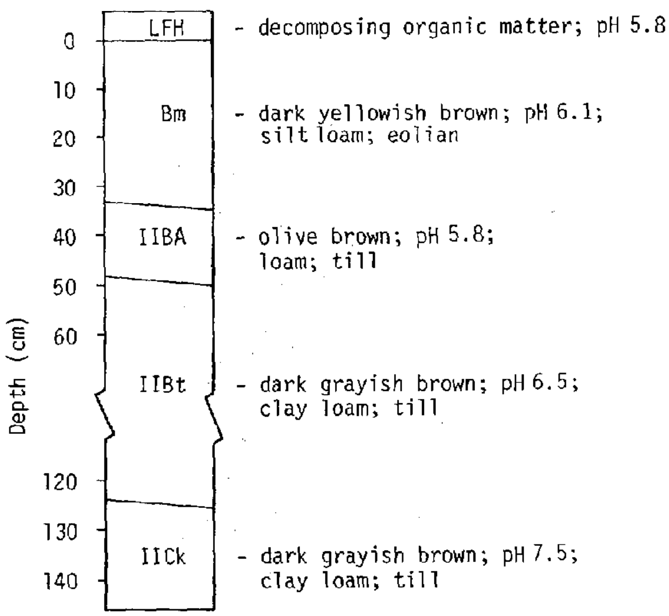
Moisture Regime: Mesic to submesic

Nutrient Regime: Medium

Discussion: Some Podzolic Gray Luvisols and Orthic Humo-Ferric Podzols occur in higher elevations. Parent material textures vary from loam to clay loam. An eolian capping between 20 - 50 cm overlies till.



Soil Profile



Common Vegetation: Climax trees are Tsuga heterophylla and Thuja plicata. Typical seral trees may include Pseudotsuga menziesii, Larix occidentalis, Pinus monticola, Pinus contorta, and Betula papyrifera. The usually open shrub layer includes Lonicera utahensis, Paxistima myrsinites, Taxus brevifolia, and Acer glabrum. The herb layer includes Chimaphylla umbellata, Linnaea borealis, and Clintonia uniflora.

SOIL TYPE - M4

Parent Material: Morainal (till)

Soil Family: Orthic Humo-Ferric Podzol, loamy-skeletal, mixed, acid, cold, perhumid

Climax Trees: Western hemlock, with alpine fir

Slope; Aspect: 9 - 45%; variable

Elevation: 1150 - 1700 m (3800 - 5600 ft)

Drainage: Well drained

Stoniness: Moderate to very stony

Depth to Bedrock: > 75 cm

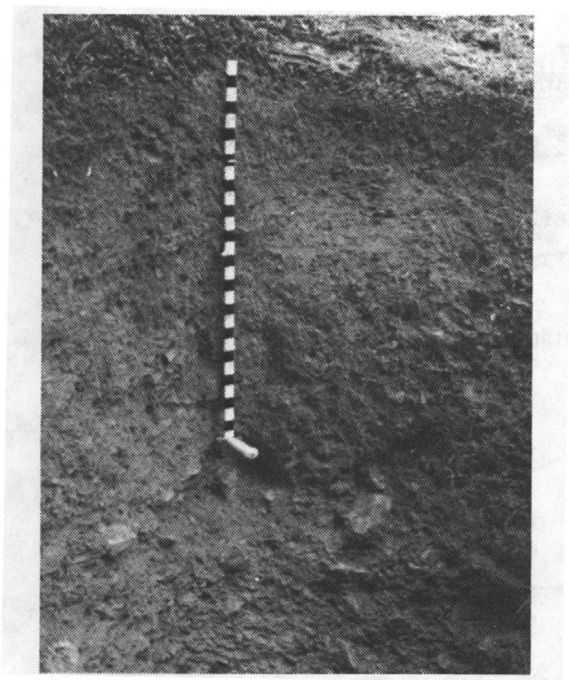
Rooting Depth: > 75 cm

Humus Form Class: Mor

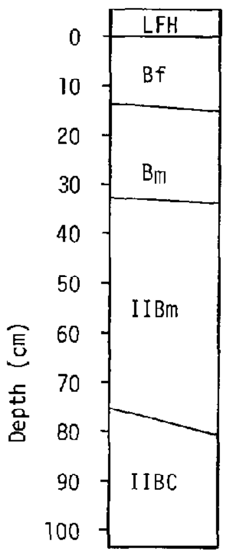
Moisture Regime: Mesic to submesic

Nutrient Regime: Medium

Discussion: Some Podzolic Gray Luvisols may occur. Parent material textures vary from gravelly loam to sandy loam. An eolian capping between 20 - 50 cm overlies till.



Soil Profile



- decomposing organic matter; pH 4.2
- reddish brown; pH 4.5; silt loam; eolian
- strong brown; pH 5.5; silt loam; eolian
- yellowish brown; pH 5.4; gravelly loam; till
- dark grayish brown; pH 5.3; gravelly loam; till

Common Vegetation: Trees may include Tsuga heterophylla, Thuja plicata, Abies lasiocarpa, Picea engelmannii, Pseudotsuga menziesii, Larix occidentalis, Pinus monticola, and Pinus contorta. The typically open shrub layer consists of Lonicera utahensis, Vaccinium membranaceum, and Paxistima myrsinites. The dominant herbs are Tiarella unifoliata, Linnaea borealis, and Clintonia uniflora.

SOIL TYPE - M5

Parent Material: Morainal (till)

Soil Family: Orthic Humo-Ferric Podzol, loamy-skeletal, mixed, acid, very cold, perhumid

Climax Trees: Alpine fir, Engelmann spruce

Slope; Aspect: 9 - 45%; variable

Elevation: > 1300 m (> 4600 ft)

Drainage: Well drained

Stoniness: Moderate to very stony

Depth of Bedrock: > 75 cm

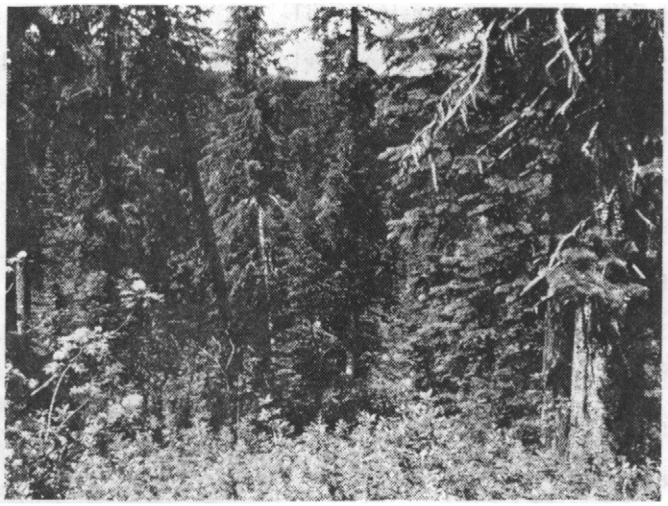
Rooting Depth: > 75 cm

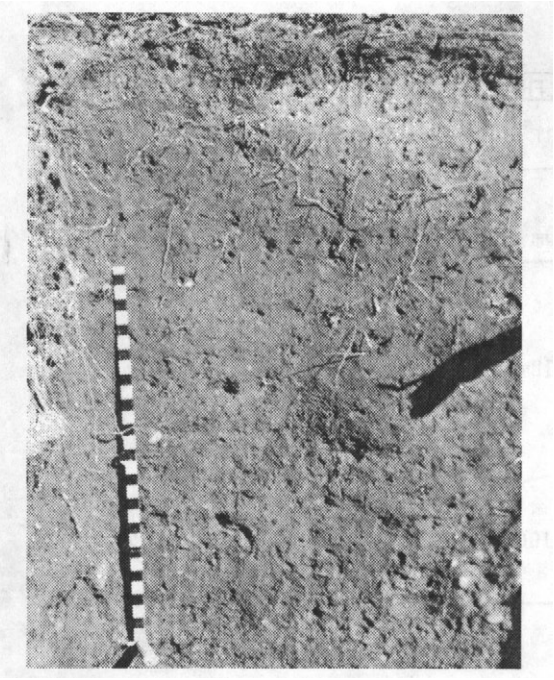
Humus Form Class: Mor

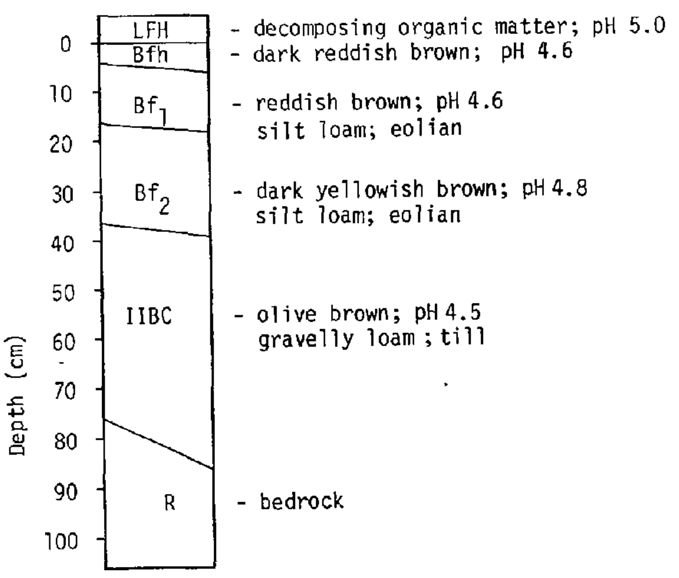
Moisture Regime: Mesic to submesic

Nutrient Regime: Medium

Discussion: Parent material textures vary from gravelly loam to sandy loam. An eolian capping between 20 - 50 cm overlies till.







Common Vegetation: The usually dense tree canopy consists primarily of Abies lasiocarpa and Picea engelmannii. A scattering of Thuja plicata, Tsuga heterophylla, and Pinus contorta can occur. Shrubs can include Rhododendron albiflorum, Ribes lacustre, Vaccinium scoparium, and Sambucus racemosa. Herbs include Thalictrum occidentalis, Clintonia uniflora, and Tiarella unifoliata.

SOIL TYPE - F1

Parent Material: Fluvial

Soil Family: Orthic Eutric Brunisol, loamy-skeletal, mixed, neutral, mild, semiarid

Climax Tree: Douglas-fir

Slope; Aspect: 15 - 45%; south

Elevation: 425 - 800 m (1400 - 2600 ft)

Drainage: Well to rapidly drained

Stoniness: Very to moderately stony

Depth to Bedrock: > 200 cm

Rooting Depth: > 100 cm

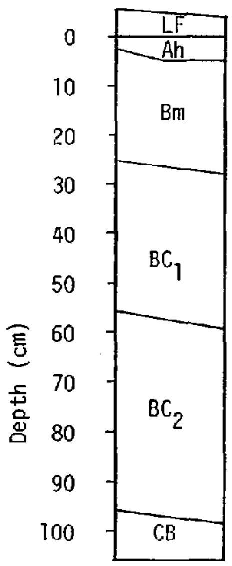
Humus Form Class: Moder

Moisture Regime: Mesic to subxeric

Nutrient Regime: Medium to poor

Discussion: Parent material textures vary from gravelly sandy loam to loam. An eolian capping may exist or be intermixed with fluvial materials due to soil creep on steeper slopes.

Soil Profile



- decomposing organic matter; pH 5.5
- very dark gray; pH 6.1
- dark yellowish brown; pH 5.9; gravelly sandy loam; fluvial
- olive brown; pH 5.6; gravelly loam; fluvial
- olive brown; pH 5.7; gravelly sandy loam; fluvial
- olive; pH 5.8; gravelly sandy loam; fluvial

Common Vegetation: The tree canopy is generally a dense cover of Pseudotsuga menziesii; a scattering of Pinus ponderosa can occur. The usually dense shrub layer includes Physocarpus malvaceous, Holodiscus discolour, Symphoricarpus albus, Corylus californica, Rosa gymnocarpa, Amelanchier alnifolia, Mahonia repens, and Spiraea betulifolia. Grasses include Calamagrotis rubescens.

SOIL TYPE - F2

Parent Material: Fluvial

Soil Family: Orthic Eutric Brunisol, coarse-loamy, mixed, neutral, cool, subhumid

Climax Trees: Grand fir and/or western red cedar

Slope; Aspect: 2 - 15%; variable

Elevation: 450 - 900 m (1500 - 3000 ft)

Drainage: Well to rapidly drained

Stoniness: Non-stony to slightly stony

Depth to Bedrock: > 200 cm

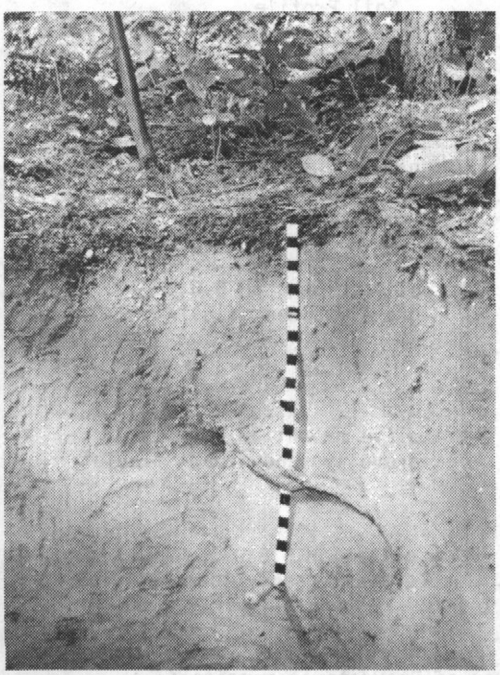
Rooting Depth: > 100 cm

Humus Form Class: Mor to moder

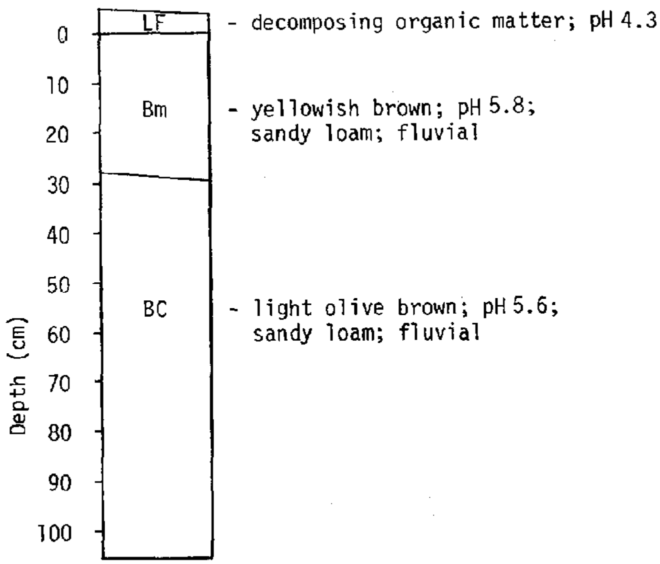
Moisture Regime: Mesic to submesic

Nutrient Regime: Medium to poor

Discussion: Some Orthic Dystric Brunisol development occurs in lower elevations. Parent material textures vary from loamy sand to fine sandy loam. An eolian capping may occur.



Soil Profile



Common Vegetation: Climax tree is Abies grandis or Thuja plicata. Typical seral tree species include Pseudotsuga menziesii, Larix occidentalis, Pinus monticola, Betula papyrifera and Populus termuloides. The usually open shrub layer includes Acer glabrum, Rubus parviflorus, Amelancier alnifolia, and Shepherdia canadensis. The herb layer includes Clintonia uniflora and Chimaphylla umbellata.

SOIL TYPE - F3

Parent Material: Fluvial

Soil Family: Orthic Eutric Brunisol, loamy-skeletal, mixed, neutral, cool, subhumid

Climax Trees: Grand fir and/or western red cedar

Slope; Aspect: 9 - 45%; variable

Elevation: 450 - 900 m (1500 - 3000 ft)

Drainage: Well to rapidly drained

Stoniness: Very to moderately stony

Depth to Bedrock: > 200 cm

Rooting Depth: > 100 cm

Humus Form Class: Mor to moder

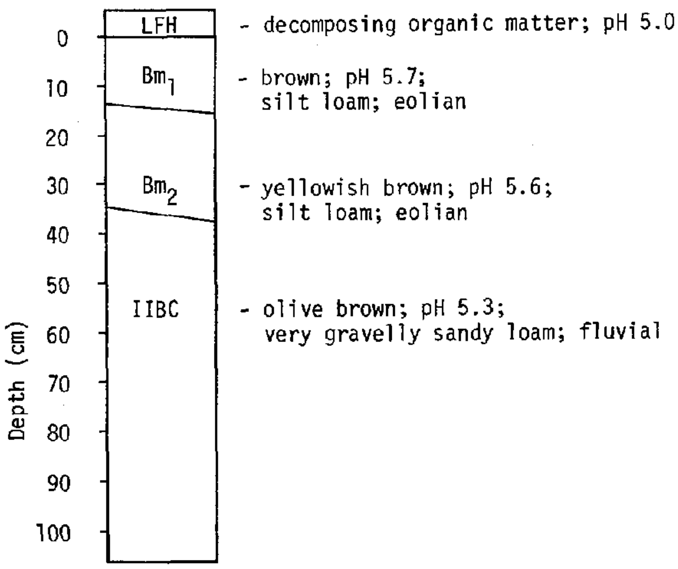
Moisture Regime: Mesic to submesic

Nutrient Regime: Medium to poor

Discussion: Some Orthic Dystric Brunisol development in lower elevations. Parent material textures vary from gravelly sandy loam to loam. An eolian capping between 20 - 50 cm usually overlies the fluvial material.

No Photo Available

Soil Profile



Common Vegetation: Climax tree is Abies grandis or Thuja plicata. Typical seral tree species include Pseudotsuga menziesii, Larix occidentalis, Pinus monticola, Betula papyrifera and Populus tremuloides. The usually open shrub layer includes Acer glabrum, Rubus parviflorus, Amelanchier alnifolia, and shepherdia canadensis. The herb layer includes Clintonia uniflora and Chimaphylla umbellata.

SOIL TYPE - F4

Parent Material: Fluvial

Soil Family: Orthic Dystric Brunisol, coarse-loamy, mixed, neutral, cool, humid

Climax Tree: Western hemlock

Slope; Aspect: 2 - 15%; variable

Elevation: 600 - 1000 m (2000 - 3300 ft)

Drainage: Well to rapidly drained

Stoniness: Non-stony to slightly stony

Depth to Bedrock: > 200 cm

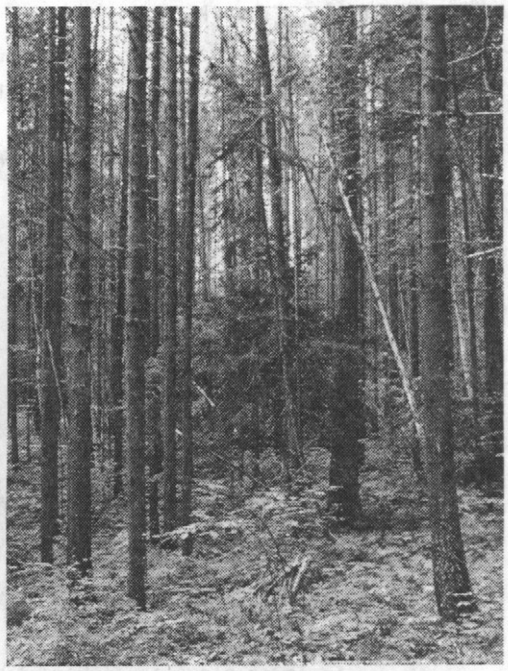
Rooting Depth: > 100 cm

Humus Form Class: Mor

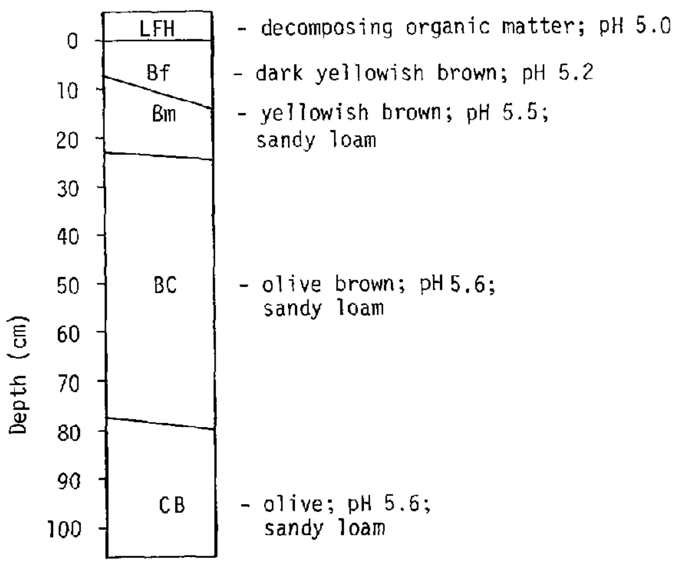
Moisture Regime: Mesic to submesic

Nutrient Regime: Medium to poor

Discussion: Some Orthic Humo-Ferric Podzol development in higher elevations. Parent material textures vary from sandy loam to loamy sand. An eolian capping between 20 - 50 cm usually overlies the fluvial material.



Soil Profile



Common Vegetation: Climax trees are Tsuga heterophylla and Thuja plicata. Typical seral trees may include Pseudotsuga menziesii, Larix occidentalis, Pinus monticola, Pinus contorta, and Betula papyrifera. The usually open shrub layer includes Lonicera utahensis, Paxistima myrsinites, Taxus brevifolia, and Acer galbrum. The herb layer includes Chimaphylla umbellata, Linnaea borealis, and Clintonia uniflora.

SOIL TYPE - F5

Parent Material: Fluvial

Soil Family: Orthic Dystric Brunisol, loamy-skeletal, mixed, neutral, cool, humid

Climax Tree: Western hemlock

Slope; Aspect: 9 - 45%; variable

Elevation: 700 - 1200 m (2300 - 4000 ft)

Drainage: Well to rapidly drained

Stoniness: Very to moderately stony

Depth to Bedrock: > 200 cm

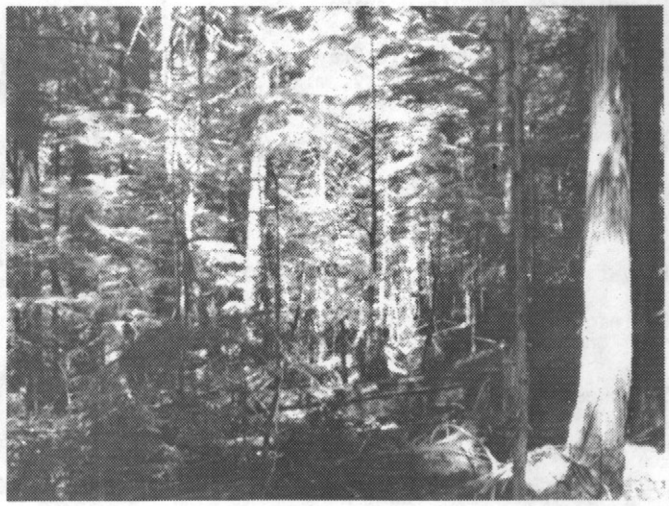
Rooting Depth: > 100 cm

Humus Form Class: Mor

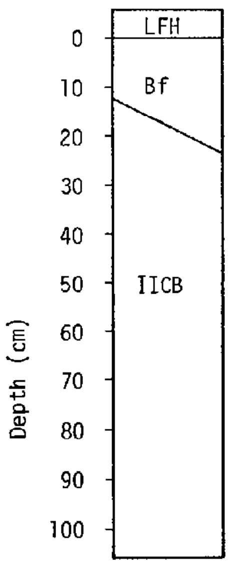
Moisture Regime: Mesic to submesic

Nutrient Regime: Medium to poor

Discussion: Some Orthic Humo-Ferric Podzol development as shown below. An eolian capping between 20 - 50 cm overlies fluvial material.



Soil Profile*



- decomposing organic matter; pH 4.3
- dark brown; pH 5.4; gravelly sandy loam; eolian
- very dark gray; pH 5.6; very gravelly sandy loam; fluvial

* Note: This profile is an Orthic Humo-Ferric Podzol

Common Vegetation: Climax trees are Tsuga heterphylla and Thuja plicata. Typical seral trees may include Pseudotsuga menziesii, Larix occidentalis, Pinus monticola, Pinus contorta, and Betula papyrifera. The usually open shrub layer includes Lonicera utahensis, Paxistima myrsinites, Taxus brevifolia, and Acer galbrum. The herb layer includes chimaphylla umbellata, Linnaea borealis, and Clintonia uniflora.

SOIL TYPE - L1

Parent Material: Lacustrine

Soil Family: Brunisolic Gray Luvisol, coarse-silty, mixed, neutral, cool, humid

Climax Tree: Western hemlock or western red cedar

Slope; Aspect: 5 - 30%; variable

Elevation: 500 - 700 m (1700 - 2300 ft)

Drainage: Moderately well to imperfectly drained

Stoniness: Non-stony

Depth to Bedrock: > 200 cm

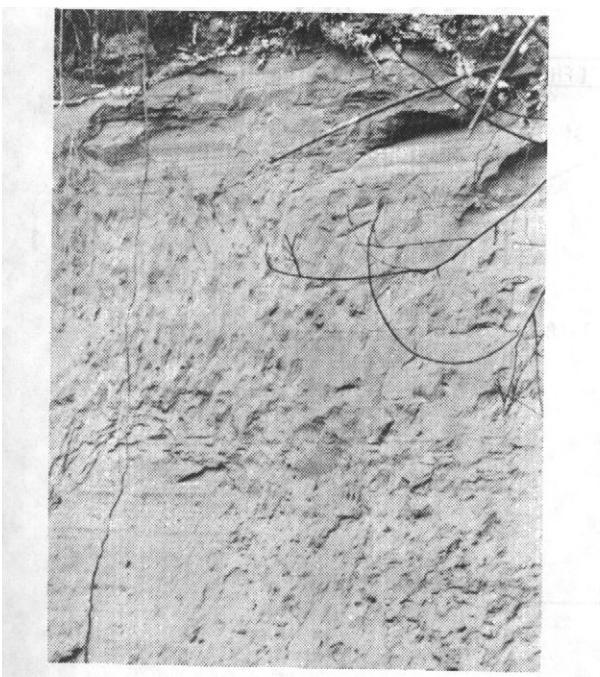
Rooting Depth: > 100 cm

Humus Form Class: Mor

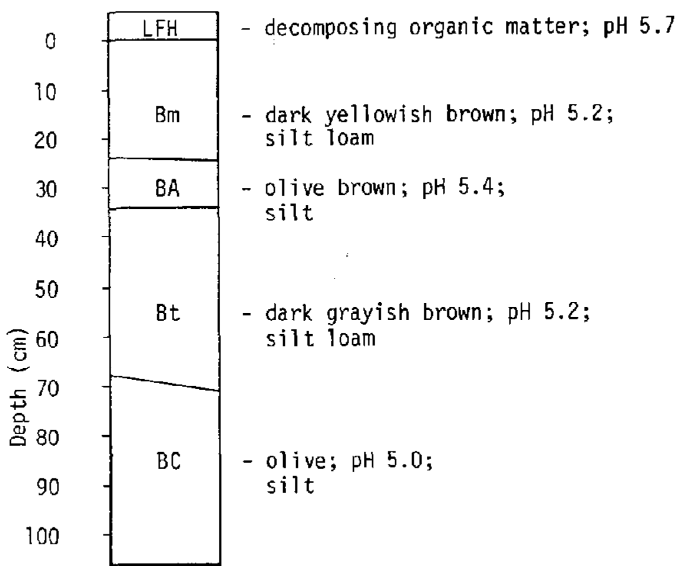
Moisture Regime: Subhygric to mesic

Nutrient Regime: Medium to very rich

Discussion: Parent material textures vary from silt loam to silt. An eolian capping may overlie lacustrine.



Soil Profile

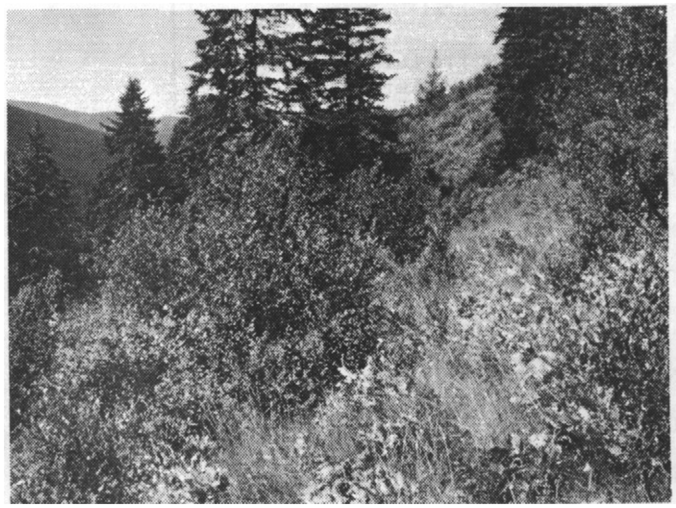


Common Vegetation: Climax tree is Tsuga heterophylla or Thuja plicata. Typical seral trees may include Pseudotsuga menziesii, Larix occidentalis, Pinus monticola, Pinus contorta, and Betula papyrifera. The usually open shrub layer includes Lonicera utahensis, Paxistima myrsinites, Taxus brevifolia, and Acer glabrum. The herb layer includes Chimaphylla umbellata, Linnaea borealis, and Clintonia uniflora.

SOIL TYPE - C1

Parent Material: Colluvium

Soil Family: Orthic Dark Brown, loamy-skeletal, mixed, shallow, neutral, mild to cool, semiarid



Climax Tree: Non-forest

Slope; Aspct: 30 - 70%; south

Elevation: 675 - 1200 m (2200 - 4000 ft)

Drianage: Well to rapidly drained

Stoniness: Very to exceedingly stony

Depth to Bedrock: 20 - 150 cm

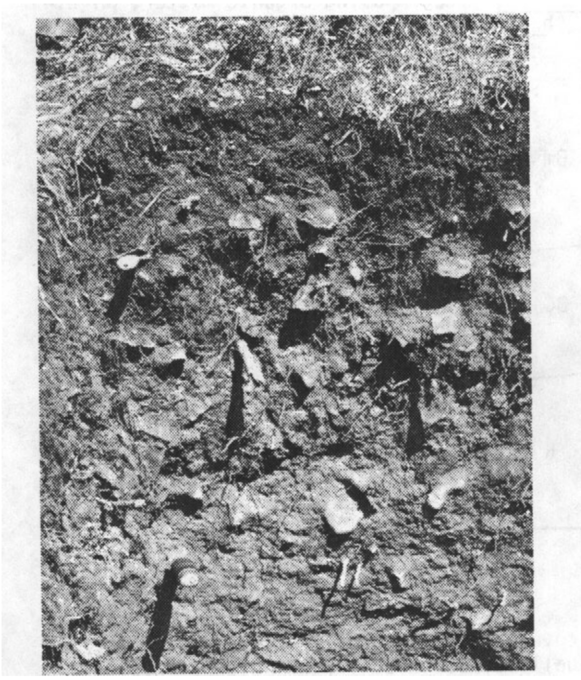
Rooting Depth: 20 - 150 cm

Humus Form Class: Mull

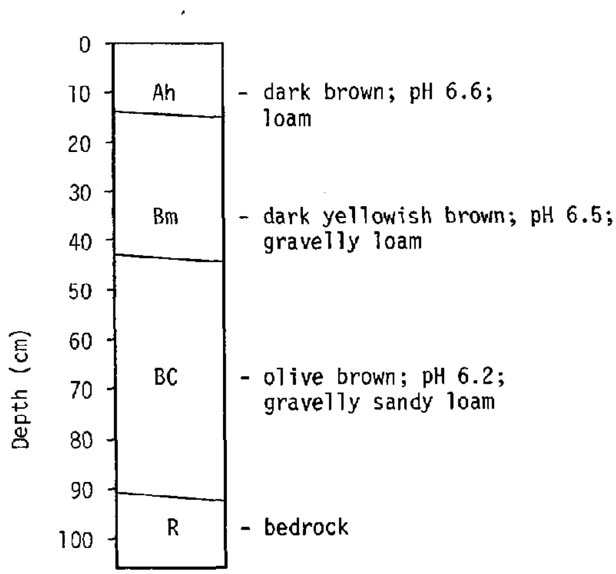
Moisture Regime: Subxeric

Nutrient Regime: Medium to rich

Discussion: Some Orthic Eutric Brunisols occur. Parent material textures vary from gravelly sandy loam to loam. Some carbonatic mineralogy on very shallow to bedrock soils. Inclusion of morainal materials common.



Soil Profile



Common Vegetation: These soils are typically non-forested with only a scattering of Pseudotsuga menziesii and Pinus ponderosa. The open to dense shrub layer consists of Amelanchier alnifolia, Mahonia repens, Spiraea betulafolia, Holodiscus discolour, Physocarpus malvaceus, and occasionally, Ceanothus sanguineus. Herb layer include Achillea millefolium, Calamagrostis rubescens, and Agropyron spicatum.

SOIL TYPE - C2

Parent Material: Colluvium

Soil Family: Orthic Eutric Brunisol, loamy-skeletal, mixed, shallow, neutral, mild to cool, semi-arid

Climax Tree: Douglas-fir

Slope; Aspect: 16 - 90%; variable

Elevation: 425 - 1100 m (1400 - 3500 ft)

Drainage: Well to rapidly drained

Stoniness: Very to exceedingly stony

Depth to Bedrock: 10 - 150 cm

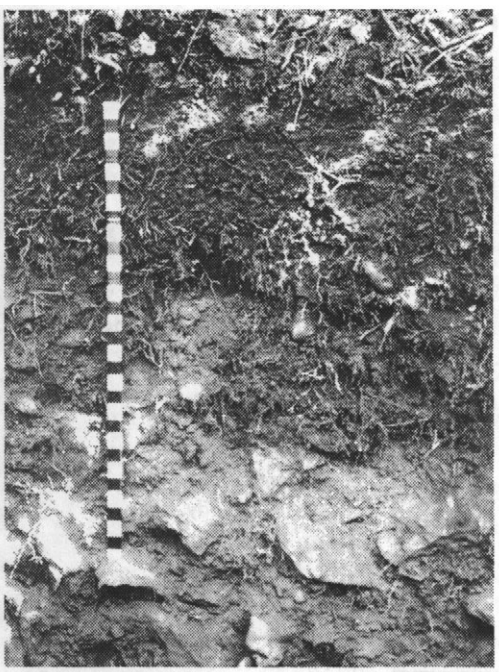
Rooting Depth: 10 - 150 cm

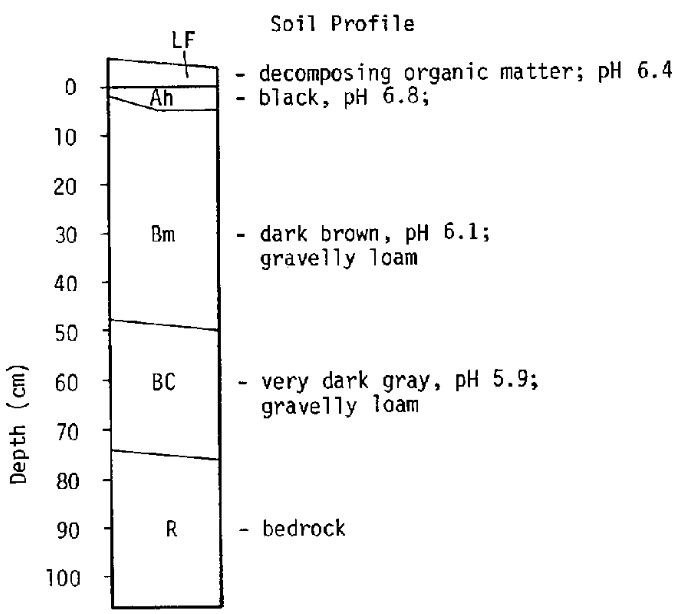
Humus Form Class: Moder

Moisture Regime: Subxeric

Nutrient Regime: Medium to poor

Discussion: Parent material textures vary from gravelley sandy loam to loam.





Common Vegetation: The tree canopy is generally a dense cover of Pseudotsuga menziesii; a scattering of Pinus ponderosa can occur. The usually dense shrub layer includes Physocarpus malvaceous, Holodiscus discolour, Symphoricarpus albus, Corylus californica, Rosa gymnocarpa, Amelanchier alnifolia, Mahonia repens, and Spiraea betulifolia. Grasses include Calamagrostis rubescens.

SOIL TYPE - C3

Parent Material: Colluvium

Soil Family: Orthic Eutric Brunisol, loamy-skeletal, mixed, (shallow), neutral, cool, subhumid

Climax Trees: Grand fir and/or western red cedar

Slope; Aspect: 16 - 70%; variable

Elevation: 425 - 1100 m (1400 - 3500 ft)

Drainage: Well to rapidly drained

Stoniness: Very to exceedingly stony

Depth to Bedrock: 50 - 150 cm

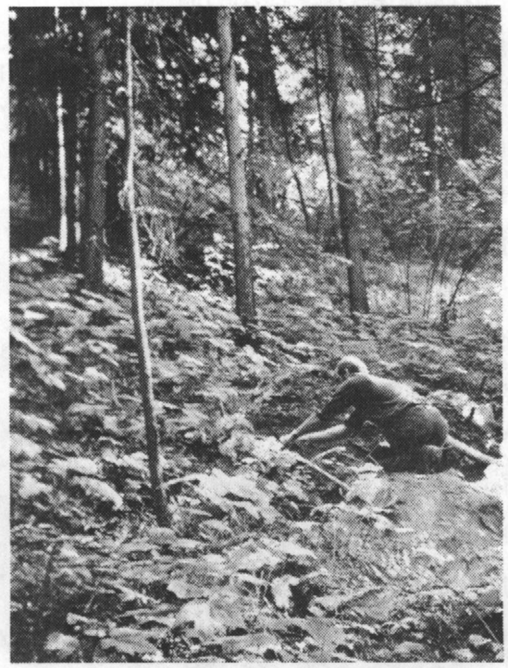
Rooting Depth: 50 - 150 cm

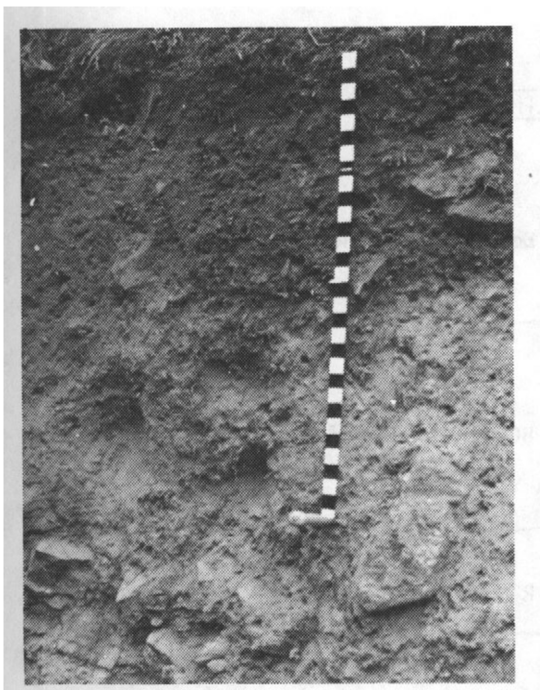
Humus Form Class: Moder to mor

Moisture Regime: Subxeric to submesic

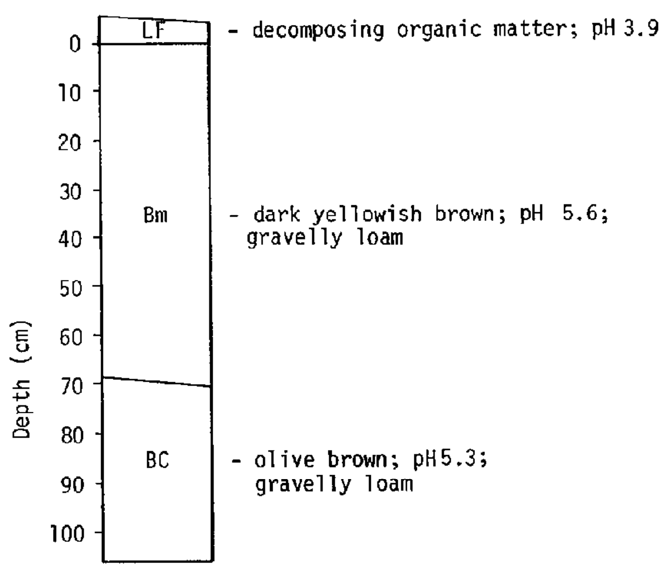
Nutrient Regime: Medium to poor

Discussion: Parent material textures vary from gravelly sandy loam to loam. Some orthic dystric brunisols.





Soil Profile



Common Vegetation: Climax tree is Abies grandis or Thuja plicata. Typical seral tree species may include Pseudotsuga menziesii, Larix occidentalis, Pinus monticola, Pinus contorta, Betula papyrifera, and Populus tremuloides. The usually open shrub layer includes Acer glabrum, Rubus parviflorus, Amelanchier alnifolia, and Symphoricarpus albus. The herb layer includes Linnaea borealis, Clintonia uniflora, and Hieracium albiflorum.

SOIL TYPE - C4

Parent Material: Colluvium

Soil Family: Orthic Dystric Brunisol, loamy-skeletal, mixed, (shallow), neutral, cool, humid

Climax Tree: Western hemlock

Slope; Aspect: 16 - 90%; north to east

Elevation: 700 - 1200 m (2300 - 4000 ft)

Drainage: Well drained

Stoniness: Very to exceedingly stony

Depth to Bedrock: 50 - 150 cm

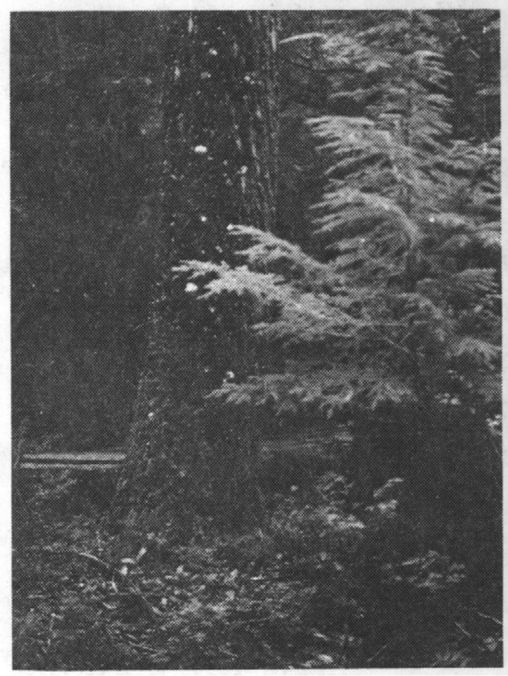
Rooting Depth: 50 - 150 cm

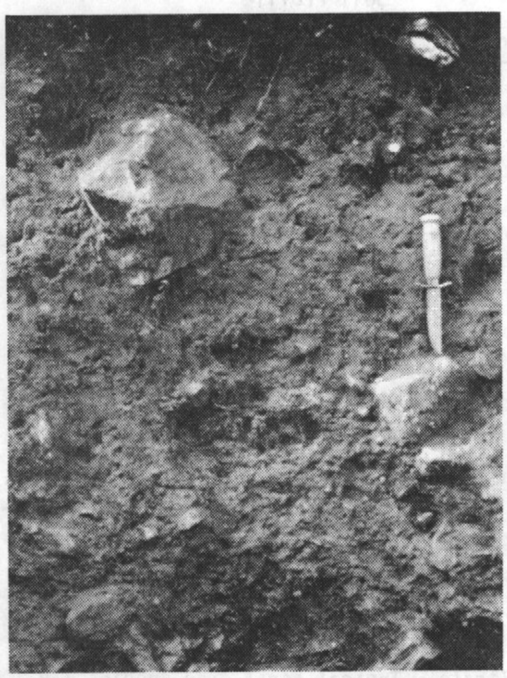
Humus Form Class: Mor

Moisture Regime: Submesic to mesic

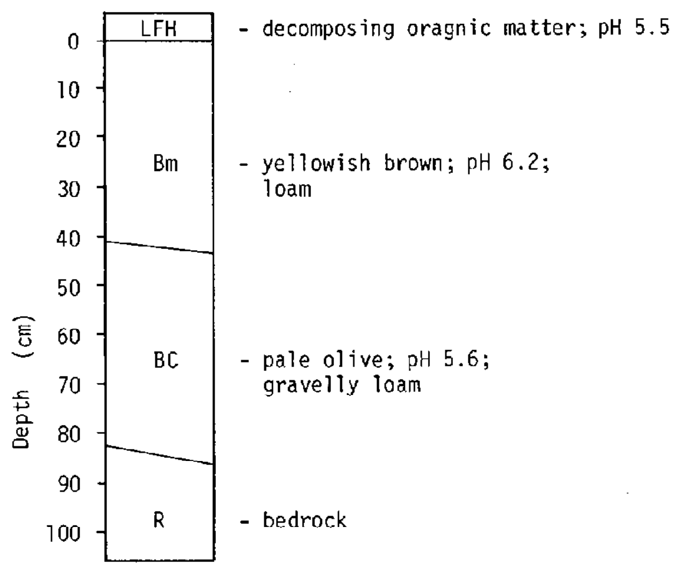
Nutrient Regime: Medium to poor

Discussion: Parent material textures vary from gravelly sandy loam to loam. Some Orthic Humo-Ferric Podzols in higher elevations, and Orthic Eutric Brunisols in lower elevations.





Soil Profile



Common Vegetation: Climax trees are Tsuga heterophylla and Thuja plicata. Typical seral trees may include Pseudotsuga menziesii, Larix occidentalis, Pinus monticola, Pinus contorta, and Betula papyrifera. The usually open shrub layer includes Lonicera utahensis, Paxistima myrsinites, Taxus bervifolia, and Acer glabrum. The herb layer includes Chimaphylla umbellata, Linnaea borealis, and Clintonia uniflora.

SOIL TYPE - C5

Parent Material: Colluvium

Soil Family: Orthic Humo-Ferric Podzol, loamy-skeletal, mixed, shallow, neutral, cold, subhumid

Climax Trees: Douglas-fir, grand fir

Slope; Aspect: 45 - 90%; south

Elevation: 1100 - 1400 m (3500 - 4500 ft)

Drainage: Rapidly drained

Stoniness: Exceedingly stony

Depth to Bedrock: 10 - 100 cm

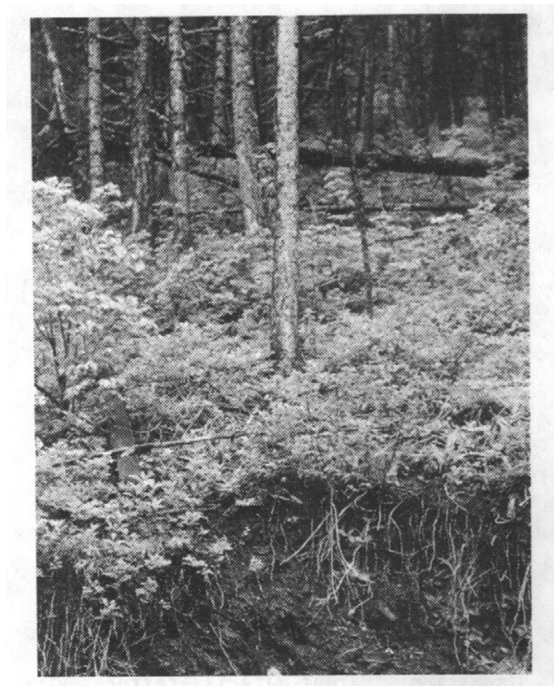
Rooting Depth: 10 - 100 cm

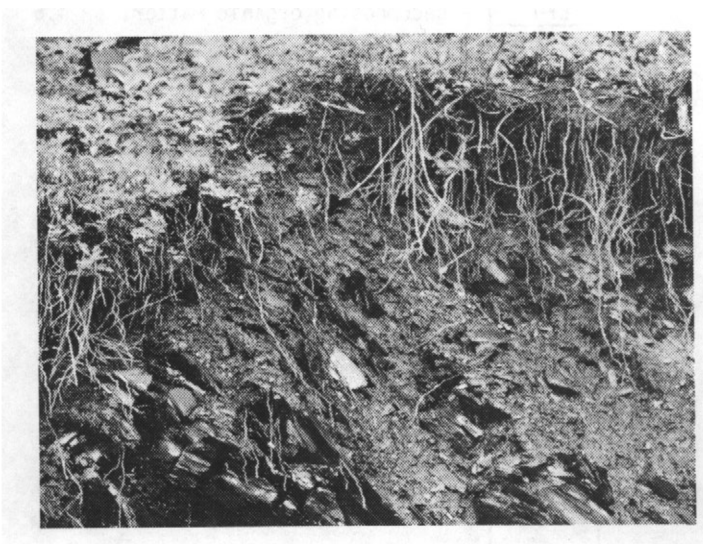
Humus Form Class: Moder

Moisture Regime: Subxeric

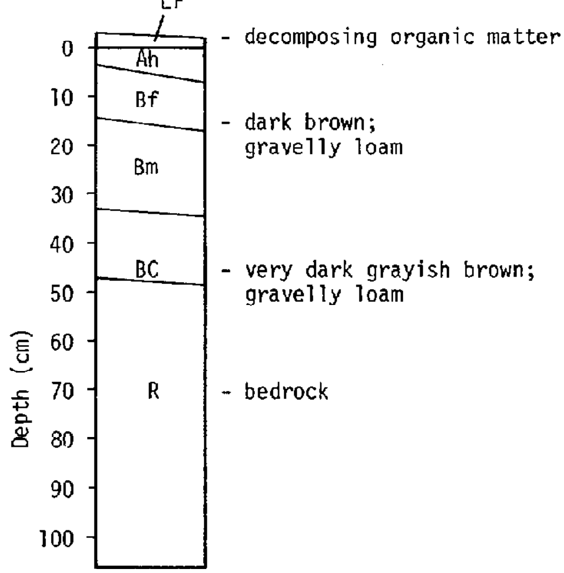
Nutrient Regime: Medium to very poor

Discussion: Parent material textures vary from very gravelly sandy loam to gravelley silt loam. Some Orthic Eutric and Dystric Brunisols also occur.





Soil Profile



Common Vegetation: The open to dense tree canopy consists primarily of Pseudotsuga menziesii, and, occasionally, Abies grandis and Betula papyrifera. Shrubs include Physocarpus malvaceus, Holodiscus discolour, Amelanchier alnifolia, Mahonia repens, and Spiraea betulafolia. Herb layer includes Disporum hookeri and Calamagrostis rubescens.

SOIL TYPE - C6

Parent Material: Colluvium

Soil Family: Orthic Humo-Ferric Podzol, loamy-skeletal, mixed, (shallow), acid, cold, perhumid

Climax Trees: Western hemlock, with alpine fir

Slope; Aspect: 30 - 90%; variable

Elevation: 1150 - 1700 m (3800 - 5600 ft)

Drianage: Well to rapidly drained

Stoniness: Very to exceedingly stony

Depth to Bedrock: 10 - 150 cm

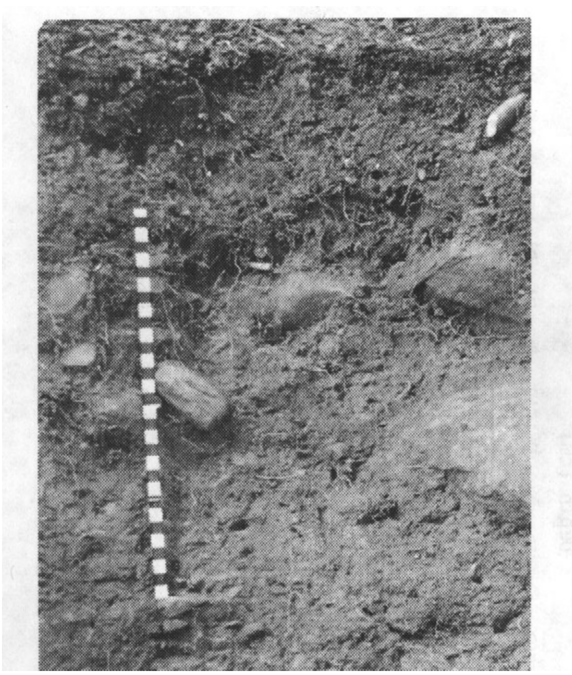
Rooting Depth: 10 - 150 cm

Humus Form Class: Mor

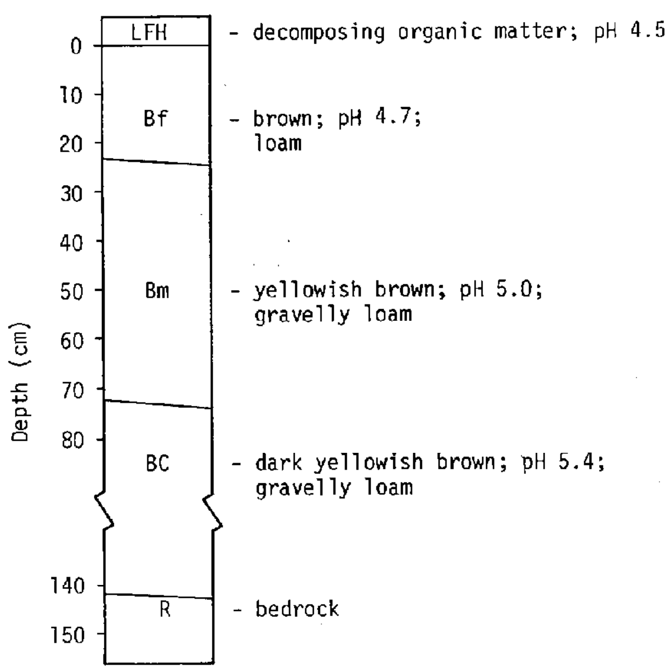
Moisture Regime: Submesic to subxeric

Nutrient Regime: Poor to medium

Discussion: Parent material textures vary from gravelly sandy loam to loam.



Soil Profile



Common Vegetation: Trees may include Tsuga heterophylla, Thuja plicta, Abies lasiocarpa, Picea engelmannii, Pseudotsuga menziesii, Larix occidentalis, Pinus monticola, and Pinus contorta. The typically open shrub layer consists of Lonicera utahensis, Vaccinium membranaceum, and Paxistima myrsinites. The dominant herbs are Tiarella unifoliata, Linnaea borealis, and Clintonia uniflora.

SOIL TYPE - C7

Parent Material: Colluvium

Soil Family: Orthic Humo-Ferric Podzol, loamy-skeletal, mixed, (shallow), acid, very cold, perhumid

Climax Trees: Alpine fir, Engelmann spruce

Slope; Aspect: 30 - 90%; variable

Elevation: > 1300 m (> 4600 ft)

Drainage: Well to rapidly drained

Stoniness: Very to exceedingly stony

Depth to Bedrock: 10 - 150 cm

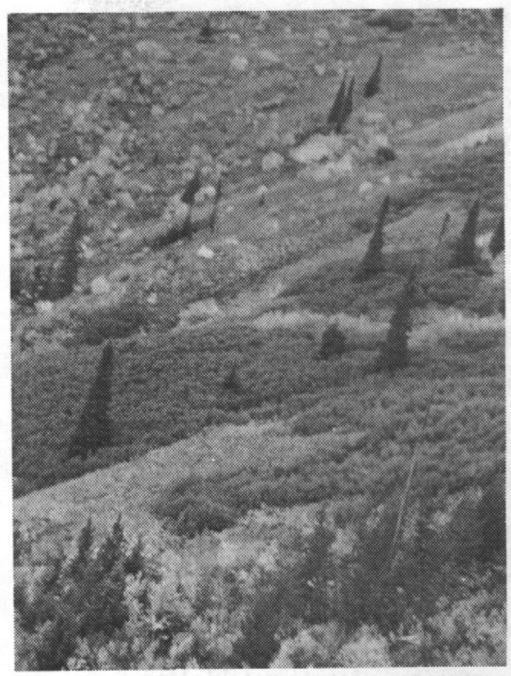
Rooting Depth: 10 - 150 cm

Humus Form Class: Mor

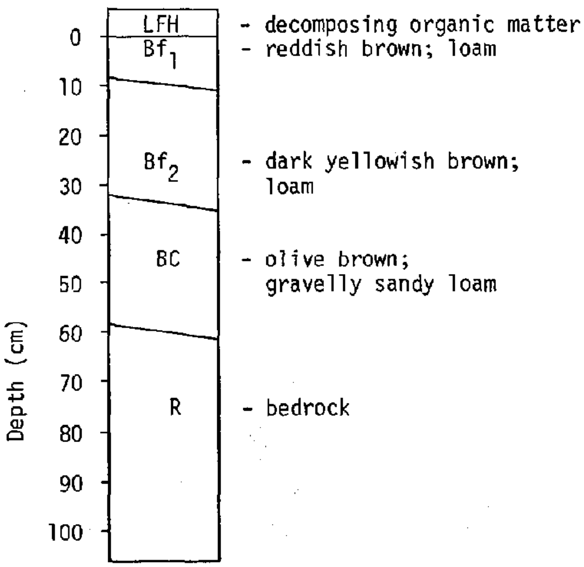
Moisture Regime: Submesic to subxeric

Nutrient Regime: Poor to medium

Discussion: Parent material textures vary from gravelly sandy loam to loam.



Soil Profile



No Photo Available

Common Vegetation: The usually dense tree canopy consists primarily of Abies lasiocarpa and Picea engelmannii. A scattering of Thuja plicata, Tsuga heterophylla, and Pinus contorta can occur. Shrubs include Rhododendron albiflorum, Ribes lacustre, Vaccinium scoparium, and Sambucus racemosa. Herbs include Thalictrum occidentalis, Clintonia uniflora, and Tiarella unifoliata.

SOIL TYPE - C8

Parent Material: Colluvium

Soil Family: Sombric Humo-Ferric Podzol, loamy-skeletal, mixed, shallow, acid, cold to very cold, subhumid

Climax Trees: Non-forest

Slope; Aspect: 30 - 70%; south

Elevation: > 1200 m (> 4000 ft)

Drainage: Well to rapidly drained

Stoniness: Very to exceedingly stony

Depth to Bedrock: 20 - 100 cm

Rooting Depth: 20 - 100 cm

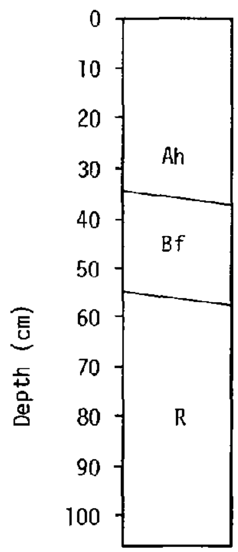
Humus Form Class: Mull

Moisture Regime: Subxeric

Nutrient Regime: Medium to rich

Discussion: Parent material textures vary from gravelly sandy loam to silt loam.

Soil Profile



Common Vegetation: Abies lasiocarpa and Picea engelmannii absent in the tree canopy but are present in stunted form and are widely spaced. Juncus spp., Phyllodoce empetriformis, and Cassiope mertensiana are present in the herb layer.

Description of Terms (Continued)

DRAINAGE

Soil drainage refers to the rapidity and extent of removal of water from soils in relation to additions. Soil drainage classes can be assessed using available water storage capacity and source of water (e.g. losses such as runoff or additions such as seepage). Seven soil drainage classes have been established ranging from very poorly drained to very rapidly drained. Since the soil map units range from poorly to rapidly drained, these five classes are defined below:

Rapidly drained -- Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (2.5-4 cm) within the control section and are usually coarse textured, or shallow, or both. Water source is precipitation.

Well drained -- Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are equalled by losses.

Moderately well drained -- Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6 cm) within the control section and are usually medium to fine textured soils; precipitation and significant additions by subsurface flow are necessary in coarse textured soils.

Imperfectly drained -- Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is major supply. If subsurface water or groundwater, or both, is main source, flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is main source if available water storage capacity is high; contribution by subsurface flow or groundwater flow, or both, increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are gleyed subgroups.

Poorly drained -- Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are main water sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Soils have a wide range in available water storage capacity, texture, and depth, and are Gleysolic or organic.

STONINESS

Stoniness is recorded as classes based on the percentage of the land surface occupied by fragments coarser than 15 cm in diameter. Stoniness is important in that stones interfere with cultivation, are obstacles for site developments such as campgrounds, and, when excessive, can hinder seeding germination or survival. The stoniness classes are:

	Surface Occupied by Stones %
Non-stony	<0.01
Slightly stony	0.01 - 0.1
Moderately stony	0.1 - 3
Very stony	3-15
Exceedingly stony	15-30
Excessively stony	>50

HUMUS FORM CLASS

Soil organic horizons (L,F, and H) may be evaluated as an organized natural body like the soil of which it is a part. Humus form class is used to describe the composition and sequence of these organic layers, which in turn reflect the kind and degree of organic matter decomposition. The characteristics of the three major humus forms in the study area are described as follows:

Typical Characteristics in Study Area

	Soil organic horizons[1]	% Organic C[2]	C/N ratio[2]	pH[2]	Soil Development[3]	Climax Trees
Mor	L,F,H present	40-60	30-60	4-5.5	O.HFP	grand fir and/or western red cedar
	F or H predominating				BR.GL	western hemlock
					O.DYB	western hemlock, alpine fir
					O.EB	alpine fir, Engelmann spruce
Moder	L,F present H lacking or thin	30-50	20-40	5-6.5	O.EB	Douglas-fir
Mull	L,F,H lacking or thin Ah present	5-20	12-20	6-7	O.DB SM.HFP	non-forest

1) L refers to fresh litter
F refers to partially decomposed litter
H refers to humified or well decomposed litter
Ah refers to surface mineral horizon with incorporated organic matter

2) % organic C, C/N ratio, pH are given for major soil organic horizons, or for mulls, where no significant organic horizons exist, for the Ah horizon.

3) O.EB - Orthic Eutric Brunisol
O.DYB - Orthic Dystric Brunisol
O.DB - Orthic Dark Brown
BR.GL - Brunisolic Gray Luvisol
O.HFP - Orthic Humo-Ferric Podzol
SM.HFP - Sombric Humo-Ferric Podzol

Humus forms have a far-reaching influence on soil genesis and are considered good indicators of many aspects of biogeochemical cycling. Thus they are an important factor to consider for management, especially in relation to runoff, erosion control, tree nutrition and establishment of natural regeneration.

MOISTURE REGIME

Ecological moisture regime refers to the amount of water available in the soil for plant growth. The moisture regimes are assessed within the framework of macroclimatic zones as expressed by vegetation (see table below). Average moisture conditions within each macroclimatic zone for deep, medium-textured, moderately-well to well drained soils on gentle to moderate slopes are considered mesic. Drier and wetter edaphic conditions can then be subjectively evaluated accordingly, with emphasis on the apparent effect moisture stresses or moisture additions have on vegetation. Thus, ecological moisture regime is an intrazonal concept while soil moisture subclasses, discussed earlier, is an interzonal concept applied independent of macroclimatic zones. The zonal framework applied to moisture and nutrient regimes is summarized below.

Macroclimatic Zone	Biogeoclimatic Subzone[1]	Biophysical Forest Zone or Subzone	Soil Map Units
1	Interior Douglas-fir wet subzone	Interior grand fir-western red cedar zone	M1,M2,F1,F2,F3,C1,C2,C3
2	Interior western hemlcok dry subzone	Interior western hemlock-western red cedar zone, Douglas-fir subzone	M3,F4,F5,L1,C4,C5
3	Interior western hemlock wet subzone	Interior western hemlock-western red cedar zone, alpine fir, Engelmann spruce subzone	M4,C6
4	Engelmann spruce-subalpine fir forest subzone	Subalpine Engelmann spruce-alpine fir zone, Douglas-fir subzone	M5,C7,C8

[1]According to Krajina (1969) [2] According to van Barneveld (in progress)

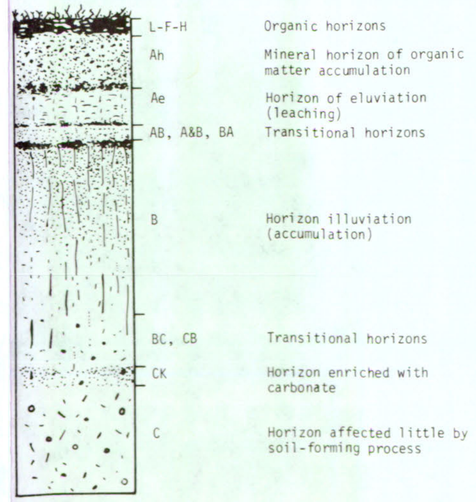
Moisture regime is expressed in terms of subxeric (dry), submesic (somewhat dry), mesic (average), and subhygric (somewhat wet). Hygric (wet) and xerix (very dry) soils exist as unmapped inclusions within the study area.

NUTRIENT REGIME

Soil nutrient regime is a relative assessment of the available nutrient supply for plant growth. As with ecological moisture regime, the assessment is made within the framework of macroclimatic zones as expressed by vegetation (see previous table). Exchangeable bases, cation exchange capacity, and % nitrogen in the upper soil mineral horizons (B horizons) were viewed for each soil map unit where data were available. Additional field notes regarding average surface textures and pH of the map units were also subjectively considered before rating the average nutrient regime for each soil map unit. The ash and eolian capping common over most of the study area tend to modify the influence of the valley's parent materials on nutrient regime. Nutrient regime is expressed in terms of very poor)oligotrophic), poor (submesotrophic), medium (mesotrophic), rich (permesotrophic), and very rich (eutrophic).

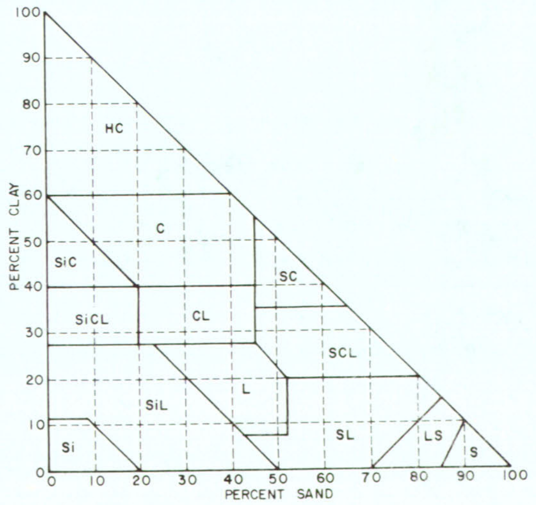
SOIL PROFILE

Common horizons in a mineral soil profile depicted below as general orientation to specific soil profile diagrams for each soil map unit. See Canada Soil Survey Committee (1978) for more details.



TEXTURE

Textural triangle below indicates relative percent sand, silt, and clay for soil texture ranges given in discussion.



A.3 Soil Correlation[1]

PREVIOUS WORK[2]		STUDY AREA		RELATED U.S. WORK[3]	
Soil Association	Soil Assoc. Comp.	Soil Type	Soil Family	U.S. Soil Family	U.S. Soil Series
Skelley (SY)	SY2	M1	Orthic Eutric Brunisol, loamy, mixed, calcareous, mild, semiarid	Coarse-loamy, mixed, frigid Andic Xerochrepts	Aits
Skelley (SY)	SY1	M2	Orthic Eutric Brunisol, loamy, mixed, calcareous, cool, subhumid	Fine-loamy, mixed, frigid Andic Xerochrepts	Smackout
Shields (SS)	SS4	M3	Brunisolic Gray Luvisol, loamy, mixed, calcareous, cool, humid		
Shields (SS) Sentinel (SL)	SS1,2 SL1	M4	Orthic Humo-Ferric Podzol, loamy-skeletal, mixed, acid, cold, perhumid	Medial over loamy-skeletal, mixed, Entic Cryandepts	Manley
		M5	Orthic Humo-Ferric Podzol, loamy-skeletal, mixed, acid, very cold, perhumid		
Kinert	KR5	F1	Orthic Euthic Brunisol, loamy-skeletal, mixed, neutral, mild, semiarid	Medial over loamy, mixed, mesic, Andic Xerochrepts	Eloika
Gillis (GS)	GS1	F2	Orthic Eutric Brunisol, coarse-loamy, mixed, neutral, cool, subhumid	Sandy, mixed, frigid Typic Xerochrepts	Scrabblers
Glenlily (GY)	GY1	F3	Orthic Eutric Brunisol, loamy-skeletal, mixed, neutral, cool, subhumid	Sandy-skeletal, mixed, frigid Andic Xerochrepts Sandy-skeletal, mixed, frigid Typic Xerochrepts	Bonner Kiehl
Gillis (GS)	GS1	F4	Orthic Dystric Brunisol, coarse-loamy, mixed, neutral, cool, humid	Sandy, mixed, frigid Typic Xerochrepts	Scrabblers
Glenlily (GY)	GY1	F5	Orthic Dystric Brunisol, loamy-skeletal, mixed, neutral, cool, humid	Sandy-skeletal, mixed, frigid Andic Xerochrepts Sandy-skeletal, mixed, frigid Typic Xerochrepts	Bonner Kiehl
Lawley (LY)	LY1	L1	Brunisolic Gray Luvisol, coarse-silty, mixed, neutral, cool, humid	Fine-silty, mixed, frigid Andic Xerochrepts	Martella

A.3 (continued)

PREVIOUS WORK[2]		STUDY AREA		RELATED U.S. WORK[3]	
Soil Association	Soil Assoc. Comp.	Soil Type	Soil Family	U.S. Soil Family	U.S. Soil Series
-none-		C1	Orthic Dark Brown, loamy-skeletal, mixed, shallow, neutral, mild semiarid	Loamy-skeletal, mixed, nonacid, mesic, Typic Xerothents	Raisio
				Loamy-skeletal, mixed, nonacid, Lithic Xerothents	Rufus
				Coarse-loamy, mixed, mesic, Pachic Hoploxerolls	Stevens
Burton town (BN)	BN5	C2	Orthic Eutric Brunisol, loamy-skeletal, mixed, shallow, neutral, mild to cool, semiarid	Loamy-skeletal, mixed, frigid Andic Xerochrepts	Hartill
Burton town (BN)	BN1	C3	Orthic Eutric Brunisol, loamy-skeletal, mixed, shallow, neutral, cool, subhumid	Loamy-skeletal, mixed frigid Andic Xerochrepts	Belzar
Bohan Creek (BK)	BK1	C4	Orthic Dystric Brunisol, loamy-skeletal, mixed, shallow, neutral, cool, humid	Medial over loamy-skeletal, mixed Entic Cryandepts	Huckle-berry
Bohan Creek (BK)	BK6	C5	Orthic Humo-Ferric Podzol, loamy-skeletal, mixed, shallow, neutral, cold, subhumid		
Bohan Creek (BK)	BK1	C6	Orthic Humo-Ferric Podzol, loamy-skeletal, mixed, acid, cold, perhumid	Loamy-skeletal, mixed, Typic Cryocherpts	Buhrig
Bonner (BO)	BO1	C7	Orthic Humo-Ferric Podzol, loamy-skeletal, mixed, acid, very cold, perhumid		(Deemer)[4]
Bonner (BO)	BO4	C8	Sombric Humo-Ferric Podzol, loamy-skeletal, mixed, shallow, acid, very cold, perhumid	- none-	

NOTES:

[1]Soil correlation between the soils of the Pend-d'Oreille River Valley in British Columbia and Jungen's (in progress) soil associations and U.S. Soil Families and Series are only approximate. The table does not imply that correlated soils are taxonomically equivalent, only that the correlated soils are similar and have been used in similar environments or landscapes.

[2]Soil Associations and components from Jungen's (in progress) reconnaissance survey of the Nelson mapsheet (82F).

[3]U.S. Soil Family and soil series used in Steven's County, Washington.

[4]Deemer is a proposed soil series only.

A.4 Soil Survey Agreement in the Pend-d'Oreille Valley, B.C.

A reconnaissance soil survey was available for the Pend-d'Oreille Valley (Jungen, in progress) before the current intermediate survey was initiated. Assuming that an intermediate level survey is more accurate than a reconnaissance survey because of more field checks and larger scale aerial photographs, an assessment of the relative agreement between the two surveys provides a measure of how accurate the reconnaissance survey was.

This information is useful for planners using the reconnaissance soil maps by Jungen in other drainages of the Nelson map sheet (82F) and for managers interested in the extent of inclusions* typically found in the map delineations**.

Since Jungen used the 1970 System of Soil Classification for Canada which differs significantly from the 1978 Canadian System of Soil Classification, no attempt was made to compare agreement between soil subgroups. Soil parent materials were compared instead. Since they strongly influence soil texture, permeability, drainage, stoniness, subgrade characteristics, and general nutrient characteristics, a comparison of soil parent materials should be a valuable measure of survey accuracy.

The average agreement of soil parent materials in the Pend-d'Oreille was approximately 73%, modal agreement was approximately 80%. This is because a high percentage (54%) of reconnaissance map units had a very high level of agreement (greater than 80%) with the intermediate survey, while approximately 17% of the reconnaissance map delineations showed less than 50% agreement. Utzig (1978) found 77% average agreement of soil parent materials in another watershed in the Nelson map area (82F).

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* Inclusions are soil types that are not extensive enough to be shown on the map unit symbols.

** A map delineation is a single area on a soil map bounded by a continuous line. Also known as a map polygon.

Most soil surveys usually claim between 70-80% accuracy for their map delineations (e.g. 20-30% unmapped inclusions permitted). On the basis of this analysis and Utzig's (1978) work, the reconnaissance soil survey meets this standard.

Assuming that soil and terrain characteristics play a significant role in determining mapping reliability (see Utzig, 1978), it may also be safe to assume that the intermediate level survey contains a similar level of reliability. Although the intermediate survey is more detailed than the reconnaissance survey, with smaller map delineations shown, the percentage of unmapped inclusions per map delineation is likely to be similar to that for the reconnaissance survey. On this basis, this report made the assumption that 25% inclusions can be expected for each map delineation on the average.

A.5 Guides for Interpreting Uses of Soil

Table A.1.

GUIDE FOR ASSESSING SOIL LIMITATIONS FOR SEPTIC TANK ABSORPTION FIELDS[5]

Ratings for septic tank absorption fields are based on the ability of the soil to filter and absorb sewage effluent. Criteria for the ratings include permeability, drainage, flooding hazard, slope, depth to bedrock. Stoniness, is also evaluated as it affects construction costs. The ratings do not preclude the necessity for on-site evaluation.

ITEMS AFFECTING USE[1]	DEGREE OF SOIL LIMITATION			
	NONE TO SLIGHT	MODERATE	SEVERE	VERY SEVERE
Permeability Class[2] (Perm)[1]	Rapid,[3] Moderately rapid	Moderate	Slow	Very Slow
Drainage[4] (Wet)	Very Rapidly,[3] Rapidly, and Well Drained	Moderately Well Drained	Imperfectly Drained	Poorly and very Poorly Drained
Flooding (Flood)	None	None	Rare (Less Than Once in 10 Years)	Occasional to Frequent (More Than Once in 10 Years)
Depth to Bedrock (Depth)	> 200 cm	100-200 cm	50-100 cm	< 50 cm
Slope Class (Slope)	1 - 4 (0-9%)	5 (10-15%)	6 (16-30%)	7-10 (> 30%)
Stoniness Class (Stony)	Non-Stony to Slightly Stony	Moderately Stony	Very Stony	Exceedingly to Excessively Stony

1 The abbreviations in brackets are used in Table 2.4 to indicate the nature of the limitation.

2 Permeability class inferred from texture, soil structure, and soil development.

3 Pollution hazard may exist if soil is adjacent to water body.

4 Imperfectly to poorly drained soils may also have a high water table.

5 Adapted from U.S.D.A. Soil Conservation Service (1971).

Table A.2.

GUIDE FOR ASSESSING SOIL LIMITATIONS FOR SHALLOW EXCAVATIONS[5]

This guide applies to soils evaluated for excavations and trenches to a depth of 1.5 to 2 metres, such as those needed for the installation of underground utilities. Criteria are based on the ease of excavation, workability resistance to sloughing and flooding hazard, and therefore, consider drainage, flooding frequency, slope, texture, depth to bedrock, and rockiness. The rating must be further evaluated with respect to the specific use. For instance, additional information such as shrink - swell potential and corrosivity is needed for ratings for pipelines. On-site investigations are needed for specific placement of excavations and trenches.

ITEMS AFFECTING USE[1]	DEGREE OF SOIL LIMITATION			
	NONE TO SLIGHT	MODERATE	SEVERE	VERY SEVERE
Drainage (Wet)	Very Rapidly, Rapidly and Well Drained	Moderately Well Drained	Imperfectly Drained	Poorly to Very Poorly Drained
Flooding (Flood)	None	Rare (Once in 10 Years or Less)	Occasional (Once in 2-9 Years)	Frequent (Every Year)
Depth to Bedrock[2] (Depth)	> 200 cm	100-200 cm	50-100 cm	< 50 cm
Slope Class (Slope)	1-4 (0-9%)	5 (10-15%)	6 (16-30%)	7-10 (>30%)
Texture[3] (Text)	fsl,sl,l,sil, sicl,scl	si,cl,sc, All Gravelly Types	c,sic,s,ls, All Very Gravelley Types	Organic
Rockiness[2,4] (Rock)	Bedrock Covers <5% Surface	Bedrock Covers 5-20% Surface	Bedrock Covers 20-50% Surface	Bedrock Covers >50% Surface

1 The abbreviations in brackets are used in Table 2.4 to indicate the nature of the limitation.

2 If bedrock is soft enough so that it can be dug with ordinary handtools or light equipment, such as backhoes, reduce ratings by one class.

3 Texture is used here as an index of workability and sidewell stability; textural symbols according to Canada Soil Survey Committee (1978).

4 Rockiness limitations are not assessed on Table 2.4. This item must be assessed by referring to the soil maps

5 Adapted from U.S.D.A. Soil Conservation Service (1971).

Table A.3.

GUIDE FOR ASSESSING SOIL LIMITATIONS FOR BUILDINGS[5]

This guide applies to soils evaluated for dwellings and buildings without basements and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundations using the Unified Classification, however, hydrologic conditions such as drainage and susceptibility to flooding are considered too. Also considered are slope, depth to bedrock, and rockiness which influence excavation and construction costs for the building itself and for the installation of utility lines. On-site investigations are needed for specific placement of buildings and utility lines.

ITEMS AFFECTING USE [1]	DEGREE OF SOIL LIMITATION			
	NONE TO SLIGHT	MODERATE	SEVERE	VERY SEVERE
Drainage (Wet)[1]	Very Rapidly, Rapidly, Well, and Moderately Well Drained	Imperfectly Drained	Poorly Drained	Very Poorly Drained
Flooding (Flood)	None	None	Rare (Less Than Once in 10 Years)	Occasional to Frequent (More Than Once in 10 Years)
Depth to Bedrock[2] (Depth)	> 100 cm	50-100 cm	10-50 cm	< 10 cm
Slope Class (Slope)	1-4 (0-9%)	5-6 (10-30%)	7 (31-45%)	9-10 (>45%)
Unified Soil Group[3] (Subgrade)	GW,GP,GM,GC, SW,SP,SM,SC	ML,CL	CH,MH,OH,OL	Pt
Rockiness[4,2] (Rock)	Bedrock Covers <5% Surface	Bedrock Covers 5-20% Surface	Bedrock Covers 20-50% Surface	Bedrock Covers >50% Surface

1 The abbreviations in brackets are used in Table 2.4 to indicate the nature of the limitation.

2 If the bedrock is soft enough so that it can be dug with light power equipment such as backhoes, moderate, severe, and very severe limitations may be reduced by one class.

3 This item estimates the strength of the soil as foundation material, that is, its ability to withstand applied loads.

4 Rockiness limitations are not assessed in Table 2.4; this item must be assessed by referring to the soil maps.

5 Adapted from U.S.D.A. Soil Conservation Service (1971).

Table A.4.

GUIDE FOR ASSESSING SOIL LIMITATIONS FOR ROADS[7]

This guide applies to soils evaluated for construction and maintenance of roads. Properties that affect design and construction of roads are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification give an indication of the traffic supporting capacity of the subgrade. Drainage and flooding affect stability. Slope, depth to bedrock, rockiness and drainage affect the ease of excavation and the amount of cut and fill to reach an even grade. Soil limitation ratings do not substitute for on-site investigations.

ITEMS AFFECTING USE[1]	DEGREE OF SOIL LIMITATION			
	NONE TO SLIGHT	MODERATE	SEVERE	VERY SEVERE
Drainage (Wet)	Very Rapidly, Rapidly, Well and Moderately Well Drained	Imperfectly Drained	Poorly Drained	Very Poorly Drained
Flooding (Flood)	None	Rare (Once in 10 Years or Less)	Occasional (Once in 2-9 Years)	Frequent (Every Year)
Depth to Bedrock[2] (Depth)	> 100 cm	50-100 cm	10-50 cm	< 10 cm
Slope Class (Slope)	1-4 (0-9%)	5-6 (10-30%)	7-8 (31-70%)	9-10 (>70%)
Subgrade Class[3] (Subgrade) a. Unified Soil Group	GW,GP,GM,GC SW,SP,SM,SC	ML CL (PI[6] <15)	CH,MH,OH,OL CL (PI[6] >15)	Pt
b. AASHO Group Classes	A-1, A-2, A-3	A-4, A-5	A-6, A-7	
Susceptibility to Frost Heaving[4] (Frost)	Low	Moderate	High	
Rockiness[5,2] (Rock)	Bedrock Covers <5% Surface	Bedrock Covers 5-20% Surface	Bedrock Covers 20-50% Surface	Bedrock Covers >50% Surface

1 The abbreviations in brackets are used in Table 2.4 to indicate the nature of the limitation.

2 If the bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery, reduce moderate, severe, and very severe limitations by one class.

3 This item estimates the strength of a soil as it applies to roadbeds. The relatively unweathered soil horizons (BC, CB, and C) are assessed.

4 See Table 2.4 for individual soil ratings.

5 Rockiness limitations are not assessed in Table 2.4; this item must be assessed by referring to the soil maps.

6 PI means plasticity index.

7 Adapted from U.S.D.A. Soil Conservation Service (1971).

Table A.5.

GUIDE FOR ASSESSING POTENTIAL FROST ACTION[4]

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

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

1 Potential frost action ratings for each soil map unit are given on Table 2.4.

2 These soils are rated one class higher when imperfectly to poorly drained.

3 Gravel and other coarse fragments in soils tend to reduce the potential for frost action, particularly if the content of such materials is high. Textural symbols according to Canada Soil Survey Committee (1978).

4 Adapted from U.S.D.A. Soil Conservation Service (1971).

Table A.6.

GUIDE FOR ASSESSING SOIL SUITABILITY FOR SAND AND GRAVEL[2]

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

ITEMS AFFECTING USE [1]	DEGREE OF SOIL SUITABILITY			
	GOOD	FAIR	POOR	UNSUITED
Unified Soil Group	GW, GP, SW, SP	SW-SM, SP-SM GP-GM, GW-GM	GM, GC, SM, SC	All Other Groups
Depth to Bedrock	> 200 cm	100 - 200 cm	50 - 100 cm	< 50 cm

1 Soil suitability ratings for sand and gravel are given for each soil map unit on Table 2.4. The relative percent of sand and gravel can be inferred from soil texture and Unified soil group.

2 Adapted from U.S.D.A. Soil Conservation Service (1971).

Table A.7.

GUIDE FOR ASSESSING SOIL SUITABILITY FOR TOPSOIL[4]

The term topsoil describes material used to cover barren surfaces exposed during construction so as to improve soil conditions for re-establishment and maintenance of vegetation and also to improve conditions where vegetation is already established. The soils are rated in terms of characteristics which are favourable to plant growth, and the ease or difficulty of the actual excavation. A soil that qualifies as a good source of topsoil must also have characteristics such that the remaining soil material is reclaimable after the uppermost soil is stripped away.

ITEM AFFECTING USE[1]	DEGREE OF SOIL SUITABILITY			
	GOOD	FAIR	POOR	VERY POOR
Drainage (Wet)[1]	Very Rapidly, Rapidly, Well and Moderately Well Drained	Imperfectly Drained	Poorly Drained	Very Poorly Drained
Thickness of Material[2] (Thick)	> 50 cm	25-50 cm	10-25 cm	< 10 cm
Texture[3] (Text)	sl, l, sil	cl, scl, sicl, sc	s, ls, c, sic	Organic
Slope Class (Slope)	1-4 (0-9%)	5 (10-15%)	6 (16-30%)	7-10 (> 30%)
Stoniness (Stony)	Non-Stony to Slightly Stony	Moderately Stony	Very Stony	Exceedingly to Excessively Stony

1 The abbreviations in brackets are used in Table 2.4 to indicate the nature of the limitation.
2 Refers to thickness of uppermost part of soil profile, usually the A and B soil horizons.
3 Textural symbols according to Canada Soil Survey Committee (1978).
4 Adapted from U.S.D.A. Soil Conservation Service (1971).

Table A.8.

GUIDE FOR ASSESSING POTENTIAL EROSION HAZARD

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

ITEM AFFECTING USE [1]	DEGREE OF SOIL LIMITATION			
	SLIGHT	MODERATE	SEVERE	VERY SEVERE
Drainage (Wet) [1]	Rapidly to Well Drained	Moderately Well to Imperfectly Drained	Poorly Drained	Very Poorly Drained
Unified Soil Group (Text)	GW, GP, SW, SP	GM, GC, SC, CH, OH	SM, CL, OL, MH	ML
Permeability Class (Perm.) [2]	Rapid	Moderate	Slow	Very Slow
Depth to Impermeable Layer (Depth) [3]	> 5 m	1-5 m	0.5 - 1 m	< 0.5 m
Forest Floor Thickness (Litter)	> 10 cm	5-10 cm	1-5 cm	< 1 cm
Slope Class (Slope)	1-5 (<16%)	6-7 (16-45%)	8 (45-70%)	9-10 (>70%)

1 The abbreviations in brackets are used in Table 2.4 to indicate the nature of the limitation.

2 Permeability class inferred from soil texture, structure, and soil development.

3 This includes depth to bedrock or other impervious material (e.g. hardpan).

Table A.9.

GUIDE FOR ASSESSING SOIL LIMITATIONS FOR CAMPGROUNDS AND PICNIC SITES[4]

This guide applies to soils considered for intensive recreational uses such as campgrounds and picnic sites where soils should be suitable for heavy foot traffic by humans and limited vehicle traffic. Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of the site.

ITEM AFFECTING USE[1]	DEGREE OF SOIL LIMITATION			
	SLIGHT	MODERATE	SEVERE	VERY SEVERE
Drainage Class[2] (Wet)	Rapidly, Well and Moderately Well Drained	Imperfectly Drained	Poorly Drained	Very Poorly Drained
Flooding (Flood)	None	None during season of use	Occasional flooding during season of use	Frequent flooding during season of use
Slope Class (Slope)	1-4 (0-9%)	5 (10-15%)	6 (16-30%)	7-10 (>30%)
Texture[2] (Text)	sl, l	sil, scl, sicl, ls, cl	sc, sic, c, si, s	Organic
Stoniness Class (Stony)	Non-stony to moderately stony (<3% of surface)	Very stony (3-15% of surface)	Exceedingly stony (15-50% of surface)	Excessively stony (>50% of surface)
Depth to Bedrock (Depth)	>100 cm	50-100 cm	20-50 cm	<20 cm
Rockiness Class[3] (Rock)	Non-rocky to Slightly Rocky (<10% of surface)	Moderately Rocky (10-25% of surface)	Very Rocky (25-50% of surface)	Exceedingly to Excessively Rocky (>50% of surface)

1 The abbreviations in brackets are used in Table 2.2 to indicate the nature of the limitation.

2 Defined by Canada Soil Survey Committee (1978).

3 Rockiness limitations are not assessed in Table 2.2. This item must be evaluated by referring to the soil maps.

4 Adapted from Montgomery and Edminster (1966) and Coen et al. (1977).

A.6 Soil Climate

The soil family was used to help define the soil map units for the Pend-d'Oreille Valley. Most of the parameters which define the family are relatively easy to apply in the field and are described in Appendix A.2 and in The Canadian System of Soil Classification (Canada Soil Survey Committee, 1978, see pp 115-124).

The method by which the soil climate data presented in section 1.5 and Appendix C was utilized to determine soil temperature classes (STC) and soil moisture subclasses(SMS) needs elaboration. It should be kept in mind that STC and SMS, when applied to the soil family, are not regional concepts as portrayed in Soils of Canada (Clayton et al., 1977), but are intended to be assessed individually for each soil (Canada Soil Survey Committee 1978; see p. 120). Soil temperature classes are based mainly on mean annual and mean seasonal soil temperature and the length of the growing season. Soil moisture subclasses are mainly separated on calculations of intensity and degree of water deficits during the growing season.

Soil temperature classes for given elevations on level slopes are summarized on Table A.10. This data was obtained directly from climatic data presented in Appendix C.2. Soil moisture subclasses were first assessed by calculating soil water deficits for deep, loamy soils. This was determined by adding a 7 cm soil moisture recharge at the start of the growing season to the climatic moisture deficit data previously supplied in the climate section. The 7 cm soil moisture recharge was based on average available water storage capacity of the upper 50 cm of soil where most rooting occurs. This information is also summarized on Table A.10.

With this general table in mind, adjustments necessarily have to be made as soil and site characteristics vary. Aspect, slope, and available water storage capacity of the soil are three critical factors which modify STC and SMS from one site to the next.

Since STC and SMS are difficult to "visualize" in the field, class breaks had to be assigned to observable and mappable characteristics in the landscape. Vegetation, in particular, should be very sensitive or responsive to soil climate. Water stresses that result from soil moisture conditions should be reflected in the kinds of vegetation that grow on a site. Thus, climax vegetation was used to determine critical breaks in STC and SMS.

The relationship between STC and SMS and climax vegetation is shown on Table A.11 on the following page. These relationships were taken into consideration during the development of a soil legend for the valley, particularly in the use of the soil family to describe soil types (see Appendix A.2).

Table A.10.

AVERAGE SOIL TEMPERATURE CLASS AND SOIL MOISTURE SUBCLASS BY ELEVATION FOR DEEP, LOAMY SOILS ON LEVEL SLOPES IN THE PEND-D'OREILLE VALLEY, B.C.

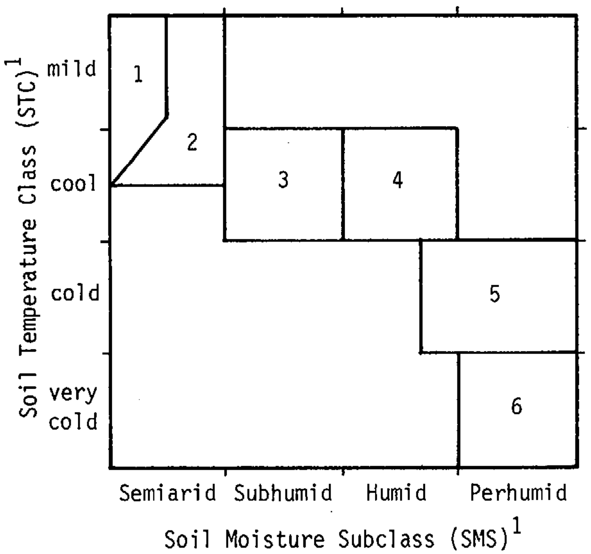
Elevation	Soil Temperature[1] Class (STC)	Soil Moisture[1,2] Subclass (SMS)
460 m (1 500 ft.)	Mild	Semiarid
610 m (2 000 ft.)	Mild	Subhumid
760 m (2 500 ft.)	Cool	Subhumid
910 m (3 000 ft.	Cool	Subhumid
1060 m (3 500 ft.)	Cold	Humid
1220 m (4 000 ft.)	Cold	Perhumid
1370 m (4 500 ft.)	Cold	Perhumid
1520 m (5 000 ft.)	Cold	Perhumid
1670 m (5 500 ft.)	Very cold	Perhumid
1820 m (6 000 ft.)	Very cold	Perhumid

[1]STC and SMS breaks defined in Appendix A.2.

[2]Assumes a 7 cm soil moisture recharge at start of growing season.

Table A.11

RELATIONSHIP BETWEEN SOIL CLIMATE AND CLIMAX VEGETATION FOR THE SOILS OF THE PEND-D'OREILLE VALLEY, B.C.



Key to Climax Vegetation Soil Development on Deep Soils

Unit No.	Dominant STC	Dominant SMS	Dominant[2] Climax Forest	Dominant Soil Development
1	Mild	Semiarid	Non-forest, primarily grasses and shrubs.	Orthic Dark Brown (Chernozomic)
2	Mild (Cool)	Semiarid	Douglas-fir	Orthic Eutric Brunisol
3	Cool	Subhumid	Grand fir and/or western red cedar	Orthic Eutric Brunisol
4	Cool	Humid	Western hemlock	Orthic Dystric Brunisol and Brunisolic Gray Luvisol
5	Cold	Perhumid (Humid)	Western hemlock with alpine fir	Orthic Humo-Ferric Podzol
6	Very Cold	Perhumid	Alpine fir, Engelmann spruce	Orthic Humo-Ferric Podzol

Note:

[1]STC and SMS breaks defined in Appendix A.2 (see description of terms opposite soil type descriptions).

[2]For correlation with Daubenmire and Daubenmire's (1968) habitat types, see Appendix A.2, see vegetation chapter for correlation with vegetation types.

Appendix B

VEGETATION RESOURCES

B.1 Keys to the Vegetation Types of the Pend-d'Oreille Valley, B.C.

B.1.1. Introduction

Two keys to the vegetation types of the Pend-d'Oreille Valley are presented: a condensed and an artificial key.

A hierarchical key for the vegetation types of the Nelson map area (NTS 82F) has been prepared by van Barneveld (in progress). This key was used in the determination of vegetation types in the Pend-d'Oreille Valley. The key follows dichotomous divisions allowing progressively more detailed identification of vegetation to any required level of generalization, from broad regional to specific type. Each plant species present at a level of division is characterized according to its constancy on either side, so that the entire species list provides varying degrees of information for making decisions. This key is quite specialized and requires a good understanding of both plant taxonomy and ecology to be used correctly in the field - because of this plus the length of the key (since it includes many vegetation types not occurring in the Study Area), it has not been included in this report. Instead, this specialized key has been condensed for the vegetation types occurring in the Pend-d'Oreille Valley (B.1.2.).

Since the condensed key follows the classification procedure used in determining vegetation types, it requires a good understanding of plant taxonomy. Therefore, an artificial key (B.1.3.) has been prepared which concentrates on plant characteristics more readily discerned by resource managers.

Step by step, the keys provide the user with a series of choices which will ultimately lead to the identification of a vegetation type. It is important to consider the full description of each step in the key when choosing between the two alternatives: if true go to the next statement, if false go to the alternate lead, which is indicated behind the statement. When keying a sample site to vegetation type, not all the species used in the description of the step need to be found on a site, but the combination of species on the site must clearly resemble the description of the step. At any one step, if it is not possible to select one of the two alternatives, it is suggested that both be followed through. Usually it will become evident that one of the alternative routes is not relevant. In rare cases both alternatives are followed through and the final choice is to choose between the types resulting from the alternatives. The soil, parent material, aspect and elevation which best typify each vegetation type are provided in the description of the vegetation type (Appendix B.2). These characteristic physical data for each vegetation type are a further aid in choosing between pairs of alternatives. The descriptions of the vegetation types are located at the end of the keys in Appendix B.2.

The vegetation types of the Pend-d'Oreille Valley and additional vegetation types of the West Kootenay area are presented and described in "Vegetation of the Nelson (NTS 82F) Area" (van Barneveld, in progress).

A constancy table for the vegetation types is presented in the above report. This table contains a species list for each vegetation type. It has two functions: (1) to act as an additional aid to the vegetation type description, so that there can be a better understanding of each vegetation type, and (2) to act as a checklist to see if the vegetation type identified by the person using the key is in fact correct. Constancy of a species is an index of the change of occurrence from one vegetation type to another, and of the occurrence in any one vegetation type. This information gives the user a better appreciation of missing species in a vegetation type and of the occurrence of species that are not usually found.

Common names in the keys are after Taylor and MacBryde's (1977) "Vascular Plants of British Columbia" (see Appendix B.7). The following are definitions of terms used in the keys:

Main tree canopy: Trees of which the crowns from the upper layer of foliage are usually above 10 m in height.

Taller tree of the tree canopy: The species of the main tree canopy that make up the upper part (upper 5% of height distribution population).

Tall shrub layer: This stratum contains all woody shrubs between 2 m and 10 m in height.

Advanced regeneration layer: This stratum contains all tree regeneration between 2 m and 10 m in height.

Low shrub layer: This stratum contains all woody shrubs below 2 m in height.

Regeneration layer: This stratum contains all trees below 2 m in height.

Herb layer: In this stratum are recorded all herbaceous species and some semi-woody plants regardless of their height.

B.1.2. Condensed Key to Vegetation Types of the Pend-d'Oreille Valley

1a One or more of Rocky Mountain Douglas-fir, common paper birch or western white pine in the advanced regeneration layer are present. One or more of birch-leaved spirea, creeping Oregon grape, soopolallie or western fescue are present.

Lead 1b on page B9

2a Grand fir and/or western white pine in the main tree canopy are present. Western hemlock in the advanced regeneration layer is present. Western red cedar and/or western hemlock in the regeneration layer are present. One or more of common western pipsissewa, blue-bead clintonia or northern twinflower are present. Ponderosa pine in the main tree canopy is usually absent. Mallow ninebark and redstem ceanothus are usually absent.

Lead 2b on page B8

3a Common paper birch and/or grand fir in the main tree canopy are present. California filbert and/or creambush oceanspray in the tall shrub layer are present. Wild sarsaparilla is present. Alpine fir in the regeneration layer is absent.

Lead 3b on page B7

4a Common saskatoon in the tall shrub layer is present. Lodgepole pine in the advanced regeneration layer is present. California filbert in the low shrub layer is present. Fireweed is present. Western hemlock in the advanced regeneration layer is absent.

Lead 4b on page B6

5a Grand fir in the main tree canopy is present. Western larch and/or trembling aspen in the advanced regeneration layer are present. California filbert in the tall shrub layer is present. One or more of common timothy, clover species or blue wild rye grass are present. Lodgepole pine and western hemlock in the advanced regeneration layer are absent. Western hemlock in the regeneration layer is absent. Evergreen yellow violet is absent.

Lead 5b on page B5

6a Grand fir in the advanced regeneration layer is present. One or more of western trumpet honeysuckle, common western pipsissewa, large-leaved rattlesnake orchid, star-flowered false Solomon's-seal or trail plant are absent. Soopolallie and black blueberry in the low shrub layer are absent. Western white pine in the regeneration layer is absent. Western bracken and fireweed are absent.
Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26) See page B22.

6b Western white pine in the regeneration layer is present. Soopolallie and/or black blueberry in the low shrub layer are present. Western bracken and/or fireweed are present. Grand fir in the advanced regeneration layer is absent. Western trumpet honeysuckle, common western pipsissewa, large-leaved rattlesnake orchid, star-flowered false Solomon's-seal or trail plant are absent.
Trembling aspen - common paper birch - western thimbleberry - western bracken (24) See page B22.

5b Lodgepole pine and/or western hemlock in the advanced regeneration layer are present. Western hemlock in the regeneration layer is present. Evergreen yellow violet is present. Grand fir in the main tree canopy is absent. Western larch and trembling aspen in the advanced regeneration layer are absent. California filbert in the tall shrub layer is absent. Common timothy, clover species and blue wild rye grass are absent.

7a Common paper birch in the main tree canopy is usually present. Grand fir in the advanced regeneration layer is present. Lodgepole pine is not the taller tree of the tree canopy. Lodgepole pine in the advanced regeneration layer is absent. Willow species in the tall shrub layer are absent. Willow species in the low shrub layer are absent. Kinnikinnick is absent.

Lead 7b on page B6

8a Lodgepole pine in the main tree canopy is present. One or more of Rocky Mountain maple, creambush oceanspray or common saskatoon in the tall shrub layer are present. One or more of Rocky Mountain maple or birch-leaved spirea in low shrub layer are present. Rocky Mountain Douglas-fir in regeneration layer is present. False Solomon's-seal and/or western fescue are present. Spreading dogbane and aster species are absent.
Western larch - western red cedar - western thimbleberry - northern twinflower (32) See page B23.

8b Spreading dogbane and/or aster species are present. Lodgepole pine in the main tree canopy is absent. Rocky Mountain maple, creambush oceanspray and common saskatoon in the tall shrub layer are absent. Rocky Mountain maple and birch-leaved spirea in the low shrub layer are absent. Rocky Mountain Douglas-fir in the regeneration layer is absent. False Solomon's-seal and western fescue are absent.
Western larch - western red cedar - rose species - blue-bead clintonia (30) See page B23.

7b Lodgepole pine is usually the taller tree in the tree canopy. Lodgepole pine in the advanced regeneration layer is present. Willow species in the tall shrub layer are present. Willow species in the low shrub layer are present. Kinnikinnick is present. Common paper birch in the main tree canopy is usually absent. Grand fir in the advanced regeneration layer is absent.

9a Western white pine and/or common paper birch in the main tree canopy are present. Western white pine and/or common paper birch in the regeneration layer are present. California filbert in the low shrub layer is present. Spreading dogbane and/or Canadian bunchberry are present. Willow species, Sitka mountain ash and thin-leaved mountain alder in the tall shrub layer are absent. Common snowberry in the low shrub layer is absent.
Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38) See page B24.

9b Willow species, Sitka mountain ash and/or thin-leaved mountain alder in the tall shrub layer are present. Common snowberry in the low shrub layer is present. Western white pine and common paper birch in the main tree canopy are absent. California filbert in the low shrub layer is absent. Spreading dogbane and Canadian bunchberry are absent.

10a Rocky Mountain Douglas-fir in the main tree canopy is present. Creambush oceanspray and/or common snowberry in the low shrub layer are present. Heart-leaved arnica is present. Sitka mountain ash in the low shrub layer is absent. Few-flowered one-sided wintergreen and evergreen yellow violet are absent.
Rocky Mountain Douglas-fir - birch-leaved spirea - pine grass - heart-leaved arnica (33a) See page B24.

10b Sitka mountain ash in the low shrub layer is present. Few-flowered one-sided wintergreen and/or evergreen yellow violet are present. Rocky Mountain Douglas-fir in the main tree canopy is absent. Creambush oceanspray and common snowberry in the low shrub layer are absent. Heart-leaved arnica is absent.
Lodgepole pine - rose species - few-flowered one-sided wintergreen - pine grass (33b) See page B24.

4b Western hemlock in the advanced regeneration layer is present. Common saskatoon in the tall shrub layer is absent. Lodgepole pine in the advanced regeneration layer is absent. Lodgepole pine in the advanced regeneration layer is absent. California filbert in the low shrub layer is absent. Fireweed is absent.

11a Rocky Mountain maple in the tall shrub layer is present. One or more of Utah honeysuckle, common saskatoon, creeping Oregon grape or birch-leaved spirea in the low shrub layer are present. Western white pine in the regeneration layer is absent. Devil's club in the low shrub layer is absent. Sweet-scented bedstraw, mountain sweetcicely, common lady fern, oak fern and cucumberroot twisted-stalk are absent.
Western hemlock - Utah honeysuckle - western yew - blue-bead clintonia (20) See page B21.

11b Western white pine in the regeneration layer is present. Devil's club in the low shrub layer is present. One or more of sweet-scented bedstraw, mountain sweetcicely, common ladyfern, oak fern or cucumberroot twisted-stalk are present. Utah honeysuckle, common saskatoon, creeping Oregon grape and birch-leaved spirea in the low shrub layer are absent.
Western hemlock- devil's club - blue-bead clintonia - unifoliate-leaved foamflower (17) See page B21.

3b Alpine fir in the regeneration layer is present. Common paper birch and grand fir in the main tree canopy are absent. California filbert and creambush oceanspray in the tall shrub layer are absent. Wild sarsaparilla is absent.

12a One or more of common paper birch or western larch in the advanced regeneration layer are present. One or more of Scouler's willow or Sitka mountain ash in the tall shrub layer are present. White-flowered rhododendron in the low shrub layer is present. False Solomon's seal and/or blue-leaved wild strawberry are present. Engelmann spruce and alpine fir in the tree canopy are absent. Western white pine in the advanced regeneration layer is absent. Birch-leaved spirea is absent.
Western larch - western red cedar - blue-bead clintonia - evergreen yellow violet (44) See page B25.

12b Engelmann spruce and/or alpine fir in the tree canopy are present. Western white pine in the advanced regeneration layer is present. Birch-leaved spirea is present. Common paper birch and western larch in the advanced regeneration layer are absent. Scouler's willow and Sitka mountain ash in the tall shrub layer are absent. White-flowered rhododendron in the low shrub layer is absent. False Solomon's seal and blue-leaved wild strawberry are absent.

13a Western red cedar and/or western hemlock are present in the tree canopy. Unifoliate-leaved foamflower is present. Lodgepole pine is usually not the taller tree of the tree canopy. Lodgepole pine in the advanced regeneration layer is absent. Willow species in the tall shrub layer are absent. Willow

species and birch-leaved spirea in the low shrub layer are absent. Pine grass and grouseberry are absent.
<u>Western hemlock - alpine fir - black blueberry - evergreen yellow violet</u> (40) See page B25.

13b Lodgepole pine is usually the taller tree of the tree canopy. Lodgepole pine in the advanced regeneration layer is present. Willow species in the tall shrub layer is present. Willow species and/or birch-leaved spirea in the low shrub layer are present. Pine grass and/or grouseberry are present. Western red cedar and western hemlock in the tree canopy are absent. Unifoliate leaved foamflower is absent.
<u>Lodgepole pine - Engelmann spruce - Oregon boxwood - common western pipsissewa</u> (39) See page B25.

2b Ponderosa pine in the main tree canopy is usually present. Mallow ninebark and redstem ceanothus is usually present. Grand fir and western white pine in the main tree canopy are absent. Werstern hemlock in the advanced regeneration layer is absent. Western red cedar and western hemlock in the regenertion layer are absent. Common western pipsissewa, blue-bead clintonia and northern twinflower are absent.

14a Willow species in the tall shrub layer are present. One or more of common juniper, arrow-leaved balsamroot or lance-leaved stonecrop are present. Rocky Mountain maple, common saskatoon and California filbert in the low shrub layer are absent. White hawkweed, Hooker's fairybells and spreading dogbane are absent.
<u>Rocky Mountain Douglas-fir - pine grass - western fescue complex</u> (15) See page B21.

14b One or more of Rocky Mountain maple, common saskatoon or California filbert in the low shrub layer are present. One or more of white hawkweed, Hooker's fairybells or spreading dogbane are present. Willow species in the tall shrub layer are absent. Common juniper, arrow-leaved balsamroot and lance-leaved stonecrop are absent.

15a California filbert in the tall shrub layer is present. One or more of Rocky Mountain maple, California filbert or mallow ninebark in the low shrub layer are present. One or more of Hooker's fairybells, blue wild rye grass or false Solomon's-seal are present. Redstem ceanothus in the tall shrub layer is absent. Common harebell is absent.
<u>Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex</u> (13) See page B20.

15b Redstem ceanothus in the tall shrub layer is present. Common harebell is present. California filbert in the tall shrub layer is absent. Rocky Mountain maple, California filbert and mallow ninebark in the low shrub layer are absent. Hooker's fairybells, blue wild rye grass and false Solomon's seal are absent.
Rocky Mountain Douglas-fir - common snowberry - pine grass - bluebunch wheat grass (11) See page B20.

1b Rocky Mountain Douglas-fir, common paper birch and western white pine in the advanced regeneration layer are absent. Birch-leaved spirea, creeping Oregon grape, soopolallie and western fescue are absent.

16a Sitka mountain alder and/or willow species in the tall shrub layer are present. Red elderberry and/or Sitka mountain alder in the low shrub layer are present. One or more of arrow-leaved ragwort, western white trillium, western meadow-rue, sweet-scented bedstraw, Sitka valerian, green false hellebore, yellow glacier lily, angelica species, rush species or red mountain-heather are present. Western hemlock or western yew in the regeneration layer are absent. Northern twinflower is absent. Lead 16b on page B10

17a Alpine fir and/or Engelmann spruce in the main tree canopy are present. Engelmann spruce and/or western red cedar in the advanced regeneration layer are present. Twinberry honeysuckle and/or western thimbleberry in the low shrub layer are present. Blue-bead clintonia is present. Rush species and red mountain-heather are absent.
Lead 17b on page B9

18a Western hemlock and/or western red cedar in the advanced regeneration layer are present. Oregon boxwood in the low shrub layer is present. Bracted lousewort is present. Common ladyfern, cucumberroot twistedstalk, oak fern and Canada violet are absent.
Engelmann spruce - black swamp gooseberry - western meadow-rue - unifoliate-leaved foamflower (10a) See page B19.

18b One or more of common ladyfern, cucumberroot twistedstalk, oak fern and Canada violet are present. Western hemlock and western red cedar in the advanced regeneration layer are absent. Oregon boxwood in the low shrub layer is absent. Bracted lousewort is absent.
Engelmann spruce - black blueberry - common lady fern - Canada violet (10b) See page B20.

17b Rush species and/or red mountain-heather are present. Alpine fir and Engelmann spruce in the main tree canopy are absent. Engelmann spruce and western red cedar in the

advanced regeneration layer are absent. Twinberry honeysuckle and western thimbleberry in the low shrub layer are absent. Blue-bead clintonia is absent.
<u>White-flowered rhododendron - alpine fir - Merten's cassiope - red mountain heather</u> (5) See page B19.

16b Western hemlock and/or western yew in the regeneration layer are present. Black swamp gooseberry in the low shrub layer is present. Northern twinflower is present. Sitka mountain alder and willow species in the tall shrub layer are absent. Red elderberry and Sitka mountain alder in the low shrub layer are absent. Arrow-leaved ragwort, western white trillium, western meadow-rue, sweet-scented bedstraw, Sitka valerian, green false hellebore, yellow glacier lily, angelica species, rush species and red mountain-heather are absent.

19a Alpine fir and/or Engelmann spruce in the advanced regeneration layer are present. Western red cedar and Rocky Mountain Douglas-fir in the advanced regeneration layer are absent. Western red cedar in the regeneration layer is absent.
<u>Alpine fir - western hemlock - white-flowered rhododendron - blue-bead clintonia - unifoliate-leaved foamflower</u> (1) See page B18.

19b Western red cedar and/or Rocky Mountain Douglas-fir in the advanced regeneration layer are present. Western red cedar in the regeneration layer is present. Alpine fir and Engelmann spruce in the advanced regeneration layer are absent.

20a Western white pine and/or Rocky Mountain Douglas-fir in the main tree canopy are present. Rocky Mountain maple in the tall shrub layer is present. Western yew in the advanced regeneration layer is present. One or more of devil's club, black swamp gooseberry or white-flowered rhododendron in the low shrub layer are present. Western yew in the regeneration layer is present. One or more of common western pipsissewa, false Solomon's seal or common lady fern are present.
<u>Western hemlock - western yew - devil's club - oak fern</u> (4) See page B19.

20b Western white pine and Rocky Mountain Douglas-fir in the main tree canopy are absent. Rocky Mountain maple in the tall shrub layer is absent. Western yew in the advanced regeneration layer is absent. Devil's club, black swamp gooseberry and white-flowered rhododendron in the low shrub layer are absent. Western yew in the regeneration layer is absent. Common western pipsissewa, false Solomon's-seal and common lady fern are absent.
<u>Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner</u> (2) See page B18.

B.1.3. Artificial Key to Common Vegetation Types of the Pend-d'Oreille Valley

1a Trees are absent in the tree canopy. Strictly high elevation above 1800 m in elevation. White-flowered rhododendron - alpine fir - Merten's cassiope - red mountain-heather (5) See page B19.

1b Trees are present in the tree canopy. If absent, then below 1800 m in elevation.

2a Rocky Mountain Douglas-fir and/or ponderosa pine are the only tree(s) present in the tree canopy.

Lead 2b on page B11

3a Willow species in the tall shrub layer are present. One or more of common juniper, arrow-leaved balsamroot or lance-leaved stonecrop are present, usually below 1150 m on rock outcrops or shallow dry soils on morainal materials or colluvium. Rocky Mountain maple, California filbert, Hooker's fairybells and white hawkweed are absent.
Rocky Mountain Douglas-fir - pine grass - western fescue complex (15) See page B21.

3b One or more of Rocky Mountain maple, California filbert, Hooker's fairybells or white hawkweed are present. Willow species in the tall shrub layer are absent. Common juniper, arrow-leaved balsamroot and lance-leaved stonecrop are absent.

4a California filbert in the tall shrub layer is present. One or more of Rocky Mountain maple, California filbert or mallow ninebark in the low shrub layer are present. One or more of Hooker's fairybells, blue wild rye grass or false Solomon's-seal are present. Types are usually found on south or west aspects below 1150 m. Redstem ceanothus in the tall shrub layer is absent. Common harebell is absent.
Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13) See page B20.

4b Redstem ceanothus in the tall shrub layer is present. Common harebell is present. California filbert in the tall shrub layer is absent. Rocky Mountain maple, California filbert and mallow ninebark in the low shrub layer are absent. Hooker's fairybells, blue wild rye grass and false Solomon's-seal are absent. This type occurs more towards the eastern end of the valley.
Rocky Mountain Douglas-fir - common snowberry - pine grass - bluebunch wheat grass (11) See page B20.

2b Trees other than Rocky Mountain Douglas-fir and/or ponderosa pine in the tree canopy are present.

5a Lodgepole pine or lodgepole pine with Rocky Mountain Douglas-fir are the only trees in the main tree canopy. Oregon boxwood, black blueberry and birch-leaved spirea in the low shrub layer are constantly present. These types represent young or maturing seral forests growing back after fire.

Lead 5b on page B12

6a One or more of willow species, thin-leaved mountain alder or Sitka mountain ash in the tall shrub layer is present. Pine grass is present. Western white pine, grand fir and common paper birch in the regenerating layer are absent. California filbert in the low shrub layer is absent. Spreading dogbane and Canadian bunchberry are absent.

Lead 6b on page B12

7a Rocky Mountain Douglas-fir in the main tree canopy is present. Creambush oceanspray and/or common snowberry in the low shrub layer are present. Heart-leaved arnica is present. Sitka mountain ash in the low shrub layer is present. Few-flowered one-sided wintergreen and evergreen yellow violet are absent.
<u>Rocky Mountain Douglas-fir - birch-leaved spirea - pine grass - heart-leaved arnica</u> (33a) See page B24.

7b Sitka mountain ash in the low shrub layer is present. Few-flowered one-sided wintergreen and evergreen yellow violet are present. Rocky Mountain Douglas-fir in the main tree canopy is absent.
<u>Lodgepole pine - rose species - few-flowered one-sided wintergreen - pine grass</u> (33b) See page B24.

6b One or more of western white pine, grand fir or common paper birch in the regenerating layer are present. California filbert in the low shrub layer is present. Spreading dogbane and/or Canadian bunchberry are present. Willow species, thin-leaved mountain alder and Sitka mountain ash in the tall shrub layer are absent. Common snowberry in the low shrub layer is absent. Pine grass is absent.
<u>Lodgepole pine - soopolallie - western bracken - green-stemmed pipecleaner</u> (38) See page B24.

5b Trees other than lodgepole pine or lodgepole pine with Rocky Mountain Douglas-fir are present in the tree canopy. A young or maturing seral forest may be included here.

8a Alpine fir and/or Engelmann spruce are present in the tree canopy. Types are usually found above 1350 m in elevation (if the tree canopy is made up entirely of western hemlock and western red cedar or only western hemlock go to lead 11a on page B13).

Lead 8b on page B14

9a Western white pine and/or Rocky Mountain Douglas-fir in the advanced regeneration layer are present. Birch-leaved spirea in the low shrub layer is usually present. Sitka valerian is absent.

Lead 9b on page B13

10a Lodgepole pine is the taller tree of the tree canopy. Lodgepole pine in the advanced regeneration layer is present. Willow species in the tall shrub layer are present. Willow species and/or birch-leaved spirea in the low shrub layer are present. Pine grass and/or grouseberry are present. Western red cedar and western hemlock in the main tree canopy are absent. Unifoliate-leaved foamflower is absent.
Lodgepole pine - Engelmann spruce - Oregon boxwood - common western pipsissewa (39) See page B25.

10b Western red cedar and/or western hemlock in the main tree canopy are present. Unifoliate-leaved foamflower is present. Lodgepole pine is not the taller tree of the tree canopy. Lodgepole pine in the advanced regeneration layer is absent. Willow species and/or birch-leaved spirea in the low shrub layer are absent. Pine grass and grouseberry are absent.
Western hemlock - alpine fir - black blueberry - evergreen yellow violet (40) See page B25.

9b Sitka valerian is present. Western white pine and Rocky Mountain Douglas-fir in the advanced regeneration layer are absent. Birch-leaved spirea in the low shrub layer is usually absent.

11a Western hemlock and/or western yew in the regeneration layer are present. Black swamp gooseberry in the low shrub layer is present. Northern twinflower is present. Sitka mountain alder in the tall shrub layer is absent. Red elderberry in the low shrub layer is absent. Arrow-leaved ragwort, western meadow-rue, green false hellebore and yellow glacier lily are absent.

Lead 11b on page B14

12a Advanced regeneration of alpine fir and/or Engelmann spruce are present. Regeneration of alpine fir and/or Engelmann spruce are present. Regeneration of western red cedar is absent.

Alpine fir - western hemlock - white-flowered rhododendron - blue-bead clintonia - unifoliate-leaved foamflower (1) See page B18.

12b Regeneration of western red cedar is present. Advanced regeneration of alpine fir and Engelmann spruce is absent. Regeneration of alpine fir and Engelmann spruce is absent.

13a Western white pine and/or Rocky Mountain Douglas-fir in the main tree canopy are present. Western yew in the regeneration layer is present. White-flowered rhododendron and/or black swamp gooseberry are present. Common western pipsissewa and/or false Solomon's-seal are present.
Western hemlock - western yew - devil's club - oak fern (4) See page B19.

13b Western white pine and Rocky Mountain Douglas-fir in the main tree canopy are absent. Western yew in the regeneration layer is absent. White-flowered rhododendron and black swamp gooseberry are absent. Common western pipsissewa and false Solomon's-seal are absent.
Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner (2) See page B18.

11b Sitka mountain alder in the tall shrub layer is present. One or more of arrow-leaved ragwort, western meadow-rue, green false hellebore, and yellow glacier lily are present. Western hemlock and western yew in the regeneration layer are absent. Black swamp gooseberry in the low shrub layer is absent. Northern twinflower is absent.

14a Advanced regeneration of western hemlock and/or western red cedar are present. Oregon boxwood in the low shrub layer is present. Bracted lousewort is present. Common lady fern, cucumberroot twistedstalk, oak fern and Canada violet are absent.
Engelmann spruce - black swamp gooseberry - western meadow-rue - unifoliate-leaved foamflower (10a) See page B19.

14b One or more of common lady fern, cucumberroot twistedstalk, oak fern and Canada violet are present. Advanced regeneration of western hemlock and/or western red cedar are absent. Oregon boxwood in the low shrub layer is absent. Bracted lousewort is absent.
Engelmann spruce - black blueberry - common lady fern - Canada violet (10b) See page B20.

8b Alpine fir and Engelmann spruce are not present in the tree canopy. Types are usually below 1350 m in elevation.

15a Vegetation confined to gullies and seepage areas. Tree canopy and regenerating species are mainly western red cedar and/or western hemlock. One or more of devil's club, Oregon boxwood, western yew, blue-bead clintonia and unifoliate-leaved foamflower occur frequently in the understory.
Western hemlock - devil's club - blue-bead clintonia - unifoliate-leaved foamflower (17) See page B21.

15b Vegetation not confined to gulleys or seepage areas. Devil's club, Oregon boxwood, western yew, blue-bead clintonia and unifoliate-leaved foamflower do not occur frequently in the understory.

16a Grand fir in the main tree canopy is present.

Lead 16b on page B15

17a Western red cedar and/or western hemlock in the main tree canopy are present. Western yew in the regenerating layer is present. Black blueberry in the low shrub layer is present. Common snowberry, California filbert and creambush oceanspray in the low shrub layer are absent.
Western red cedar - Utah honeysuckle - western yew - blue-bead clintonia (20) See page B21.

17b One or more of common snowberry, California filbert or creambush oceanspray in the low shrub layer are present. Western red cedar and western hemlock in the main tree canopy are absent. Western yew in the regenerating layer is absent. Black blueberry in the low shrub layer is absent.
Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26) See page B22.

16b Grand fir in the main tree canopy is absent.

18a Advanced regeneration of alpine fir is present. This type is found on disturbed logged or burned sites usually above 1150 m in elevation.
Western larch - western red cedar - blue-bead clintonia - evergreen yellow violet (44) See page B25.

18b Advanced regeneration of alpine fir is absent. These types are found on disturbed logged or burned sites below 1150 m in elevation.

19a The tree canopy consists of a dense cover of western red cedar, western white pine and Rocky Mountain Douglas-fir. Few herbs are present. Tall shrubs of Rocky Mountain maple and common saskatoon are absent. In the low shrub layer Rocky

Mountain maple, soopolallie and birch-leaved spirea are absent. In the regeneration layer western hemlock and Rocky Mountain Douglas-fir are absent (this rare type occurred in one location).
Western larch - western red cedar - rose species - blue-bead clintonia (30) See page B23.

19b Tall shrubs of Rocky Mountain maple and/or common saskatoon are present. In the low shrub layer Rocky Mountain maple, soopolallie and/or birch-leaved spirea are present. In the regeneration layer western hemlock and/or Rocky Mountain Douglas-fir are present.

20a Trembling aspen and/or common paper birch are the dominant trees in the tree canopy. Advanced regeneration of trembling aspen is present. Fireweed is present. Large-leaved rattlesnake orchid is absent.
Trembling aspen - common paper birch - western thimbleberry - western bracken (24) See page B22.

20b Large-leaved rattlesnake orchid is present. Trembling aspen and common paper birch are not the dominant trees in the tree canopy. Advanced regeneration of trembling aspen is absent. Fireweed is absent.

21a Tree canopy may be largely dominated by lodgepole pine and Rocky Mountain Douglas-fir. Advanced regeneration of lodgepole pine is present. Willow species in the low shrub layer are present. Spreading dogbane is present. Advanced regeneration of grand fir is absent.
Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38) See page B24.

21b Advanced regeneration of grand fir may be present. The tree canopy is not dominated by lodgepole pine and Rocky Mountain Douglas-fir. Advanced regeneration of lodgepole pine is absent. Willow species in the low shrub layer are absent. Spreading dogbane is absent.

22a California filbert in the tall shrub layer is present. California filbert and/or creambush oceanspray in the low shrub layer are present. Blue wild rye grass and/or mountain sweetcicely are present. Black blueberry and soopolallie in the low shrub layer are absent. Western white pine in the regeneration layer is absent.
Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26) See page B22.

22b Black blueberry and/or soopolallie in the low shrub layer are present. Western white pine in the regeneration layer is present. California filbert in the tall shrub layer is absent. California filbert and creambush oceanspray in the low shrub layer are absent. Blue wild rye grass and mountain sweetcicely are absent.
<u>Western larch - western red cedar - western thimbleberry - northern twinflower</u> (32) See page B23.

B.2 Description of the Vegetation Types of the Pend-d'Oreille Valley, B.C.

Alpine fir - western hemlock - white-flowered rhododendron - blue-bead clintonia - unifoliate-leaved foamflower (1)

The tree canopy consists of a more or less open to closed (ranging between 30-70%) cover of Engelmann spruce and alpine fir. A few trees of western hemlock and lodgepole pine may be present. Advanced regeneration species in a more or less open cover are alpine fir, Engelmann spruce and western hemlock. The more or less open to closed low shrub layer consists of black blueberry and white-flowered rhododendron. The regeneration layer consists of western hemlock and alpine fir. Few species are in the herb layer. Those usually present include unifoliate-leaved foamflower, five-leaved creeping raspberry, blue-bead clintonia and few-flowered one-sided wintergreen. This type is found on moderately well drained and well drained Podzolic soils on most materials, on all aspects above 1150 m in elevation, but usually found around 1600 m. It represents maturing seral or maturing climatic climax stages within the western hemlock - western red cedar or Engelmann spruce - alpine fir forest zones. This type is a fairly widespread type at higher elevations in the Pend-d'Oreille Valley.

Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner (2)

The tree canopy consists of a closed (ranging between 60-80%) cover of western hemlock and western red cedar. A few trees of Engelmann spruce and alpine fir may occur in the canopy. Advanced regeneration of western hemlock and western red cedar form an open to more or less open cover. The regeneration layer consists of western hemlock and western red cedar. Few species are in the herb layer. Those usually present include few-flowered one-sided wintergreen, blue-bead clintonia, five-leaved creeping raspberry and unifoliate-leaved foamflower. This type is found on well drained Podzolic soils on most materials. It occurs on all aspects between 1300-1700 m in elevation. It represents maturing seral or maturing climatic climax stages within the western hemlock - western red cedar forest zone. It is a fairly widespread vegetation type in the Pend-d'Oreille Valley.

Western hemlock - western yew - devil's club - oak fern (4)

The tree canopy consists of a closed (ranging between 50-80%) cover of western hemlock and western red cedar. A few trees of Rocky Mountain Douglas-fir, Engelmann spruce and alpine fir may occur. An open to more or less open cover between 2-10 metres in height, is formed mostly by western hemlock, western red cedar, western yew and Rocky Mountain maple. An open to more or less open covered low shrub layer consists of black blueberry, Utah honeysuckle and devil's club. Regenerating species are western hemlock and western red cedar. Few species are in the herb layer. Those usually present include large-leaved rattlesnake orchid, blue-bead clintonia, oak fern, cucumberroot twistedstalk and unifoliate-leaved foamflower. This type is found on imperfectly drained to well drained Podzolic soils on most materials. It is on all aspects from 1150 to 1650 m in elevation. It represents maturing seral or maturing climatic climax stages within the western hemlock - western red cedar forest zone. It is not a widespread vegetation type in the Pend-d'Oreille Valley.

White-flowered rhododendron - alpine fir - Merten's cassiope - red mountain-heather (5)

This type resembles plant communities of the krummholz subzone. There is no tree canopy. Black blueberry, white-flowered rhododendron and creeping juniper make up the low shrub layer. Many species are found in the herb layer. This type is found on wind swept mountain tops on the north side of the Pend-d'Oreille River.

Engelmann spruce - black swamp gooseberry - western meadow-rue - unifoliate-leaved foamflower (10a)

The tree canopy consists of a more or less open to closed (ranging between 25-70%) cover of Engelmann spruce and alpine fir. A few trees of western red cedar can also occur. Advanced regeneration of alpine fir and Engelmann spruce form approximately 20-35% cover. Western red cedar may also be present. The open to very open low shrub layer consists mostly of black blueberry, black swamp gooseberry, western thimbleberry, red elderberry, Utah honeysuckle and white-flowered rhododendron. Many species are present in the herb layer. Common species include blue-bead clintonia, sweet-scented bedstraw, unifoliate-leaved foamflower, mountain sweetcicely and western meadow-rue. This type is found on imperfectly drained to well drained Podzolic soils on most materials. It occurs on all aspects above 1400 m in elevation. It represents maturing seral stages within the western hemlock - western red cedar forest zone. It is not a widespread vegetation type in the Pend-d'Oreille Valley.

Engelmann spruce - black blueberry - common lady fern - Canada violet (10b)

This type is similar to that described above. The tree canopy may be more open. Seepage can be present and there is more competition of species in the herb layer. This type tends to be on more imperfectly drained soils.

Rocky Mountain Douglas-fir - common snowberry - pine grass - bluebunch wheat grass (11)

The tree canopy is an open to closed cover of Rocky Mountain Douglas-fir. A few trees of ponderosa pine may occur. Between 2-10 metres in height, the open to more or less open (ranging between 15-40%) cover consists of Rocky Mountain Douglas-fir, common saskatoon and redstem ceanothus. The more or less open to closed low shrub layer consists of creeping Oregon grape, birch-leaved spirea and redstem ceanothus. Almost always present in the herb layer are bluebunch wheat grass, common yarrow and pine grass. This type is found on well drained to rapidly drained Brunisolic soils usually on morainal materials or colluvium. It occurs usually on south or west aspects below 1150 m in elevation. It represents young seral or maturing seral stages within an edaphic climax of Rocky Mountain Douglas-fir. This type is not as widespread as the above type in the Pend-d'Oreille Valley.

Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)

The tree canopy is an open to closed cover of Rocky Mountain Douglas-fir. A few trees of ponderosa pine may occur. Between 2-10 m in height, the open to more or less open (ranging between 15-40%) cover consists of Rocky Mountain Douglas-fir, California filbert and creambush oceanspray. The more or less open to closed low shrub layer consists of common snowberry, baldhip rose, common saskatoon, creeping Oregon grape, birch-leaved spirea, mallow ninebark and creambush oceanspray. Almost always present in the herb layer are wild strawberry, pine grass and Hooker's fairybells. This type is found on well drained to rapidly drained Brunisolic soils on most materials. It occurs usually on south or west aspects below 1150 m in elevation. It represents young seral, maturing seral or edaphic climax stages within an edaphic climax of Rocky Mountain Douglas-fir. On most of the deeper and moister soils this type has already developed into an edaphic climax, but on the drier, shallower soils usually seral species are still present. This type occurs frequently on south aspects in the Pend-d'Oreille Valley.

Rocky Mountain Douglas-fir - pine grass - western fescue complex (15)

The tree canopy consists of an open (less than 10%) cover of Rocky Mountain Douglas-fir, and/or ponderosa pine, or trees may be absent. Between 2-10 m in height, creambush oceanspray and Rocky Mountain Douglas-fir occupy less than 20% cover. The open to more or less open low shrub layer consists of common saskatoon, creeping Oregon grape, creambush oceanspray, mallow ninebark and birch-leaved spirea. Numerous species are present in the herb layer. Species almost always present include kinnikinnik, common yarrow, pine grass, western fescue, bluebunch wheat grass and lance-leaved stonecrop. This type is found on well drained to rapidly drained Brunisolic or Regosolic soils on either rock outcrops, morainal materials or colluvium. It occurs usually on south or west aspects below 1150 m in elevation. It represents pioneer seral or young seral stages within an edaphic climax of Rocky Mountain Douglas-fir. On the drier, shallow soils, this type will probably remain as a pioneer community of herbs and shrubs. On the wetter, deeper soils this type will take the form of an edaphic climax stand of Rocky Mountain Douglas-fir. This type occurs throughout the Pend-d'Oreille Valley.

Western hemlock - devil's club - blue-bead clintonia - unifoliate-leaved foamflower (17)

The tree canopy consists of a closed (ranging between 50-80%) cover of western red cedar and western hemlock. A few trees of grand fir, Rocky Mountain Douglas-fir and western white pine may occur in the canopy. Advanced regeneration of western hemlock and western red cedar form between 25-50% cover. Western yew and grand fir may be present as well. The more or less open (ranging between 25-50%) covered low shrub layer consists mostly of western hemlock, western red cedar, Oregon boxwood and devil's club. Numerous herbs are present in this type. Blue-bead clintonia, unifoliate-leaved foamflower, common western pipsissewa and northern twinflower are usually present. This type is found on imperfectly drained Brunisolic and Podzolic soils mainly on fluvial materials. It is on all aspects from 650-1300 m in elevation. It represents maturing seral to maturing climatic climax stages within the western hemlock - western red cedar forest zone. It is a fairly widespread vegetation type in the Pend-d'Oreille Valley confined mostly to fluvial gulleys.

Western hemlock - Utah honeysuckle - western yew - blue-bead clintonia (20)

The tree canopy consists of a more or less open to closed (ranging between 40-80%) cover of western hemlock, western red cedar, western white pine, common paper birch, western larch, Rocky Mountain Douglas-fir, and grand fir. Advanced regeneration of western hemlock, western red cedar and common paper birch form approximately 20-40% cover. The more or less open (approximately 25-50%) low shrub layer consists of western hemlock, western red cedar, Utah honeysuckle, Oregon boxwood, Rocky Mountain maple, birch-leaved spirea and western yew. The open to closed (approximately 10-60%) cover in the herb layer consists of large-leaved rattlesnake orchid, common western pipsissewa, northern twinflower, blue-bead clintonia and false Solomon's-seal. This type is found on moderately well drained to well drained Dystric Brunisolic, Luvisolic and Podzolic soils on most materials. It is on all aspects from 650 to 1500 m in elevation. It represents young seral or maturing seral stages within the western hemlock - western red cedar forest zone. It is a widespread vegetation type in the Pend-d'Oreille Valley.

Trembling aspen - common paper birch - western thimbleberry - western bracken (24)

The tree canopy consists of a more or less open to closed (ranging between 20-60%) cover of common paper birch and trembling aspen. A few trees of western larch, lodgepole pine, Rocky Mountain Douglas-fir, and/or western white pine may occur in the canopy. Many species make up an open cover and occur in the advanced regeneration and tall shrub layer. The more common species are western red cedar, Rocky Mountain maple, common paper birch, western white pine, California filbert, common saskatoon and trembling aspen. The usually somewhat open (ranging between 25-50%) low shrub layer contains many species, Oregon boxwood, western thimbleberry, common saskatoon, creeping Oregon grape and soopolallie are almost always present. The usually dense herb layer consists of common western pipsissewa, blue-bead clintonia, western bracken and fireweed. This type is found on well drained Brunisolic and Podzolic soils, usually on fluvial materials, on all aspects from 650 to 1300 m in elevation. It represents young seral or maturing seral stages within the grand fir - western red cedar or western hemlock - western red cedar forest zones. This vegetation type is not widespread in the Pend-d'Oreille Valley.

Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)

The tree canopy consists of a closed (ranging between 50-70%) cover of western white pine, common paper birch and Rocky Mountain Douglas-fir. Grand fir, trembling aspen and lodgepole pine may occur in small amounts in the canopy. Advanced regeneration of Rocky Mountain Douglas-fir, common paper birch and grand fir and tall shrubs of California filbert and Rocky Mountain maple form approximately 25-35% cover. The cover of the low shrub layer is open and is made up mostly of Rocky Mountain maple, western thimbleberry, California filbert, common snowberry, baldhip rose, common saskatoon, creeping Oregon grape and birch-leaved spirea. Numerous herb species are present in this type. Common western pipsissewa, blue-bead clintonia, white hawkweed, Hooker's fairybells, and western meadow-rue are usually present in the herb layer. This type is found on well drained

Dystric Brunisolic, Luvisolic and Podzolic soils on most materials. It occurs usually on east or south aspects from 650 to 1100 m in elevation. It represents young seral or maturing seral stages within the grand fir - western red cedar forest zones. It is a widespread vegetation type in the Pend-d'Oreille Valley.

Western larch - western red cedar - rose species - blue-bead clintonia (30)

The tree canopy consists of a closed cover of western red cedar, western white pine, western larch and Rocky Mountain Douglas-fir. Advanced regeneration of western red cedar and Rocky Mountain Douglas-fir form up to 50% cover. The more or less open (ranging between 25-50%) cover in the low shrub layer consists of western red cedar, Oregon boxwood, western thimbleberry, western white pine, baldhip rose, common saskatoon and creeping Oregon grape. The forest floor is strewn with litter and few herbs are present. The dominant ones are northern twinflower, few-flowered one-sided wintergreen, blue-bead clintonia and evergreen violet. This type is found on well drained Brunisolic soils on morainal materials or colluvium. It has been observed on an east or north aspect between 650-1000 m in elevation. It represents young seral or maturing seral stages within the grand fir - western red cedar forest zone. It has been recorded only once in the Pend-d'Oreille Valley. This type is not considered common.

Western larch - western red cedar - western thimbleberry - northern twinflower (32)

The tree canopy has a somewhat open to closed (ranging between 35-70%) cover of common paper birch, western larch and Rocky Mountain Douglas-fir. A few trees of western red cedar, western white pine, lodgepole pine and trembling aspen may occur in the canopy. Advanced regeneration of western red cedar, common paper birch, Rocky Mountain Douglas-fir and grand fir forms between 10-35% cover. Western hemlock and western white pine may also occur in small amounts. The more or less open low shrub layer has many species present. Utah honeysuckle, black blueberry, Oregon boxwood, Rocky Mountain maple, western thimbleberry, soopolallie, baldhip rose, common saskatoon, birch-leaved spirea and creeping Oregon grape are present. Many species occur in the herb layer. Large-leaved rattlesnake orchid, common western pipsissewa, northern twinflower, few-flowered one-sided wintergreen, blue-bead clintonia and white hawkweed are present. This type is found on well drained Dystric Brunisolic, Luvisolic and Podzolic soils, on most materials, on all aspects, from 650 to 1300 m in elevation. It represents young seral or maturing seral stages within the grand fir - western red cedar or western hemlock - western red cedar forest zones. It is a widespread vegetation type in the Pend-d'Oreille Valley.

Rocky Mountain Douglas-fir - birch-leaved spirea - pine grass - heart-leaved arnica (33a)

The tree canopy consists of an open to closed (ranging between 20-70%) cover of lodgepole pine. A few trees of Rocky Mountain Douglas-fir may occur. In the advanced regeneration layer the open cover consists mainly of lodgepole pine and Rocky Mountain Douglas-fir. Rocky Mountain maple, common saskatoon, Sitka mountain ash, thin-leaved mountain alder and willow species may be present in the tall shrub layer. The open, low shrub layer consists of black blueberry, Oregon boxwood, baldhip rose, birch-leaved spirea and common saskatoon. Many species are present in the herb layer. Species usually always present include common western pipsissewa, white hawkweed, Hooker's fairybells and pine grass. This type is found on moderately well drained to rapidly drained Podzolic and Brunisolic soils on most materials. It is usually on south or west aspects above 1000 m in elevation. It represents young seral stages within the western hemlock - western red cedar forest zone. It is not a widespread vegetation type in the Pend-d'Oreille Valley.

Lodgepole pine - rose species - few-flowered one-sided wintergreen - pine grass (33b)

Vegetation type 33b occurs usually at a higher elevation than vegetation type 33a. The absence of Rocky Mountain Douglas-fir in the tree canopy is an important keying characteristic. This group is very similar to that of vegetation type 33a.

Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)

The tree canopy consists of a more or less open to closed (approximately 30-60%) cover of lodgepole pine and Rocky Mountain Douglas-fir. Western white pine, common paper birch and western larch may occur in small amounts in the tree canopy. The more or less open (ranging between 25-50%) cover of the advanced regeneration layer consists of western red cedar, western white pine, common paper birch, Rocky Mountain Douglas-fir, western hemlock and lodgepole pine. The partly open low shrub layer is abundant with species, the commonest ones being black blueberry, Oregon boxwood, western thimbleberry, soopolallie and birch-leaved spirea. The herb layer consists of white hawkweed, blue-bead clintonia, few-flowered one-sided wintergreen, northern twinflower and large-leaved rattlesnake orchid. This type is found on well drained Brunisolic and Podzolic soils on most materials, but predominantly on fluvial parent materials. It is on all aspects from 650 to 1150 m in elevation. It represents young seral or maturing seral stages within the grand fir - western red cedar or western hemlock - western red cedar forest zones. It is a fairly widespread vegetation type in the Pend-d'Oreille Valley.

Lodgepole pine - Engelmann spruce - Oregon boxwood - common western pipsissewa (39)

Lodgepole pine is usually the taller tree of the tree canopy. The more or less open tree canopy is dominated by lodgepole pine. A few trees of western white pine, Rocky Mountain Douglas-fir, Engelmann spruce and alpine fir may occur. Advanced regeneration of alpine fir, and Engelmann spruce form open to more or less open cover. A few trees of Rocky Mountain Douglas-fir and western hemlock may be present. The open to more or less open low shrub cover is dominated by black blueberry, Oregon boxwood and birch-leaved spirea. In the usually open herb layer common western pipsissewa, evergreen yellow violet and white hawkweed are almost always present. This type is found on moderately well drained to rapidly drained Podzolic and Brunisolic soils on most materials, on all aspects from 1300 to 1950 m in elevation. It represents young seral or maturing seral stages within the western hemlock - western red cedar forest zone. It is not to widespread a vegetation type in the Pend-d'Oreille Valley.

Western hemlock - alpine fir - black blueberry - evergreen yellow violet (40)

The tree canopy consists of a closed (ranging between 50-80%) cover of western white pine, western larch, Rocky Mountain Douglas-fir, western red cedar, alpine fir, western hemlock and Engelmann spruce. Advanced regeneration of western hemlock, western red cedar and alpine fir form variable covers. The open to more or less open low shrub layer consists of Utah honeysuckle, black blueberry, and Oregon boxwood. The regeneration layer is formed by western hemlock, western red cedar, alpine fir and Engelmann spruce. Few herbs make up the herb layer, including unifoliate-leaved foamflower, large-leaved rattlesnake orchid, evergreen yellow violet, northern twinflower and blue-bead clintonia. This type is found on well drained Podzolic and Brunisolic soils on most materials, on all aspects between 1150-1700 m in elevation. It represents young seral or maturing seral stages within the western hemlock - western red cedar forest zone. It is a widespread type in the Pend-d'Oreille Valley.

Western larch - western red cedar - blue-bead clintonia - evergreen yellow violet (44)

The tree canopy consists of an open to more or less open (ranging between 5-40%) cover of western larch and Rocky Mountain Douglas-fir. Advanced regeneration of western hemlock and western red cedar form approximately 20-50% cover. Rocky Mountain Douglas-fir, Engelmann spruce and alpine fir may occur in small amounts. A more or less open to closed (approximately 35% or greater) cover of black blueberry, Utah honeysuckle, Oregon boxwood, and western thimbleberry form the low shrub layer. Numerous herbs are present in this type. Those usually present include blue-bead clintonia, evergreen yellow violet, few-flowered one-sided wintergreen and fireweed. This type is found on well drained Podzolic soils on most materials between 1150 and 1650 m in elevation. It represents young seral stages within the western hemlock - western red cedar forest zone. This vegetation type is not widespread in the Pend-d'Oreille Valley.

B.3 Major Succession Trends and Their Relation to Soils, Aspect and Causal Factors

Vegetation types are listed in Table B.1 for each soil type in which they commonly occur. Additional vegetation types may occur within the soil types because of inclusions. An asterisk(*) beside the vegetation type indicates the vegetation type(s) is (are) characteristic of the soil type.

The successional vegetation that may establish following a disturbance is dependent on a large number of conditions. Therefore, it is difficult to predict with a high degree of confidence what vegetation will occur after any one disturbance. In the table, the "Causal Factors" for each successional stand were determined after the fact. The user is advised to use the information in reverse (i.e., to predict the successional pattern following certain site treatments) with considerable discretion.

How to Use the Table

STEP 1 The user must identify the soil type of concern. This is located in the "Soil Type" column (e.g., the user is interested in soil M1).

Soil Type	Aspect	Causal Factors	Early Seral
M1			
M2			
M3			
M4			
M5			

STEP 2 Identify the aspect of the site under consideration and then proceed to the aspect column to locate the desired aspect (e.g., the user is interested in a south aspect).

Soil Type	Aspect	Causal Factors	Early Seral
M1	south		
M2			
M3			

STEP 3 Identify the causal factor of concern. Within the aspect range previously identified, proceed to the causal factor column to locate the desired causal factor (e.g., the causal factor is a severe burn).

Soil Type	Aspect	Causal Factors	Early Seral
M1	south	severe burn	
M2			
M3			

STEP 4 Within the causal factor boundary is a list of vegetation types and their habitat characteristics. More detailed habitat characteristics for each vegetation type can be found in "Vegetation of the Nelson (NTS 82F) Area" (van Barneveld, in progress).

Table B.1.

MAJOR SUCCESSION TRENDS AND THEIR RELATION TO SOILS, ASPECT, AND CAUSAL FACTORS OF THE PEND-D'OREILLE VALLEY, B.C.

Script indicates vegetation types which could occur on the soil type but were not observed during the study.

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPE
M1	South	severe burn	Trembling aspen - common paper birch - western thimbleberry - western bracken (24) Note: Moisture indicating species in this vegetation type, such as common paper birch and western red cedar are absent.	-south facing slopes -insolation -summer drought -on fine to medium textured well drained materials	Rocky Mountain Douglas-fir common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on medium to coarse textured well drained materials	An edaphic climax of Rocky Mountain Douglas-fir. Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)* Note: Seral lodgepole pine and ponderosa pine which can occur in this vegetation type are absent.
			Rocky Mountain Douglas-fir - pine grass - western fescue complex (15)	-south facing slopes -insolation -summer drought -on very shallow well drained soils			
		light burn	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -drier environment than type (11)	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -drier environment than type (11)	An edaphic climax of Rocky Mountain Douglas-fir. Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)* Note: Seral lodgepole pine which can occur in this vegetation type are absent
			*Rocky Mountain Douglas-fir - common snowberry - pine grass - bluebunch wheat grass (11)**	-south facing slopes -insolation -summer drought -wetter environment than type (13)	*Rocky Mountain Douglas-fir - common snowberry - pine grass - bluebunch wheat grass (11)**	-south facing slopes -insolation -summer drought -a wetter environment than type (13)	
		accumulative effect of repetitive burns	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on medium to coarse textured well drained materials			Rocky Mountain Douglas-fir - pine grass - western fescue complex (15) Note: On steep slopes with shallow soils or on rock outcrops this vegetation type will remain as a community of herbs and shrubs with a few scattered trees.
M2	All aspects	severe burn	Trembling aspen - common paper birch - western thimbleberry - western bracken (24)* Note: Moisture indicating species in this vegetation type, such as common paper birch and	-on medium to fine textured well drained materials -warm to hot summer temperature -an extended growing season			*A climatic climax of grand fir - western red cedar. No climax stands were found during the study.*

Table B.1.: (Continued)

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPE
M2 cont'd	All aspects cont'd		and western red cedar, present.				
			Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)	-on medium to coarse well drained materials -warm to hot summer temperatures -an extended growing season	Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)	-on medium to coarse well drained materials. -warm to hot summer temperatures -an extended growing season	
		Light burn or clear-cut Selective logging	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)*	-on well drained materials -warm to hot summer temperatures -an extended growing season -a drier environment than type (32)	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)*	-on well drained materials -warm to hot summer temperatures -an extended growing season -a drier environment than type (32)	*A climatic climax of grand fir - western red cedar. No climax stands were found during the study.*
			Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on moderately well drained materials -warm to hot summer temperatures -an extended growing season -a wetter environment than type (26)	Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on moderately well drained materials -warm to hot summer temperatures -an extended growing season -a wetter environment than type (26)	
M3	All aspects	Severe burn	Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)	-on well drained materials -moderately mild to cool temperatures -on coarser materials and lower in elevation than type (33b)	Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)	-on well drained materials -moderate mild to cool temperatures	*A climatic climax of hemlock - red cedar. Engelmann spruce - western hemlock - cucumberroot twisted stalk - green-stemmed pipecleaner (2)* *Note: Seral lodgepole pine, Engelmann spruce and alpine fir, which can occur in this vegetation type are absent.*
			Lodgepole pine - rose species - few-flowered one-sided wintergreen (33b)*	-on well drained materials -moderately mild to cool temperatures -on finer materials and higher in elevation than type (38)			
		Lightburn or clear-cut Selective logging	Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on well drained materials -moderately mild to cool temperatures -on deep Brunisolic Grey Luvisols	Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on well drained materials -moderately mild to cool temperatures -a drier environment than type (20)	*A climatic climax of western hemlock - western red cedar. Engelmann spruce - western hemlock - cucumberroot twisted stalk - green-stemmed pipecleaner (2)* *Note: Seral lodgepole pine, Engelmann spruce and alpine fir, which can occur in this type are absent.*

Table B.1.: (Continued)

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPE
M3 cont'd					Western red cedar - Utah honeysuckle - western yew blue-bead clintonia (20)*	-on moderately well drained materials -moderately mild to cool temperatures -decaying organic layer is an important source of nutrients -a wetter environment than type (32)	
M4	All aspects	Severe burn	Lodgepole pine - rose species-few-flowered one-sided wintergreen (33b)	-on well drained materials -moderately cool temperatures -lower in elevation than type (39)			A climatic climax of western hemlock - western red cedar. Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner (2)* Note: Seral lodgepole pine, Engelmann spruce and alpine fir which can occur in this vegetation type are absent.
			Lodgepole pine - Engelmann spruce - Oregon boxwood - common western pipsissewa (39)*	-on well drained materials -moderately cool temperatures -higher in elevation than type (33b)	Lodgepole pine - Engelmann spruce - Oregon boxwood - common western pipsissewa (39)*	-on well drained materials -moderately cool temperatures	
		Lightburn or clear-cut Selective logging	Western larch - western red cedar - blue-bead clintonia - evergreen yellow violet (44)*	-on well drained materials -moderately cool temperatures -on deep podzolic soils -usually above 1150 m elevation			A climatic climax of western hemlock - western red cedar. Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner (2)* Note: Seral lodgepole pine, Engelmann spruce and alpine fir which can occur in this type are absent.
			Western hemlock - alpine fir - black blueberry - evergreen yellow violet (40)*	-on well drained materials -moderately cool temperatures -on deep podzolic soils -usually above 1300 m elevation	Western hemlock - alpine fir - black blueberry - evergreen yellow violet (40)*	-on well drained materials -moderately cool temperatures -on deep podzolic soils	
					Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner (2)*	-on well drained materials -moderately cool temperatures -on podzolic soils with a rich organic layer	

Table B.1.: (Continued)

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPE
M4	All aspects cont'd	Lightburn or clear-cut Selective logging cont'd	Engelmann spruce - black swamp gooseberry - western meadow-rue - unifoliate - leaved foamflower (10a)	-on moderately well to well drained materials -on deep strongly acidic podzolic soils above 1600 m elevation -cool temperatures and short growing days -a drier environment than type (10b)	Engelmann spruce - black swamp gooseberry - western meadow rue - unifoliate-leaved foamflower (10a)	-on moderately well to well drained materials -on deep strongly acidic podzolic soils above 1600 m elevation -cool temperatures and short growing days -a drier environment than type (10b)	*A climatic climax of western hemlock - western red cedar. Western hemlock - western yew - devil's club - oak fern (4) Note: Seral western white pine, Rocky Mountain Douglas-fir, Engelmann spruce and alpine fir which can occur in this vegetation type are absent.*
			Engelmann spruce - black blueberry - common lady fern - Canada violet (10b)	-on imperfectly drained to well drained materials -on deep strongly acidic podzolic soils above 1600 m elevation -cool temperatures and short growing days -a wetter environment than type (10a)	Engelmann spruce - black blueberry - common lady fern - Canada violet (10b)	-on imperfectly drained to well drained materials -on deep strongly acidic podzolic soils above 1600 m elevation -cool temperatures and short growing days -a wetter environment than type (10a)	
					Western hemlock - western yew - devil's club - oak fern (4)	-on well drained materials -on deep podzolic soils with a rich organic layer	
M5	All aspects	Burns and harsh climate conditions	Engelmann spruce - black swamp gooseberry - western meadow-rue - unifoliate - leaved foamflower (10a)*	-on well drained materials -on deep podzolic soils above 1600 m elevation -deep snow accumulation	Engelmann spruce - black swamp gooseberry - western meadow-rue - unifoliate-leaved foamflower (10a)*	-on well drained materials -on deep podzolic soils above 1600 m elevation -deep snow accumulation	*A climatic climax of western hemlock - western red cedar or subalpine Engelmann spruce - alpine fir. Note: The regenerating species potential will determine the climax.*
					Alpine fir - western hemlock - white-flowered rhododendron - unifoliate - leaved foamflower (1)*	-on well drained materials above 1600 m elevation -podzolic soils -cool temperatures and short growing days -deep snow accumulation	
F1	South	Severe burn	Trembling aspen - common paper birch - western thimbleberry - western bracken (24)* Note: Moisture indicating species in this vegetation type, such as common paper birch and western red cedar absent.	-south facing slopes -insolation -summer drought -on medium textured well drained materials	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on medium to coarse textured well drained materials	An edaphic climax of Rocky Mountain Douglas-fir. Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex. (13)*

Table B.1.: (Continued)

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPES
F1 cont'd			Rocky Mountain Douglas-fir - pine grass - western fescue complex (15)	-south facing slopes -insolation -summer drought -on very shallow well drained materials			
		Lightburn	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on medium to coarse textured well drained materials	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on medium to coarse textured well drained materials	An edaphic climax of Rocky Mountain Douglas-fir. Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)* Note: Seral lodgepole pine and ponderosa pine which can occur in this vegetation type are absent.
		Accumulative effect of repetitive burns	Rocky Mountain Douglas-fir - common snowberry - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on medium to coarse textured well drained materials			Rocky Mountain Douglas-fir - pine grass - western fescue complex (15) Note: On steep slopes with shallow soils this vegetation type will remain as a community of herbs and shrubs with a few scattered trees.
F2	All aspects	Severe burn	*Trembling aspen - common paper birch - western thimbleberry - western bracken (24)** *Note: Moisture indicating species in this vegetation type, such as common paper birch and western red cedar, present.*	-on medium textured well drained materials. -warm to hot summer temperatures -an extended growing season			*A climatic climax of grand fir - western red cedar. No climax stands were found during the study.*
			Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)*	-on medium to coarse well drained materials -warm to hot summer temperatures -an extended growing season	Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)	-on medium to coarse well drained materials -warm to hot summer temperatures -an extended growing season	
		Lightburn or clear-cut Selective logging	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)*	-on well drained to rapidly drained materials -warm to hot summer temperatures -an extended growing season -a drier environment than type (32)	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweet-cicely (26)*	-on well drained to rapidly drained materials -warm to hot summer temperatures -an extended growing season -a drier environment than type (32)	*A climatic climax of grand fir - western red cedar. No climax stands were found during the study.*

Table B.1.: (Continued)

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPES
F2 cont'd	All aspects cont'd	Lightburn or clear-cut Selective logging cont'd	Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on well drained materials -warm to hot summer temperatures -an extended growing season -a wetter environment than type (26)	Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on well drained materials -warm to hot summer temperatures -an extended growing season -a wetter environment than type (26)	
F3	All aspects	Severe burn	Trembling aspen - common paper birch - western thimbleberry - western bracken (24) Note: Moisture indicating species in this vegetation type, such as common paper birch and western red cedar, present.	-on medium textured well drained materials -warm to hot summer temperature -an extended growing season			*A climatic climax of grand fir - western red cedar. No climax stands were found during the study.*
			Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)*	-on well drained materials -on medium to coarse materials -warm to hot summer temperatures -an extended growing season	Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)*	-on well drained materials -on medium to coarse materials -warm to hot summer temperatures -an extended growing season	
		Lightburn or clear-cut Selective logging	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)*	-on well drained to rapidly drained materials -warm to hot summer temperatures -an extended growing season -a drier environment than type (32)	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)*	-on well drained to rapidly drained materials -warm to hot summer temperatures -an extended growing season -a drier environment than type (32)	*A climatic climax of grand fir - western red cedar. No climax stands were found during the study.*
			Western larch - western red cedar - thimbleberry - northern twinflower (32)*	-on well drained materials -warm to hot summer temperatures -an extended growing season	Western larch - western red cedar - thimbleberry - northern twinflower (32)*	-on well drained materials -warm to hot summer temperatures -an extended growing season -a drier environment than type (26)	
F4	All aspects	Lightburn or clear-cut Selective logging	Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on well drained to rapidly drained materials -moderately mild to cool temperatures -on deep brunisolic soils	Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on well drained to rapidly drained materials -moderately mild to cool temperatures -a drier environment than type (20)	*A climatic climax of western hemlock - western red cedar. Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed*

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Table B.1.: (Continued)

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPES
F4 cont'd					Western red cedar - Utah honeysuckle - western yew - blue-bead clintonia (20)	-on well drained materials -moderately mild to cool temperatures -decaying organic layer is an important source of nutrients -a wetter environment than type (32)	*pipecleaner* (2) *Note: Seral lodgepole pine, Engelmann spruce and alpine fir, which can occur in this vegetation type are absent.*
					Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner (2)	-on well drained materials -moderately mild to cool temperatures	
					Western hemlock - devil's club - bluebead clintonia - unifoliate - leaved foam-flower (17)	-on well drained materials -moderately mild to cool temperatures -on soils with a rich organic layer	*A climatic climax of western hemlock - western red cedar.* *Western hemlock - western yew devil's club - oak fern* (4) *Note: Seral western white pine, Rocky Mountain Douglas-fir, Engelmann spruce and alpine fir, which can occur in this vegetation type are absent.*
					Western hemlock - western yew - devil's club - oak fern (4)	-on well drained materials -moderately mild to cool temperatures -on deep soils with a rich organic layer	
F5	All aspects	Lightburn or clear-cuts Selective logging	Western larch - western red cedar - western thimbleberry - northern twinflower (32)	-on well drained to rapidly drained materials -moderately mild to cool temperatures -on deep soils	Western larch - western red cedar - western thimbleberry - northern twinflower (32)	-on well drained to rapidly drained materials -moderately mild to cool temperatures -a drier environment than type (20)	*A climatic climax of western hemlock - western red cedar.* *Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner* (2) *Note: Seral lodgepole pine, Engelmann spruce and alpine fir which can occur in this vegetation type are absent.*
					Western red cedar - Utah honeysuckle - western yew a blue-bead clintonia (20)*	-on well drained materials -decaying organic layer is an important source of nutrients -moderately mild to cool temperatures -a wetter environment than type (32)	
					Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner (2)*	-on well drained materials -moderately mild to cool temperatures	

Table B.1.: (Continued)

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPES
F5 cont'd	All aspects	Lightburn or clear-cuts Selective logging cont'd			Western hemlock - devil's club - blue-bead clintonia - unifoliate - leaved foamflower (17)*	-on well drained materials -moderately mild to cool temperatures -on soils with rich organic layer	A climatic climax of western hemlock - western red cedar. Western hemlock - western yew - devil's club - oak fern (4)* Note: Seral western white pine, Rocky Mountain Douglas-fir, Engelmann spruce and alpine fir, which can occur in this vegetation type are absent.
					Western hemlock - western yew - devil's club - oak fern (4)*	-on well drained materials -moderately mild to cool temperatures -on deep soils with a rich organic layer	
L1		Severe burn	Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)*	-on fine textured materials -a drier environment than type (32)	Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)*	-on fine textured materials -a drier environment than type (32)	*A climatic climax of grand fir - western red cedar or western hemlock - western red cedar. Note: The regeneration species potential will determine the climax.*
		Lightburn or clear-cut Selective logging	Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on fine textured materials -a wetter environment than type (38)	Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on fine textured materials -a drier environment than type (20)	*A climatic climax of grand fir - western red cedar or western hemlock - western red cedar. Note: The regenerating species potential will determine the climax.*
					Western red cedar - Utah honeysuckle - western yew - blue-bead clintonia (20)*	-on fine textured materials -a wetter environment than type (32)	*A climatic climax of western hemlock - western red cedar. Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner* (2) *Note: Seral lodgepole pine, Engelmann spruce and alpine fir, which can occur in this vegetation type are absent.*
					Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner (2)	-on fine textured materials	
			Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)*	-on fine textured materials -a dry environment	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)*	-on fine textured materials -a dry environment	*A climatic climax of grand fir - western red cedar. No climax stands were found during the study.*
C1	South	Severe burn	Rocky Mountain Douglas-fir - pine grass - western fescue complex (15)*	-south facing slopes -insolation -summer drought -on very shallow well drained soils	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on well drained materials	An "edaphic" climax of Rocky Mountain Douglas-fir. Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)* Note: Seral lodgepole

Table B.1.: (Continued)

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPES
C1 cont'd			*Trembling aspen - common paper birch - western thimbleberry - western bracken* (24) *Note: Moisture indicating species in this vegetation type, such as common paper birch and western red cedar are absent.*	-south facing slopes -insolation -summer drought -on fine to medium textured well drained materials			pine and ponderosa pine which can occur in this vegetation type are absent.
		Lightburn	Rocky Mountain - Douglas -fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on well drained materials	Rocky Mountain - Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on well drained materials	An edaphic climax of Rocky Mountain Douglas-fir. Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)* Note: Seral lodgepole pine and ponderosa pine which can occur in this vegetation type are absent.
		Accumulative effect of repetitive burns	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on well drained materials			Rocky Mountain Douglas-fir - pine grass - western fescue complex (15)* Note: On steep slopes with shallow soils or on rock outcrops this vegetation type will remain as a community of herbs and shrubs with a few scattered trees.
C2	South	Severe burn	Trembling aspen - common paper birch - western thimbleberry - western bracken (24) Note: Moisture indicating species in this vegetation type, such as common paper birch and western red cedar are absent.	-south facing slopes -insolation -summer drought -on fine to medium textured well drained materials	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on well drained materials	An edaphic climax of Rocky Mountain Douglas-fir. Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)* Note: Seral lodgepole pine and ponderosa pine which can occur in this vegetation type are absent.
			Rocky Mountain Douglas-fir - pine grass - western fescue complex (15)*	-south facing slopes -insolation -summer drought -on very shallow well drained soils			
		Lightburn	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -a drier environment than type (11)	Rocky Mountain Douglas-fir -common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -a drier environment than type (11)	An edaphic climax of Rocky Mountain Douglas-fir. Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)* Note: Seral Lodgepole pine and ponderosa pine which can occur in the vegetation type are absent.

Table B.1.: (Continued)

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPES
C2 cont'd			Rocky Mountain Douglas-fir - common snowberry - pine grass - bluebunch wheat grass (11)*	-south facing slopes -insolation -summer drought -a wetter environment than type (13)	Rocky Mountain Douglas-fir - common snowberry - pine grass - bluebunch wheat grass (11)*	-south facing slopes -insolation -summer drought -a wetter environment than type (13)	
		Accumulative effect of repetitive burns	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)	-south facing slopes -insolation -summer drought -on well drained materials			Rocky Mountain Douglas-fir - pine grass - western fescue complex (15) Note: On steep slopes with shallow soils or on rock outcrops this vegetation type will remain as a community of herbs and shrubs with a few scattered trees.
C3	All aspects	Severe burn	Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)	-on medium to coarse well drained materials -warm to hot summer temperatures -an extended growing season	Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)	-on medium to coarse well drained materials -warm to hot summer temperatures -an extended growing season	*A climatic climax of grand fir - western red cedar. No climax stands were found during the study.*
		Lightburn or clear-cut Selective logging	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)*	-on well drained to rapidly drained materials -warm to hot summer temperatures -an extended growing season -a drier environment than type (32)	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)*	-on well drained to rapidly drained materials -warm to hot summer temperatures -an extended growing season -a drier environment than type (32)	*A climatic climax of grand fir - western red cedar. No climax stands were found during the study.*
			Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on well drained materials -warm to hot summer temperatures -an extended growing season	Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on well drained materials -warm to hot summer temperatures -an extended growing season -a wetter environment than type (26)	
C4	All aspects	Severe burn	Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)	-on medium to coarse well drained materials -moderately mild to cool temperatures -lower in elevation than type (33b)	Western red cedar - Utah honeysuckle - western yew blue-bead clintonia (20)	-on well drained materials -moderately mild to cool temperatures	*A climatic climax of western hemlock - western red cedar, Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner* (2)

Table B.1.: (Continued)

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPES
C4 cont'd			Lodgepole pine - rose species - few flowered one-sided wintergreen (33b)*	-on well drained materials -moderately mild to cool temperatures -higher in elevation than type (38)			*Note: Seral lodgepole pine, Engelmann spruce and alpine fir, which can occur in this vegetation type are absent.*
		Lightburn or clear-cut Selective logging	Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on well drained materials -moderately mild to cool temperatures -on deep soils	Western larch - western red cedar - western thimbleberry - northern twinflower (32)*	-on well drained materials -moderately mild to cool temperatures -a drier environment than type (20)	*A climatic climax of western hemlock - western red cedar. Engelmann spruce - western hemlock - cucumberroot twisted-stalk - green stemmed pipecleaner (2)*
					Western red cedar - Utah honeysuckle - western yew - blue-bead clintonia (20)*	-on well drained materials -moderately mild to cool temperatures -a wetter environment than type (32)	*Note: Seral lodgepole pine, Engelmann spruce and alpine fir, which can occur in this vegetation type are absent.*
C5	South to south-west aspects	Lightburn	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)	-south facing slopes -insolation -summer drought -on rapidly drained materials -a drier environment than type (32)	Rocky Mountain Douglas-fir common snowberry - Hooker's fairybells - mountain sweetcicely (26)	-south facing slopes -insolation -summer drought -on rapidly drained materials -on shallow soils and a drier environment than type (32)	*An edaphic climax of grand fir - western red cedar. No climax stands were found during the study.*
			Western larch - western red cedar - western thimbleberry - northern twinflower (32)	-south facing slopes -insolation -summer drought -on rapidly drained materials -on deeper soils and a wetter environment than type (26)	Western larch - western red cedar - western - thimbleberry - northern twinflower (32)	-south facing slopes -insolation -summer drought -on rapidly drained materials -a wetter environment than type (26)	
			Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)	-south facing slopes -insolation -summer drought -a drier environment than (26) and (32)	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -a drier environment than (26) and (32)	An edaphic climax of Rocky Mountain Douglas-fir. Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)* Note: Seral lodgepole pine and ponderosa pine which can occur in this vegetation type are absent.
		Severe burn	Rocky Mountain Douglas-fir - pine grass - western fescue complex (15)*	-south facing slopes -insolation -summer drought -on very shallow well drained soils	Rocky Mountain Douglas-fir - pine grass - western fescue complex (15)*	-south facing slopes -insolation -summer drought -on very shallow well drained soils	An edaphic climax of Rocky Mountain Douglas-fir. Rocky Mountain Douglas-fir - common snowberry - Hooker's

Table B.1.: (Continued)

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPES
C5 Cont'd	South to south-west aspects cont'd		Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on rapidly drained materials	Rocky Mountain Douglas-fir - common snowberry Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on rapidly drained materials	fairybells - pine grass complex (13)* Note: Seral lodgepole pine and ponderosa pine which can occur in this vegetation type are absent.
			Rocky Mountain Douglas-fir - birch-leaved spirea - pine grass - heart-leaved arnica (33a)*	-south facing slopes -insolation -summer drought -on rapidly drained materials			
		Accumu-lative effect of repetitive burns	Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)*	-south facing slopes -insolation -summer drought -on rapidly drained materials			Rocky Mountain Douglas-fir - pine grass - western fescue complex (15) On steep slopes with shallow soils or on rock outcrops this vegetation type will remain as a community of herbs and shrubs with a few scattered trees.
C6	All aspects	Severe burn	Lodgepole pine - rose species - few-flowered one-sided wintergreen (33b)	-on well drained materials -moderately cool temperatures -lower in elevation than type (39)			A climatic climax of western hemlock - western red cedar. Engelmann spruce - western hemlock - cucumberroot twisted-stalk - green-stemmed pipe-cleaner (2)* Note: Seral lodgepole pine, Engelmann spruce and alpine fir which can occur in this vegetation type are absent.
			Lodgepole pine - Engelmann spruce - Oregon boxwood - common western pipsissewa (39)*	-on well drained materials -moderately cool temperatures -higher in elevation than type (33b)	Lodgepole pine - Engelmann spruce - Oregon boxwood - common western pipsissewa (39)*		
		Lightburn or clear-cut Selective logging	Western larch - western red cedar - blue-bead clintonia - evergreen yellow violet (44)*	-on well drained materials -moderately cool temperatures -on deep podzolic soils -usually above 1150 m elevation			A climatic climax of western hemlock - western red cedar. Engelmann spruce - western hemlock - cucumberroot twisted-stalk - green-stemmed pipeclean-er (2)* Note: Seral lodgepole pine, Engelmann spruce and alpine fir which can occur in this vegeta-tion type are absent.
			Western hemlock - alpine fir - black blueberry - evergreen yellow violet (40)*	-on well drained materials -moderately cool temperatures -on deep podzolic soils -usually above 1300 m elevation	Western hemlock - alpine fir - black blueberry - evergreen yellow violet (40)*	-on well drained materials -moderately cool temperatures -on deep podzolic soils	
					Engelmann spruce - western hemlock - cucumberroot	-on well drained materials	

Table B.1.: (Continued)

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPES
C6 cont'd					twistedstalk - green-stemmed pipecleaner (2)*	-moderately cool temperatures -on podzolic soils with a rich organic layer	
			Engelmann spruce - black swamp gooseberry - western meadow-rue - unifoliate -leaved foamflower (10a)	-on moderately well to well drained materials -on deep strongly acidic podzolic soils above 1600 m elevation -cool temperatures and short growing days -a drier environment than type (10b)	Engelmann spruce - black swamp gooseberry - western meadow-rue - unifoliate -leaved foamflower (10a)	-on moderately well to well drained materials -on deep strongly acidic podzolic soils above 1600 m elevation -cool temperatures and short growing days -a drier environment than type (10b)	
		Lightburn or clear-cut Selective logging cont'd	Engelmann spruce - black blueberry - common lady fern - Canada violet (10b)	-on imperfectly drained to well drained materials -on deep strongly acidic soils above 1600 m elevation -cool temperatures and short growing days -a wetter environment than type (10a)	Engelmann spruce - black blueberry - common lady fern - Canada violet (10b)	-on imperfectly drained to well drained materials -on deep strongly acidic soils above 1600 m elevation -cool temperatures and short growing days -a wetter environment than type (10a)	*A climatic climax of western hemlock - western red cedar. Western hemlock - western yew - devil's club - oak fern. (4)* *Note: Seral western white pine, Rocky Mountain Douglas-fir, Engelmann spruce and alpine fir which can occur in this vegetation type are absent.*
					Western hemlock - western yew - devil's club - oak fern (4)	-on well drained materials -on deep podzolic soils with a rich organic layer	
C7	All aspects	Burns and harsh climatic conditions	Engelmann spruce - black swamp gooseberry - western meadow-rue - unifoliate - leaved foamflower (10a)*	-on well to well drained materials -on deep podzolic soils above 1600 m elevation -deep snow accumulation	Engelmann spruce - black swamp gooseberry - western meadow-rue - unifoliate - leaved foamflower (10a)*	-on well to well drained materials -on deep podzolic soils above 1600 m elevation -deep snow accumulation	*A climatic climax of western hemlock - western red cedar or subalpine Engelmann spruce - alpine fir.* *Note: The regenerating species potential will determine the climax.*
					Alpine fir - western hemlock - white-flowered rhododendron - unifoliate - leaved foamflower (1)*	-on well drained materials above 1600 m elevation -podzolic soils -cool temperatures and short growing days -deep snow accumulation	

Table B.1.: (Continued)

SOIL TYPE	ASPECT	CAUSAL FACTOR	EARLY SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	MATURING SERAL VEGETATION TYPES	HABITAT CHARACTERISTICS	CLIMAX VEGETATION TYPES
C8	Open	Burns and harsh climatic conditions	White-flowered rhododendron - alpine fir - Merten's cassiope - red mountain-heather (5)*	-on shallow well drained soils -wind exposure -deficit in summer moisture -cool temperatures and short growing days			*A climatic climax of subalpine Engelmann spruce - alpine fir*
		Accumulative effect of repetitive burns and harsh climatic conditions					White-flowered rhododendron - alpine fir - Merten's cassiope - red mountain-heather (5) Note: This vegetation type will remain as a community of herbs and shrubs.
	South	Accumulative effect of repetitive burns, toxic smelter fumes and severe soil erosion on south aspects	Rocky Mountain Douglas-fir - pine grass - western fescue complex (15) Note: Due to extremely shallow soils and summer drought this community is the first to establish. In time this community will succeed to a climatic climax	-on shallow well drained soils -deficient in summer moisture			*A climatic climax of western hemlock - western red cedar.* There was no evidence at the time of the study to suggest that the climax will be western hemlock - western red cedar. It is felt that due to the high elevation, the climax will be western hemlock - western red cedar.
0	All aspects mainly open	seepage or collecting sites		Note: Only two sites were found in the valley during the study Site 1: An edaphic climax characterized by sedge species, common cattail, watersmartweed and reed canary grass. Site 2: Western hemlock - devil's club - blue-bead clintonia - unifoliate - leaved foamflower (17) Due to construction disturbance this site is a poor representative of this vegetation type.			

B.4 Vegetation Cover and White-tailed Deer Winter Food Preference Species for Each Vegetation Type

The data used for Table B.2 has been extracted from "Vegetation of the Nelson (82F) Area" (van Barneveld, in progress). The table shows the vegetation cover and the white-tailed deer winter food preference species in the Pend-d'Oreille for each vegetation type.

Vegetation Cover (Table B.2a)

Vegetation cover is divided into three parts:

i) % Crown Cover

ii) % Shrub Cover

iii) % Herb Cover

i) % Crown Cover was used to find the amount of snowfall interception by the tree canopy. (See Table B.3 for results). The crown cover is the vegetation cover in the dominant tree canopy. The average % crown cover and the typical % crown cover are presented in the table.

The average % crown cover is: $\left(\sum_{1=1}^{n} CC \right) \Big/ N$ in which:

CC = % crown cover in the main tree canopy of a plot of a vegetation type

N = total number of plots in the vegetation type

Due to low sampling intensities, the average % crown cover may not represent the typical crown cover for the vegetation type, the typical % crown cover was estimated. This is a subjective estimate based on field observations.

ii) % Shrub Cover was used as an index to the hiding cover for deer. (See Table B.3 for results). The shrub cover is the woody vegetation cover below 10 m.

The average % shrub cover and typical % shrub cover are presented in the table.

The average shrub cover is: $\left(\sum_{1=1}^{n} SC \right) \Big/ N$ in which:

SC = % shrub cover of a plot of a vegetation type

N = total number of plots in a vegetation type

Due to low sampling intensities, the average % shrub cover may not represent the typical shrub cover for the vegetation type, the typical % shrub cover was estimated. This is a subjective estimate based on field observations.

iii) % Herb Cover was used as an aid in rating the Winter Forage Species Potential for each vegetation type (see Table B.3 for results).

The herb cover is the vegetation cover in the herbaceous layer. This does not include the roots and stems of woody plants which are present in the herbaceous layer.

The average % herb cover and typical % herb cover are presented in the table.

The average herb cover is: $\left(\sum_{1=1}^{n} HC \right) \Big/ N$ in which:

HC = % herb cover for a plot of a vegetation type

N = total number of plots in a vegetation type

White-tailed Deer Winter Food Preference Species (Table B.2b)

This table was used to determine the presence of winter forage species in each vegetation type. Overall assessments are provided on Table B.3 in Appendix B.5 and on Table 4.2 in Chapter Four.

The species listed are placed into three preference classes: high, medium, and low. This is based on field observations of the B.C. Fish and Wildlife Branch as indicated on Table 4.1 in Chapter Four.

The average % cover figure presented is the average % cover for each species in the vegetation type.

$\left(\sum_{1=1}^{n} PC \right) \Big/ N$ in which:

PC = % cover of the species for a plot of a vegetation type

N = total number of plots in the vegetation type

The % constancy figure presented reflects the % chance of that species occurring in the vegetation type.

Because the average % herb cover may not represent the typical herb cover for the vegetation type, the typical herb cover was estimated. This is a subjective estimate based on field observations.

Table B.2.

VEGETATION COVER AND WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE
(Data extracted from van Barneveld, in progress)

Vegetation Type	Number of Plot Samples/Type
Alpine fir - Western hemlock - white-flowered rhododendron - unifoliate-leaved foamflower (1)	12

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	40	37	70	62	30	50

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus			1	8				
common saskatoon					1	8		
Oregon-grape								
western red cedar	2	8	1	17	1	8		
Rocky Mountain Douglas-fir								
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp								
rose spp								
American red blackberry								
Oregon boxwood					5	50		
kinnikinnick								
western red-osier dogwood								
Low Preference Species								
California filbert								
common paper birch								
grand fir								
creambush oceanspray								
Lewis' mock-orange								
ninebark								
red elderberry								
soopolallie								

Table B.2. (Continued)

Vegetation Type

Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipecleaner (2)

Number of Plot Samples/Type

8

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	80	81	20	26	30	44

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus common saskatoon Oregon-grape western red cedar Rocky Mountain Douglas-fir blue grass spp bluebunch wheat grass	13	75	4	75	3	63		
Medium Preference Species								
willow spp rose spp American red blackberry Oregon boxwood kinnikinnick western red-osier dogwood					3	38		
Low Preference Species					1	13		
California filbert common paper birch grand fir creambush oceanspray Lewis' mock-orange ninebark red elderberry soopolallie								

Table B.2. (Continued)

Vegetation Type

Western hemlock - western yew-devil's club-oak fern (4)

Number of Plot Samples/Type

11

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	65	68	40	38	50	53

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus								
common saskatoon					1	9		
Oregon-grape								
western red cedar	12	82	5	73	6	91		
Rocky Mountain Douglas-fir	1	36			1	9		
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp								
rose spp								
American red blackberry								
Oregon boxwood					3	64		
kinnikinnick								
western red-osier dogwood					1	9		
Low Preference Species								
California filbert								
common paper birch								
grand fir								
creambush oceanspray								
Lewis' mock-orange								
ninebark								
red elderberry								
soopolallie								

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
White-flowered rhododendron - alpine fir - Merten's cassiope - red mountain heather (5)	6

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	0	5	5	12	90	86

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus								
common saskatoon								
Oregon-grape								
western red cedar								
Rocky Mountain Douglas-fir								
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp					1	33		
rose spp								
American red blackberry								
Oregon boxwood								
kinnikinnick								
western red-osier dogwood								
Low Preference Species								
California filbert								
common paper birch								
grand fir								
creambush oceanspray								
Lewis' mock-orange								
ninebark								
red elderberry								
soopolallie								

Table B.2. (Continued)

Vegetation Type

Engelmann spruce - black swamp gooseberry - western meadow-rue - unifoliate-leaved foamflower (10a)

Number of Plot Samples/Type

12

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	40	44	50	48	80	76

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus								
common saskatoon								
Oregon-grape								
western red cedar	2	17	2	33	1	17		
Rocky Mountain Douglas-fir	1	8						
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp								
rose spp								
American red blackberry								
Oregon boxwood					4	67		
kinnikinnick								
western red-osier dogwood								
Low Preference Species								
California filbert								
common paper birch								
grand fir								
creambush oceanspray								
Lewis' mock-orange								
ninebark								
red elderberry								
soopolallie					1	42		

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
Engelmann spruce - black blueberry - common lady fern - Canada violet (10b)	8

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	40	44	60	59	95	95

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus								
common saskatoon								
Oregon-grape								
western red cedar								
Rocky Mountain Douglas-fir								
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp								
rose spp								
American red blackberry					1	25		
Oregon boxwood								
kinnikinnick								
western red-osier dogwood								
Low Preference Species								
California filbert								
common paper birch								
grand fir								
creambush oceanspray								
Lewis' mock-orange								
ninebark								
red elderberry					2	63		
soopolallie								

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
Rocky Mountain Douglas-fir - common snowberry - pine grass - bluebunch wheat grass (11)	12

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	10	29	60	58	85	85

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus			2	42	3	67		
common saskatoon			3	67	5	83		
Oregon-grape					10	100		
western red cedar								
Rocky Mountain Douglas-fir	15	100	11	92	2	58		
blue grass spp								
bluebunch wheat grass							9	75
Medium Preference Species								
willow spp					1	8		
rose spp					2	75		
American red blackberry					2	8		
Oregon boxwood					1	58		
kinnikinnick							2	33
western red-osier dogwood								
Low Preference Species								
California filbert								
common paper birch								
grand fir			1	8				
creambush oceanspray			6	67	8	58		
Lewis' mock-orange					3	25		
ninebark					2	33		
red elderberry								
soopolallie					1	8		

Table B.2. (Continued)

Vegetation Type
Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)

Number of Plot Samples/Type
11

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	40	36	60	61	50	51

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus					1	18		
common saskatoon			2	45	5	91		
Oregon-grape					7	100		
western red cedar								
Rocky Mountain Douglas-fir	24	91	10	91	2	64		
blue grass spp							1	27
bluebunch wheat grass							1	18
Medium Preference Species								
willow spp			1	9				
rose spp					7	91		
American red blackberry								
Oregon boxwood					2	55		
kinnikinnick							2	18
western red-osier dogwood								
Low Preference Species								
California filbert			2	36	4	36		
common paper birch			1	9	1	9		
grand fir								
creambush oceanspray			5	55	6	64		
Lewis' mock-orange					2	27		
ninebark					8	45		
red elderberry								
soopolallie					1	9		

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
Rocky Mountain Douglas-fir - pine grass - western fescue complex (15)	4

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	0	1	30	24	90	81

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus			1	25	1	25		
common saskatoon					6	100		
Oregon-grape					2	75		
western red cedar								
Rocky Mountain Douglas-fir	3	50	5	75	2	50		
blue grass spp								
bluebunch wheat grass							6	75
Medium Preference Species								
willow spp			2	25	2	50		
rose spp					1	25		
American red blackberry								
Oregon boxwood					2	50		
kinnikinnick								
western red-osier dogwood								
Low Preference Species								
California filbert								
common paper birch								
grand fir								
creambush oceanspray			2	25	4	50		
Lewis' mock-orange								
ninebark					9	75		
red elderberry								
soopolallie								

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
Western hemlock - devil's club - blue-bead clintonia - unifoliate-leaved foamflower (17)	10

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	70	71	30	28	70	72

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus								
common saskatoon					1	10		
Oregon-grape					1	10		
western red cedar	12	70	13	100	7	100		
Rocky Mountain Douglas-fir	2	40						
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp					1	10		
rose spp					1	40		
American red blackberry								
Oregon boxwood					3	90		
kinnikinnick								
western red-osier dogwood					1	10		
Low Preference Species								
California filbert			1	20				
common paper birch	1	20	1	10				
grand fir	2	20	3	30	2	30		
creambush oceanspray								
Lewis' mock-orange								
ninebark								
red elderberry								
soopolallie					1	20		

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
Western red cedar - Utah honeysuckle - western yew - blue-bead clintonia (20)	7

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	70	64	50	54	40	37

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus			1	14				
common saskatoon					1	71		
Oregon-grape					2	71		
western red cedar	15	57	25	100	8	100		
Rocky Mountain Douglas-fir	14	71	2	29				
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp			1	14				
rose spp					2	71		
American red blackberry								
Oregon boxwood					18	86		
kinnikinnick								
western red-osier dogwood								
Low Preference Species								
California filbert			1	14				
common paper birch	6	57	2	43				
grand fir	4	43	1	29	3	14		
creambush oceanspray								
Lewis' mock-orange								
ninebark								
red elderberry					1	14		
soopolallie								

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
Trembling aspen - common paper birch - western thimbleberry - western bracken (24)	10

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	40	35	70	79	60	62

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus			1	20	2	30		
common saskatoon			3	50	6	100		
Oregon-grape					3	60		
western red cedar			3	40	2	40		
Rocky Mountain Douglas-fir	1	20	3	40	2	60		
blue grass spp							1	10
bluebunch wheat grass								
Medium Preference Species								
willow spp			8	60	5	70		
rose spp					1	50		
American red blackberry					1	10		
Oregon boxwood					13	100		
kinnikinnick							2	30
western red-osier dogwood								
Low Preference Species								
California filbert			2	40	3	60		
common paper birch	13	50	6	60	2	40		
grand fir	1	10			1	20		
creambush oceanspray			1	10	1	20		
Lewis' mock-orange					1	10		
ninebark					13	60		
red elderberry								
soopolallie								

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)	8

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	50	55	60	47	50	53

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus					1	13		
common saskatoon			3	50	3	75		
Oregon-grape					7	100		
western red cedar	1	13	3	38	1	38		
Rocky Mountain Douglas-fir	25	100	7	63	2	50		
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp			1	26	1	13		
rose spp					6	88		
American red blackberry								
Oregon boxwood					2	50		
kinnikinnick							1	13
western red-osier dogwood					1	13		
Low Preference Species								
California filbert			4	63	7	75		
common paper birch	9	75	10	75	4	63		
grand fir	6	25	5	63	1	38		
creambush oceanspray			1	13	3	63		
Lewis' mock-orange					1	25		
ninebark								
red elderberry								
soopolallie								

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
Western larch - western red cedar - rose species - blue-bead clintonia (30)	2

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	60	68	40	85	20	40

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus								
common saskatoon					3	100		
Oregon-grape					3	100		
western red cedar	8	100	30	100	24	100		
Rocky Mountain Douglas-fir	20	100	8	100				
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp			2	50				
rose spp					8	100		
American red blackberry								
Oregon boxwood					12	100		
kinnikinnick								
western red-osier dogwood								
Low Preference Species								
California filbert								
common paper birch	4	50	4	50				
grand fir			4	50	2	50		
creambush oceanspray								
Lewis' mock-orange								
ninebark								
red elderberry								
soopolallie								

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
Western larch - western red cedar - western thimbleberry - northern twinflower (32)	7

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	50	49	60	60	50	54

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus								
common saskatoon			1	43	3	86		
Oregon-grape					2	57		
western red cedar	4	29	5	86	3	57		
Rocky Mountain Douglas-fir	15	86	8	86	3	86		
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp			1	14				
rose spp					3	100		
American red blackberry								
Oregon boxwood					8	86		
kinnikinnick								
western red-osier dogwood								
Low Preference Species								
California filbert			1	14	1	14		
common paper birch	4	71	3	57	1	14		
grand fir			2	43	1	29		
creambush oceanspray					1	14		
Lewis' mock-orange								
ninebark					1	14		
red elderberry								
soopolallie					8	71		

Table B.2. (Continued)

Vegetation Type

Rocky Mountain Douglas-fir - birch-leaved spirea - pine grass - heart-leaved arnica (33a)

Number of Plot Samples/Type

2

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	40	20	50	63	80	80

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus								
common saskatoon			8	100	8	100		
Oregon-grape					2	100		
western red cedar								
Rocky Mountain Douglas-fir	8	100	8	100	2	100		
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp			3	100	1	100		
rose spp					3	100		
American red blackberry								
Oregon boxwood					1	50		
kinnikinnick							2	100
western red-osier dogwood								
Low Preference Species								
California filbert								
common paper birch								
grand fir	1	50						
creambush oceanspray			1	50	2	100		
Lewis' mock-orange								
ninebark					1	50		
red elderberry								
soopolallie					1	50		

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
Lodgepole pine - rose species - few-flowered one-sided wintergreen - pine grass (33b)	6

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	40	40	60	73	40	25

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus								
common saskatoon			1	33	5	100		
Oregon-grape					2	66		
western red cedar			1	17	1	50		
Rocky Mountain Douglas-fir			6	66	2	66		
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp			6	83	4	100		
rose spp					7	100		
American red blackberry					13	83		
Oregon boxwood							1	17
kinnikinnick								
western red-osier dogwood								
Low Preference Species								
California filbert								
common paper birch								
grand fir								
creambush oceanspray								
Lewis' mock-orange					2	50		
ninebark								
red elderberry								
soopolallie					3	66		

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)	8

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	50	42	60	74	70	65

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus			1	13	1	13		
common saskatoon			1	25	2	50		
Oregon-grape					2	50		
western red cedar			14	75	4	63		
Rocky Mountain Douglas-fir	3	50	6	75	4	88		
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp			3	63	2	38		
rose spp					3	63		
American red blackberry								
Oregon boxwood					13	88		
kinnikinnick							1	25
western red-osier dogwood								
Low Preference Species								
California filbert			2	38	2	38		
common paper birch	2	38	5	75	2	63		
grand fir					1	25		
creambush oceanspray			1	13	1	13		
Lewis' mock-orange								
ninebark								
red elderberry								
soopolallie					20	88		

Table B.2. (Continued)

Vegetation Type

Lodgepole pine - Engelmann spruce - Oregon boxwood - common western pipsissewa (39)

Number of Plot Samples/Type

13

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	40	40	50	66	50	37

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus								
common saskatoon					1	31		
Oregon-grape					1	23		
western red cedar			1	15	1	31		
Rocky Mountain Douglas-fir	2	46	2	46	2	23		
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp			1	38	2	54		
rose spp					1	8		
American red blackberry								
Oregon boxwood					22	100		
kinnikinnick								
western red-osier dogwood								
Low Preference Species								
California filbert								
common paper birch								
grand fir								
creambush oceanspray								
Lewis' mock-orange								
ninebark								
red elderberry								
soopolallie					2	23		

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
Western hemlock - alpine fir - black blueberry - evergreen yellow violet (40)	9

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	60	60	70	76	40	31

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus								
common saskatoon					1	22		
Oregon-grape					1	11		
western red cedar	2	33	8	78	7	78		
Rocky Mountain Douglas-fir	14	67	2	33				
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp					1	22		
rose spp					1	11		
American red blackberry								
Oregon boxwood					17	100		
kinnikinnick								
western red-osier dogwood								
Low Preference Species								
California filbert								
common paper birch								
grand fir			1	11				
creambush oceanspray								
Lewis' mock-orange								
ninebark								
red elderberry								
soopolallie								

Table B.2. (Continued)

Vegetation Type	Number of Plot Samples/Type
Western larch - western red cedar - blue-bead clintonia - evergreen yellow violet (44)	6

Table B.2a: VEGETATION COVER OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Cover Component	% Tree Cover		% Shrub Cover		% Herb Cover	
	Typical	Average	Typical	Average	Typical	Average
% Crown Cover	15	18	90	86	40	60

Table B.2b: WHITE-TAILED DEER WINTER FOOD PREFERENCE SPECIES OF THE PEND-D'OREILLE VALLEY FOR EACH VEGETATION TYPE

Species	Average Cover in Tree Layer	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer between 2-10 M	% Constancy (% chance of occurrence)	Average % Cover in Shrub Layer below 2 M	% Constancy (% chance of occurrence)	Average % Cover in Herb Layer	% Constancy (% chance of occurrence)
High Preference Species								
redstem ceanothus								
common saskatoon					1	33		
Oregon-grape								
western red cedar	1	17	13	83	11	83		
Rocky Mountain Douglas-fir	4	50	3	67	2	33		
blue grass spp								
bluebunch wheat grass								
Medium Preference Species								
willow spp			4	67	3	50		
rose spp								
American red blackberry								
Oregon boxwood					31	100		
kinnikinnick							1	17
western red-osier dogwood					10	17		
Low Preference Species								
California filbert					1	17		
common paper birch			2	33				
grand fir								
creambush oceanspray					1	17		
Lewis' mock-orange								
ninebark								
red elderberry								
soopolallie					7	17		

B.5 Vegetation Interpretations for White-tailed Deer Habitat Management

Explanation of ratings used in Table B.3:

i) Rate of Succession

Factors considered when rating succession were:

a) the number of regenerating tree species present on the site

b) the vigour of the regenerating species

c) the time and type of disturbance on the site

d) the physical characteristics of the site (i.e., elevation, aspect, slope, depth to bedrock, moisture regime)

If the rate of succession of the site being sampled seemed to best typify the rate of succession exemplified throughout the valley, it was rated as normal. Any deviation from normal resulted in one of the other ratings.

VS - very slow

S - slow

N - normal

R - rapid

VR - very rapid

ii) Snow Interception by Tree Canopy

The mobility of deer and the availability of forage species is restricted by snowdepth. Snow interception by tree canopy is rated as follows:

L (low) - <40% tree cover

M (moderate) - 40-60% tree cover

H (high) - >60% tree cover

iii) Shrub Density

The mobility of deer and their hiding cover from predators is affected by shrub cover density. Shrub density is rated as follows:

L (low) - <20% shrub cover

M (moderate) - 20-40% shrub cover

H (high) - >40% shrub cover

iv) Presence of Winter Forage Species and Winter Forage Species Potential

Factors considered when rating winter forage species and winter forage species potential were:

a) Table B.2b - "White-tailed Deer Winter Food Preference Species of the Pend-d'Oreille Valley for each vegetation type

b) rate of succession for each vegetation type

c) field observations

If the presence of winter forage species and the winter forage species potential on the site being sampled seemed to best typify the presence of winter forage species and the winter forage species potential exemplified throughout the valley, it was rated as moderate. Any deviation from moderate resulted in one of the other ratings.

VL - very low

L - low

M - moderate

H - high

VH - very high

v) Interpretations of Vegetation Types for the Management of White-tailed Deer Habitat are based on field observations of the plant ecologist and discussions with the wildlife biologist. On site inspections are needed to refine these interpretations.

Table B.3.

INTERPRETATIONS OF VEGETATION TYPES OF THE PEND-D'OREILLE VALLEY FOR THE MANAGEMENT OF WHITE-TAILED DEER HABITAT

Vegetation Type	Elevation (m)	Aspect	Rate Of Succession	Snow Interception By Tree Canopy	Shrub Cover Density	Presence Of Winter Forage Species	Winter Forage Species Potential	Interpretations Of Vegetation Types For The Management For White-Tailed Deer Habitat
Alpine fir-western hemlock - white-flowered rhododendron - unifoliate-leaved foamflower (1)	>1600	all aspects	S	L-M	H	L	L	Cool temperatures, deep snows, short growing days and high podzolized soils limit forage and browse productivity. This type is found above the winter ranges.
Engelmann spruce - western hemlock - cucumberroot twisted stalk - green-stemmed pipecleaner (2)	1300-1700	all aspects	N	H	L	L	L-M	Opening of the tree canopy will cause an increase in western red cedar regeneration. The well developed moss layer and the decaying organic materials of the forest floor are important in supplying the site continually with nutrients. The moss layer and decaying organic material should not be disturbed. This type is found above the winter range.
Western hemlock - western yew - devil's club - oak fern (4)	1150-1650	all aspects	N-R	H	M-H	L	L-M	Opening of the tree canopy will cause an increase in western red cedar regeneration. The well developed moss layer and the decaying organic material of the forest floor are important in supplying the site continually with nutrients. The moss layer and decaying organic material should not be disturbed. This type is found above the winter range.
White-flowered rhododendron - alpine fir - Mertin's cassiope - red mountain-heather (5)	>1650	south to open	VS	VL	VL	VL	VL	The combined effect of wind exposure, shallowness of soils and rapid drainage because of convex shape of the slopes, frequently renders these sites deficient in summer moisture. The cool temperatures, deep snows and short growing days limit forage and browse productivity.

Table B.3.: (Continued)

Vegetation Type	Elevation (m)	Aspect	Rate Of Succession	Snow Interception By Tree Canopy	Shrub Cover Density	Presence Of Winter Forage Species	Winter Forage Species Potential	Interpretations Of Vegetation Types For The Management For White-Tailed Deer Habitat
Engelmann spruce-black swamp gooseberry - western meadow-rue - unifoliate-leaved foamflower (10a)	>1400	all aspects	N	M-L	H	L	L	The cool temperatures, relatively short growing days and strongly acidic soils limit browse and forage productivity. Excessive wetness may provide watering opportunities.
Engelmann spruce - black blueberry - common lady fern - Canada violet (10b)	>1400	all aspects	N	M-L	H	L	L	The cool temperatures, relatively short growing days and strongly acidic soils limit browse and forage productivity. Excessive wetness may provide watering opportunities.
Rocky Mountain Douglas-fir - common snowberry - pine grass - bluebunch wheat grass (11)	<1300	south to west	S-N	L	H	VH	VH	These sites occur on steep south to west facing slopes with shallow soils or on rock outcrops. Insolation permits availability of browse in late fall and early spring. Marginal snow depths require maintenance of canopy cover. Planting, widely-spaced apart, of Rocky Mountain Douglas-fir and/or ponderosa pine will reduce snow depth. The abundance of browse species may be improved through seeding, planting, fertilizing or light spring burns. Short time moisture availability requires careful timing of treatments. Faulty timing will lead to soil erosion and site destruction. Weeds can become a problem on disturbed sites.
Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)	<1300	south	S-N	L-M	H	H	H	These sites occur on shallow or deeper soils on south facing slopes. Insolation permits availability of browse in late fall and early spring. Available tree cover will keep snow depths minimal. On sites with canopy cover 60%, thinning may be permitted to improve browse. Browse values will further improve by seeding, planting, fertilizing or light spring burns. Faulty

Table B.3.: (Continued)

Vegetation Type	Elevation (m)	Aspect	Rate Of Succession	Snow Interception By Tree Canopy	Shrub Cover Density	Presence Of Winter Forage Species	Winter Forage Species Potential	Interpretations Of Vegetation Types For The Management For White-Tailed Deer Habitat
								timing may result in soil erosion and site destruction. Weed invasion can become a problem on disturbed sites.
Rocky Mountain Douglas-fir - pine grass - western fescue complex (15)	<1300	south	VS	L	M	H-VH	VH	These sites occur on steep south facing slopes with shallow soils or on rock outcrops. Insolation permits availability of browse in late fall and early spring. Marginal snowdepths require maintenance of canopy cover. Planting, widely-spaced Rocky Mountain Douglas-fir and/or ponderosa pine will reduce snowdepth. The abundance of browse species may be improved through seeding, planting, fertilizing or light spring burns. Short time moisture availability requires careful timing of treatments. Faulty timing will lead to soil erosion and site destruction. Weeds can become a problem on disturbed sites.
Western hemlock - devil's club - blue-bead clintonia - unifoliate-leaved foam-flower (17)	650-1300	all aspects	R-N	H	M	L	L	Opening of the tree canopy will cause an increase in western red cedar regeneration and other browse species. The moss layer and decaying organic material should not be disturbed. The tree canopy must be maintained to reduce snowdepths in spring and fall. Proximity to creeks may provide watering opportunities. Hiding cover is important.
Western red cedar - Utah honeysuckle - western yew - blue-bead clintonia (20)	650-1500	all aspects	N	H	H	M	H	Opening of tree canopy will cause an increase in western red cedar regeneration and other browse species. The decaying organic materials of the forest floor are an important source of nutrients and should not be disturbed. Canopy cover must be maintained to reduce snowdepths.

Table B.3.: (Continued)

Vegetation Type	Elevation (m)	Aspect	Rate Of Succession	Snow Interception By Tree Canopy	Shrub Cover Density	Presence Of Winter Forage Species	Winter Forage Species Potential	Interpretations Of Vegetation Types For The Management For White-Tailed Deer Habitat
Trembling aspen - common paper birch - western thimbleberry - western bracken (24)	650-1300	all aspects	N	L	H	VH	VH	On south aspects insolation permits availability of browse in late fall and early spring. Available tree cover will keep snow depths minimal. Browse species may be improved through seeding, planting, fertilizing or light spring burns. Times of treatment is crucial. Faulty timing may result in soil erosion and site destruction. Weed invasion can become a problem.
Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - mountain sweetcicely (26)	650-1100	all aspects	N	M-H	H	H	H	This vegetation type is frequently found adjacent to four vegetation types (types 11,13,15,24) which are rich in browse species but of limiting snowdepths. In areas where browse is abundant the canopy should not be thinned. Where browse is significant, light canopy thinning to increase understory growth may be desired. The abundance of browse can be increased through fertilizing or burning in spring a light scarification on stable materials can also increase the availability of browse species. Weed invasion can become a problem on sites next to open waste areas.
Western larch - western red cedar - rose species - blue-bead clintonia (30)	650-1100	east	N	H	H	L-M	M	This vegetation type was recorded once during the study. Interpretations are tentative.

Table B.3.: (Continued)

Vegetation Type	Elevation (m)	Aspect	Rate Of Succession	Snow Interception By Tree Canopy	Shrub Cover Density	Presence Of Winter Forage Species	Winter Forage Species Potential	Interpretations Of Vegetation Types For The Management For White-Tailed Deer Habitat
Western larch - western red cedar - western thimbleberry - northern twinflower (32)	650-1300	all aspects	N	M	H	M	M	Fertilization or spring burning will increase browse abundance. The decaying organic material of the Forest floor is an important source of nutrients and should not be disturbed. In areas where browse is abundant, the snow interception by the canopy may be more significant than additional browse. Where browse supply is light, thinning to increase understory growth may be desired.
Rocky Mountain Douglas-fir - birch-leaved spirea - pine grass - heart-leaved arnica (33a)	>1000	all aspects	N	L	L	L	M	The abundance of browse species may be increased through fertilizing. The tree canopy must be maintained to minimize snow depths.
Lodgepole pine - rose spp. - few-flowered one-sided wintergreen (33b)	>1000	all aspects	N	L	L	L	L	The abundance of browse species may be increased through fertilizing. The tree canopy must be maintained to minimize snowdepths.
Lodgepole pine - soopolallie - western bracken - red-stemmed pipecleaner (38)	650-1150	all aspects	N	M-L	M	M	M	Fertilization will increase browse abundance. The tree canopy must be maintained to minimize snowdepths. Weed invasion can become a problem on sites next to open waste areas.
Lodgepole pine - Engelmann spruce - Oregon boxwood - common western pipsissewa (39)	1300-1950	all aspects	N	M	L	L	L	Fertilization will increase browse abundance. This type is found above the winter range.
Western hemlock - alpine fir - black blueberry - evergreen yellow violet (40)	1150-1700	all aspects	N	H-M	H	L	L	Opening of the tree canopy will cause an increase in western red cedar regeneration. The decaying organic materials of the floor is an important source for nutrients and

Table B.3.: (Continued)

Vegetation Type	Elevation (m)	Aspect	Rate Of Succession	Snow Interception By Tree Canopy	Shrub Cover Density	Presence Of Winter Forage Species	Winter Forage Species Potential	Interpretations Of Vegetation Types For The Management For White-Tailed Deer Habitat
								should not be disturbed. This type is above the winter range.
Western larch - western red cedar - blue-bead clintonia - evergreen yellow violet (44)	1150-1170	all aspects	N	VL	H	L	L	This vegetation type is usually located on disturbed sites. Browse species may be increased by fertilizing, seeding or planting of browse species. This type occurs above the winter range.

B.6 Vegetation Correlation

Vegetation Types[1]	Plant Associations According to Daubenmire (1952)	Described by	Plant Association According to Krajine (1969)	Described by
- Rocky Mountain Douglas-fir - common snowberry - Hooker's fairybells - pine grass complex (13)	- Rocky Mountain Douglas-fir/ mallow ninebark association[2]	Daubenmire 1952		
	- Rocky Mountain Douglas-fir/ mallow ninebark association (mallow ninebark phase)[3]	Pfister et. al. 1977		
- Western hemlock - western yew - devil's club - oak fern (4)	- Western red cedar/devil's club association [2,3]	Daubenmire 1952, Pfister et. al. 1977	- Devil's club association (Slope devil's club forest type and Slope devil's club, northern variant, forest type)[4]	Bell 1964
			- Devil's club association[5]	Utzig et. al. 1978
- Engelmann spruce - western hemlock - cucumberroot twistedstalk - green-stemmed pipe cleaner (2)	- Western hemlock/blue-bead clintonia association (wild sarsaparilla phase)[3]	Pfister et. al. 1977	- Slope normal moss association[4]	Bell 1964
	- Western hemlock/Oregon boxwood association[2]	Daubenmire 1952	- Bunchberry-moss association[5]	Utzig et. al. 1978

1 Vegetation Resources of the Nelson (NTS 82F) Area - van Barneveld, J., in progress, R.A.B., Ministry of Environment, Province of British Columbia.

2 As described in Forest Vegetation of Northern Idaho and Adjacent Washington and It's Bearing on Concepts of Vegetation Classification - Daubenmire, R., 1952, Ecol. Monogr., 22:301-330.

3 As described in Forest Habitats of Montana - Pfister, R. et. al., 1977, U.S.D.A. Forest Service General Technical Report INT-34, May 1977.

4 As described in Phytocoenoses in the Dry Subzone of the Interior Western Hemlock Zone of British Columbia - Bell, M., - 1964 University of British Columbia Ph.D. Thesis.

5 As described in Ecological Classification for the Nelson Forest District - Utzig, G., et. al., 1978 - Ministry of Forests, Province of British Columbia.

B.7 List of Plants Discussed in this Report

B.7.1. List of Vascular Plants by Botanical Name

Vascular plant nomenclature is after Taylor and MacBryde 1977, "Vascular Plants of British Columbia".

BOTANICAL NAME	COMMON NAME
Abies grandis	grand fir
Abies lasiocarpa	alpine fir
Acer glabrum	Rocky Mountain maple
Achillea millefolium	common yarrow
Adenocaulon bicolor	trail plant
Agropyron spicatum	bluebunch wheat grass
Alnus incana	thin-leaved mountain alder
Alnus viridis subsp. sinuata	Sitka mountain alder
Amelanchier alnifolia	common saskatoon
Angelica spp.	angelica spp.
Apocynum androsaemifolium	spreading dogbane
Aralia nudicaulis	wild sarsaparilla
Arctostaphylos uva-ursi	kinnikinnick
Arnica cordifolia	heart-leaved arnica
Aster spp.	aster spp.
Athyrium felix-femina	common lady fern
Balsamorhiza sagittata	arrow-leaved balsamroot
Betula papyrifera	common paper birch
Calamagrostis rubescens	pine grass
Campanula rotundifolia	common harebell
Cassiope mertensiana	Mertens' cassiope
Ceanothus sanguineus	redstem ceanothus
Chimaphila umbellata	common western pipsissewa
Clintonia uniflora	blue-bead clintonia
Cornus canadensis	Canadian bunchberry
Cornus sericea	western red-osier dogwood
Corylus cornuta var. californica	California filbert
Disporum hookeri	Hooker's fairybells
Elymus glauca	blue wild rye grass
Epilobium angustifolium	fireweed
Erythronium grandiflorum	yellow glacier lily
Festuca occidentalis	western fescue
Fragaria virginiana subsp. glauca	blue-leaved wild strawberry
Fragaria virginiana subsp. virginiana	wild strawberry
Galium triflorum	sweet-scented bedstraw
Goodyera oblongifolia	large-leaved rattlesnake orchid
Gymnocarpium dryopteris	oak fern
Hieracium albiflorum	white hawkweed
Holodiscus discolor	creambush oceanspray
Juncus spp.	rush spp.
Juniperus communis	common juniper
Juniperus horizontalis	creeping juniper
Larix occidentalis	western larch
Linnaea borealis	northern twinflower
Lonicera ciliosa	western trumpet honeysuckle
Lonicera involucrata	twinberry honeysuckle
Lonicera utahensis	Utah honeysuckle
Mahonia spp.	Oregon-grape
Mahonia repens	creeping Oregon-grape
Oplopanax horridus	devil's club
Orthilia secunda	few-flowered one-sided wintergreen
Osmorhiza chilensis	mountain sweetcicely
Paxistima myrsinites	Oregon boxwood
Pedicularis bracteosa	bracted lousewort
Philadelphus lewisii	Lewis' mock-orange
Phleum pratense	common timothy
Phyllodoce empetriformis	red mountain-heather

Physocarpus spp.	ninebark
Physocarpus malvaceus	mallow ninebark
Picea engelmannii	Engelmann spruce
Pinus contorta	lodgepole pine
Pinus monticola	western white pine
Pinus ponderosa	ponderosa pine
Poa spp.	blue grass spp.
Populus tremuloides	trembling aspen
Pseudotsuga menziesii	Rocky Mountain Douglas-fir
Pteridium aquilinum	western bracken
Ribes lacustre	black swamp gooseberry
Rhododendron albiflorum	white-flowered rhododendron
Rosa spp.	rose spp.
Rosa gymnocarpa	baldhip rose
Rubus idaeus	American red blackberry
Rubus parviflorus	western thimbleberry
Rubus pedatus	five-leaved creeping raspberry
Salix spp.	willow spp.
Salix scouleriana	Scouler's willow
Sambucus racemosa	red elderberry
Sedum lanceolatum	lance-leaved stonecrop
Senecio triangularis	arrow-leaved ragwort
Shepherdia canadensis	soopolallie
Smilacina racemosa	false Solomon's-seal
Smilacina stellata	star-flowered false Solomon's-seal
Sorbus sitchensis	Sitka mountain ash
Spiraea betulifolia	birch-leaved spirea
Streptopus amplexifolius	cucumberroot twistedstalk
Symphoricarpos albus	common snowberry
Taxus brevifolia	western yew
Thalictrum occidentale	western meadow-rue
Thuja plicata	western red cedar
Tiarella unifoliata	unifoliate-leaved foamflower
Trifolium spp.	clover spp.
Trillium ovatum	western white trillium
Tsuga heterophylla	western hemlock
Vacinium membranaceum	black blueberry
Vaccinium scoparium	grouseberry
Valeriana sitchensis	Sitka valerian
Veratrum viride	green false hellebore
Viola canadensis	Canada violet
Viola orbiculata	evergreen yellow violet

B.7.2. List of Mosses by Botanical Name

Latin nomenclature of the mosses is after Lawton (1971) "Moss Flora of the Pacific Northwest". Common names have been informally standardized within the Vegetation Section, Resource Analysis Branch.

BOTANICAL NAME	COMMON NAME
Phytidiadelphus triquetrus	red-stemmed pipecleaner
Rhytidiopsis robusta	green-stemmed pipecleaner

B.7.3. List of Vascular Plants by Common Name

Vascular plant nomenclature is after Taylor and MacBryde 1977, "Vascular Plants of British Columbia".

COMMON NAME	BOTANICAL NAME
alpine fir	Abies lasiocarpa
American red blackberry	Rubus idaeus
angelica spp.	Angelica spp.
arrow-leaved balsamroot	Balsamorhiza sagittata
arrow-leaved ragwort	Senecio triangularis
aster spp.	Aster spp.
baldhip rose	Rosa gymnocarpa
birch-leaved spirea	Spiraea betulifolia
black blueberry	Vaccinium membranaceum
black swamp gooseberry	Ribes lacustre
blue-bead clintonia	Clintonia uniflora
bluebunch wheat grass	Agropyron spicatum
blue grass spp.	Poa spp.
blue-leaved wild strawberry	Fragaria virginiana subsp. glauca
blue wild rye grass	Elymus glauca
bracted lousewort	Pedicularis bracteosa
California filbert	Corylus cornuta var. californica
Canadian bunchberry	Cornus canadensis
Canada violet	Viola canadensis
clover spp.	Trifolium spp.
common harebell	Campanula rotundifolia
common juniper	Juniperus communis
common lady fern	Athyrium filix-femina
common paper birch	Betula papyrifera
common saskatoon	Amelanchier alnifolia
common snowberry	Symphoricarpos albus
common timothy	Phleum pratense
common western pipsissewa	Chimaphila umbellata
common yarrow	Achillea millefolium
creambush oceanspray	Holodiscus discolor
creeping juniper	Juniperus horizontalis
creeping Oregon-grape	Mahonia repens
cucumberroot twistedstalk	Streptopus amplexifolius
devil's club	Oplopanax horridus
Engelmann spruce	Picea engelmannii
evergreen yellow violet	Viola orbiculata
false Solomon's-seal	Smilacina racemosa
few-flowered one-sided wintergreen	Orthilia secunda
fireweed	Epilobium angustifolium
five-leaved creeping raspberry	Rubus pedatus
grand fir	Abies grandis
green false hellebore	Veratrum viride
grouseberry	Vaccinium scoparium
heart-leaved arnica	Arnica cordifolia
Hooker's fairybells	Disporum hookeri
kinnikinnick	Arctostaphylos uva-ursi
lance-leaved stonecrop	Sedum lanceolatum
large-leaved rattlesnake orchid	Goodyera oblongifolia
Lewis' mock-orange	Philadelphus lewisii
lodgepole pine	Pinus contorta
mallow ninebark	Physocarpus malvaceus
Mertens' cassiope	Cassiope mertensiana
mountain sweetcicely	Osmorhiza chilensis
ninebark	Physocarpus spp.
northern twinflower	Linnaea borealis

oak fern	Gymnocarpium dryopteris
Oregon-grape	Mahonia spp.
Oregon boxwood	Paxistima myrsinites
pine grass	Calamagrostis rubescens
ponderosa pine	Pinus ponderosa
red elderberry	Sambucus racemosa
red mountain-heather	Phyllodoce empetriformis
redstem ceanothus	Ceanothus sanguineus
Rocky Mountain Douglas-fir	Pseudotsuga menziesii
Rocky Mountain maple	Acer glabrum
rose spp.	Rosa spp.
rush spp.	Juncus spp.
Scouler's willow	Salix scouleriana
Sitka mountain alder	Alnus viridis subsp. sinuata
Sitka mountain ash	Sorbus sitchensis
Sitka valerian	Valeriana sitchensis
soopolallie	Shepherdia canadensis
spreading dogbane	Apocynum androsaemifolium
star-flowered false Solomon's-seal	Smilacina stellata
sweet-scented bedstraw	Galium triflorum
thin-leaved mountain alder	Alnus incana
trailplant	Adenocaulon bicolor
trembling aspen	Populus tremuloides
twinberry honeysuckle	Lonicera involucrata
unifoliate-leaved foamflower	Tiarella unifoliata
Utah honeysuckle	Lonicera utahensis
western bracken	Pteridium aquilinum
western fescue	Festuca occidentale
western hemlock	Tsuga heterophylla
western larch	Larix occidentalis
western meadow-rue	Thalictrum occidentale
western red cedar	Thuja plicata
western red-osier dogwood	Cornus sericea
western thimbleberry	Rubus parviflorus
western trumpet honeysuckle	Lonicera ciliosa
western white pine	Pinus monticola
western white trillium	Trillium ovatum
western yew	Taxus brevifolia
white-flowered rhododendron	Rhododendron albiflorum
white hawkweed	Hieracium albiflorum
wild sarsaparilla	Aralia nudicaulis
wild strawberry	Fragaria virginiana subsp. virginiana
willow spp.	Salix spp.
yellow glacier lily	Erythronium grandiflorum

B.7.4. List of Mosses by Common Name

Latin nomenclature of the mosses is after Lawton (1971) "Moss Flora of the Pacific Northwest". Common names are in use within the Vegetation Section, Resource Analysis Branch.

COMMON NAME	BOTANICAL NAME
green-stemmed pipecleaner	Rhytidiopsis robusta
red-stemmed pipecleaner	Rhytidiadelphus triquetrus

Appendix C

CLIMATE

APPENDIX PAGE

C.1 Survey Methods

Very few long term climatological observations have been made within the Study Area. Those that have been made are representative of only the very lowest elevations. Daily observations of temperature and precipitation have been made at Waneta, near the west of the Study Area, since 1913. Although this station ceased to be an operational component of the Atmospheric Environment Service - Environment Canada-climatological network in 1978, the historical data are available in published form. During 1969 and 1970, a valley bottom transect of seven precipitation stations was operated by the Climatology Section of the B.C. Land Inventory. At each of these stations an estimate of expected long term precipitation was arithmetically made using comparative data from the long term station at Waneta.

Because of the deficiency of climatological data from the Pend-d'Oreille Valley, it was necessary to extrapolate local climatological relationships using long term climatological data collected from stations in the lower Columbia River Valley. The effect of increasing elevation on temperature and precipitation regimes was determined using published data from four Atmospheric Environment Service climatological stations, Trail-Sunningdale (433 m), Warfield-Trail (606 m), Rossland (1007 m) and Old Glory Mountain (2347 m). The derived relationships were felt to be representative of the western portion of the Study Area after they were calibrated using the long term data from Waneta. Freeze free periods and growing seasons were then calculated using these calibrated data.

The average amount of solar radiation incident on a level surface in the Study Area was felt to be adequately represented by corresponding values at Trail. These averages were initially determined using 10 years of sunshine data from Trail-Tadanac, meteorological tables indicating the solar radiation at the top of the atmosphere, and an empirically derived equation, determined using total solar radiation data at Summerland, relating the three factors. Between April and September the relationship was determined to be:

$$Qs = .233\ Qo + .52\ (n/N)\ (Qo)$$

where Qs is total solar radiation in langleys/day received on a horizontal surface, Qo is the total solar radiation in langleys/day at the top of the atmosphere and n/N is the ratio of actual number of recorded sunshine hours to potential sunshine hours over the same period.

The average total solar radiation values were partitioned into direct and diffuse components (Hay, 1977). Interpolating from published tables (Buffo et al., 1972) the direct solar radiation component was calculated for a wide variety of aspects and site inclinations. The diffuse component was independently calculated for slopes between 0 and 60°. For each slope/aspect combination, the two calculated components were added to provide an estimate of the average total solar radiation available to such sites between May and September inclusive.

Total monthly potential evapotranspiration (PET) was estimated for each slope and aspect combination at a variety of elevations. Monthly totals from May through September were added to provide an estimate of seasonal PET which was to be used in subsequent site analyses.

Before the PET could be determined it was first necessary to calculate the net radiation for each slope/aspect combination. This was accomplished by applying the appropriate solar radiation and temperature data to an empirical equation developed by Linacre (1968). The net radiation value was then multiplied by a temperature dependent factor extracted from meteorological tables (Chang, 1968) which accounts for vapour pressure characteristics and by 1.26, an empirically derived constant of proportionality (Priestley and Taylor, 1972). The product, divided by the latent heat of vaporization, enabled an estimate of PET.

The seasonal potential evapotranspiration, for each slope/aspect combination at each elevation, was subtracted from the seasonal precipitation as determined for each elevation. Where PET exceeded precipitation, a climatic moisture deficit was said to occur, where the converse was true a climatic moisture surplus was indicated.

Estimates of site climates at various elevations relate specifically to the Waneta to Seven Mile Creek portion of the Study Area. Although it is felt that the temperature, solar radiation and potential evapotranspiration estimates will adequately represent other portions of the Study Area, differences in precipitation, and hence climatic moisture balance, have to be estimated for the Seven Mile Creek to Limpid Creek, and the Limpid Creek to Lomond Creek areas. This is done by increasing the precipitation estimate at a corresponding elevation in the Waneta area by a factor of 8% and 12% respectively. The obtained value may then be added to the appropriate PET value to determine the climatic moisture balance for these areas. Examples are provided in Tables C.6 and C.7 (in Appendix C.2).

Estimation of Monthly Soil Temperatures and Soil Temperature Classes from Climatic Data

Monthly soil temperatures were estimated for the western portion of the Pend-d'Oreille River Valley at elevations between 450 and 1830 metres (1500 and 6000 feet). Extrapolated and calibrated climatological data, derived from a long term regional transect of Atmospheric Environment Service climatological stations west of Trail, were applied to a series of empirical equations developed by Ouellet (1973). These equations, applied sequentially, enabled a prediction of soil temperatures for any particular elevation and month. As the climatic data used represent long term averages, predicted monthly soil temperatures are similarly indicative of average conditions.

Having calculated the monthly soil temperatures at different elevations, further computation was necessary in order to identify soil temperature classes as defined in The Canadian System of Soil Classification (Canada Soil Survey Committee, 1978). The mean annual soil temperature (MAST), mean summer soil temperature (MSST), number of day soil temperatures greater than 5°C and 15°C and the number of degree days above 5°C and 15°C were calculated. Soil temperatures were calculated for a depth of 50 cm. Table C.8 presents a summary of these derived data at various elevations and indicates the approximate soil temperature class at each elevation for each soil temperature parameter. As these estimates assume a non-sloping site surface, the application of these data under field conditions will necessitate some subjective modification. Because of different precipitation regimes, the estimation of soil temperatures and soil temperature classes in the eastern portions of the Study Area will require a complete recomputation.

C.2 Climate Tables

Tables C.1 to C.8 were referred to in section 1.5 of the report. The data presented in these tables have all been extrapolated from stations outside the Study Area (see Appendix C.1 on survey methods).

Table C.1a.

MONTHLY MEAN MINIMUM TEMPERATURE (^{o}C) AT SELECT ELEVATIONS IN THE PEND-D'OREILLE RIVER VALLEY

ELEVATION (m)	ANNUAL	JAN.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
460	0.3	- 8.5	0	3.1	6.5	8.0	7.3	3.8	0.8
610	1.9	- 7.7	1.4	5.1	8.3	11.0	10.2	6.5	2.2
760	1.2	- 8.3	0.5	4.3	7.5	10.3	9.6	5.9	1.5
910	0.4	- 8.9	-0.4	3.4	6.7	9.7	8.9	5.3	0.8
1 060	-0.3	- 9.6	-1.3	2.6	5.8	9.0	8.3	4.7	0.1
1 220	-1.0	-10.2	-2.3	1.8	5.0	8.3	7.6	4.0	-0.5
1 370	-1.8	-10.8	-3.2	1.0	4.2	7.7	7.0	3.4	-1.2
1 520	-2.5	-11.4	-4.1	0.1	3.4	7.0	6.0	2.8	-1.9
1 670	-3.2	-12.0	-5.0	-0.7	2.6	6.3	5.8	2.2	-2.6
1 820	-3.9	-12.6	-5.9	-1.5	1.8	5.6	5.2	1.6	-3.3

Table C.1b.

MONTHLY MEAN MAXIMUM TEMPERATURE (^{o}C) AT SELECT ELEVATIONS IN THE PEND-D'OREILLE RIVER VALLEY

ELEVATION (m)	MAY	JUNE	JULY	AUG
460	21.3	24.5	30.0	32.4
610	19.8	23.3	28.7	31.1
760	18.4	21.9	27.4	29.8
910	17.0	20.6	26.1	26.8
1 060	15.5	19.2	24.7	27.3
1 220	14.1	17.8	23.4	26.1
1 370	12.7	16.5	22.1	24.8
1 520	11.2	15.1	20.8	23.5
1 670	9.8	13.7	19.5	22.3
1 820	8.4	12.3	18.1	21.0

Table C.2.

MONTHLY MEAN TEMPERATURE (^{o}C) AT SELECT ELEVATIONS IN THE PEND-D'OREILLE RIVER VALLEY

ELEVATION (m)	ANNUAL	JAN.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
460	8.5	-4.3	9.0	13.2	16.6	20.4	19.6	15.2	8.7
610	7.6	-4.8	7.9	12.1	15.6	19.5	18.7	14.3	7.9
760	6.8	-5.4	6.7	11.1	14.5	18.6	17.8	13.5	7.1
910	5.9	-6.5	5.6	10.0	13.5	17.6	16.9	12.6	6.3
1 060	5.0	-7.1	4.5	8.9	12.4	16.7	16.1	11.8	5.4
1 220	4.2	-7.7	3.4	7.9	11.4	15.8	15.2	10.9	4.6
1 370	3.3	-8.2	2.2	6.8	10.3	14.9	14.3	10.1	3.8
1 520	2.5	-8.8	1.1	5.7	9.3	14.0	13.4	9.2	3.0
1 670	1.6	-9.2	0	4.6	8.3	13.1	12.5	8.3	2.2
1 820	0.7	-9.8	-1.1	3.5	7.3	12.2	11.6	7.4	1.4

Table C.3.

THE PERIOD AND DURATION OF GROWING SEASON (WHEN MEAN DAILY AIR TEMPERATURES ARE GREATER THAN 5°C) AT SELECT ELEVATIONS IN THE PEND-D'OREILLE RIVER VALLEY

ELEVATION (m)	GROWING SEASON PERIOD	DURATION (DAYS)
460	MARCH 17 - NOVEMBER 7	236
610	MARCH 24 - NOVEMBER 2	223
760	APRIL 5 - OCTOBER 29	210
910	APRIL 12 - OCTOBER 22	197
1 060	APRIL 18 - OCTOBER 18	185
1 220	APRIL 26 - OCTOBER 13	172
1 370	MAY 3 - OCTOBER 9	159
1 520	MAY 11 - OCTOBER 4	146
1 670	MAY 17 - SEPTEMBER 30	134
1 820	MAY 25 - SEPTEMBER 26	122
1 970	JUNE 4 - SEPTEMBER 22	110

Table C.4.

THE FREEZE FREE PERIOD AND DURATION OF FREEZE FREE PERIOD FOR SELECT ELEVATIONS IN THE PEND-D'OREILLE RIVER VALLEY

ELEVATION (m)	FREEZE FREE PERIOD	DURATION (DAYS)
460	MAY 25 - SEPTEMBER 14	113
610	MAY 8 - OCTOBER 1	147
760	MAY 14 - SEPTEMBER 27	137
910	MAY 23 - SEPTEMBER 24	125
1 060	MAY 30 - SEPTEMBER 22	116
1 220	JUNE 7 - SEPTEMBER 17	103
1 370	JUNE 15 - SEPTEMBER 15	93
1 520	JUNE 22 - SEPTEMBER 10	81
1 670	JUNE 29 - SEPTEMBER 8	72
1 820	JULY 14 - SEPTEMBER 3	62

Table C.5a.

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 460 m IN THE WESTERN PEND-D'OREILLE VALLEY

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	201	201	201	201	201
	PET	476	399	285	159	38
	CMB	-266	-198	- 84	+ 42	+163
NE/NW	PPT	201	201	201	201	201
	PET	467	413	323	235	147
	CMB	-266	-212	-122	- 34	+ 54
EAST/WEST	PPT	201	201	201	201	201
	PET	467	450	412	362	293
	CMB	-266	-249	-211	-161	- 92
SE/SW	PPT	201	201	201	201	201
	PET	467	488	474	433	359
	CMB	-266	-287	-273	-232	-158
SOUTH	PET	201	201	201	201	201
	PET	467	502	488	447	359
	CMB	-266	-301	-287	-246	-158

Table C.5b.

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 610 m IN THE WESTERN PEND-D'OREILLE VALLEY

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	252	252	252	252	252
	PET	450	384	274	152	34
	CMB	-198	-132	- 22	+100	+218
NE/NW	PPT	252	252	252	252	252
	PET	450	397	310	225	140
	CMB	-198	-145	- 58	+ 27	+112
EAST/WEST	PPT	252	252	252	252	252
	PET	450	434	397	349	281
	CMB	-198	-182	-145	- 97	- 29
SE/SW	PPT	252	252	252	252	252
	PET	450	571	456	417	345
	CMB	-198	-219	-204	-165	- 93
SOUTH	PET	252	252	252	252	252
	PET	450	484	470	431	345
	CMB	-198	-232	-218	-179	- 93

Table C.5c.

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 760 m IN THE WESTERN PEND-D' OREILLE VALLEY

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	277	277	277	277	277
	PET	440	375	267	147	31
	CMB	-163	- 98	+ 10	+130	+246
NE/NW	PPT	277	277	277	277	277
	PET	440	389	303	219	135
	CMB	-163	-112	- 26	+ 58	+142
EAST/WEST	PPT	277	277	277	277	277
	PET	440	425	388	340	274
	CMB	-163	-148	-111	- 63	- 3
SE/SW	PPT	277	277	277	277	277
	PET	440	461	447	408	337
	CMB	-163	-184	-170	-131	- 60
SOUTH	PET	277	277	277	277	277
	PET	440	474	460	421	337
	CMB	-163	-197	-183	-144	- 60

Table C.5d.

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 910 m IN THE WESTERN PEND-D'OREILLE VALLEY

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	302	302	302	302	302
	PET	431	366	260	142	28
	CMB	-129	- 64	+ 42	+160	+274
NE/NW	PPT	302	302	302	302	302
	PET	431	380	295	213	130
	CMB	-129	- 78	+ 7	+ 89	+172
EAST/WEST	PPT	302	302	302	302	302
	PET	431	415	379	332	267
	CMB	-129	-113	- 77	- 30	+ 35
SE/SW	PPT	302	302	302	302	302
	PET	431	450	437	399	329
	CMB	-129	-148	-135	- 97	- 27
SOUTH	PET	302	302	302	302	302
	PET	431	464	450	412	329
	CMB	-129	-162	-148	-110	- 27

Table C.5e.

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 1060 m IN THE WESTERN PEND-D'OREILLE VALLEY

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	327	327	327	327	327
	PET	414	352	249	135	25
	CMB	- 87	- 25	+ 78	+192	+302
NE/NW	PPT	327	327	327	327	327
	PET	414	365	283	203	123
	CMB	- 87	- 38	+ 44	+124	+204
EAST/WEST	PPT	327	327	327	327	327
	PET	414	399	364	319	256
	CMB	- 87	- 72	- 37	+ 8	+ 71
SE/SW	PPT	327	327	327	327	327
	PET	414	433	420	383	316
	CMB	- 87	-106	- 93	- 56	+ 11
SOUTH	PET	327	327	327	327	327
	PET	414	446	433	396	316
	CMB	- 87	-119	-106	- 69	+ 11

Table C.5f.

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT A ELEVATION OF 1220 m IN THE WESTERN PEND-D'OREILLE VALLEY

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	352	352	352	352	352
	PET	407	345	243	130	22
	CMB	- 55	+ 7	+109	+154	+330
NE/NW	PPT	352	352	352	352	352
	PET	407	358	277	198	119
	CMB	- 55	- 6	+ 75	+154	+233
EAST/WEST	PPT	352	352	352	352	352
	PET	407	392	358	313	251
	CMB	- 55	- 40	- 6	+ 39	+101
SE/SW	PPT	352	352	352	352	352
	PET	407	426	413	374	310
	CMB	- 55	- 74	- 61	- 24	+ 42
SOUTH	PET	352	352	352	352	352
	PET	407	439	425	389	310
	CMB	- 55	- 87	- 73	- 37	+ 42

Table C.5g.

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 1370 m IN THE WESTERN PEND-D'OREILLE VALLEY

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	377	377	377	377	377
	PET	397	337	237	126	19
	CMB	- 20	+ 40	+140	+251	+358
NE/NW	PPT	377	377	377	377	377
	PET	397	349	270	192	115
	CMB	- 20	+ 28	+107	+185	+262
EAST/WEST	PPT	377	377	377	377	377
	PET	397	383	349	305	255
	CMB	- 20	- 6	+ 28	+ 72	+133
SE/SW	PPT	377	377	377	377	377
	PET	397	416	403	367	302
	CMB	- 20	- 39	- 26	+ 10	+ 75
SOUTH	PET	377	377	377	377	377
	PET	397	429	416	380	302
	CMB	- 20	- 52	- 39	- 3	+ 75

Table C.5h.

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 1520 m IN THE WESTERN PEND-D'OREILLE VALLEY

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	403	403	403	403	403
	PET	383	325	227	120	16
	CMB	+ 20	+ 78	+176	+283	+387
NE/NW	PPT	403	403	403	403	403
	PET	383	337	260	184	109
	CMB	+ 20	+ 66	+143	+219	+294
EAST/WEST	PPT	403	403	403	403	403
	PET	383	369	336	294	234
	CMB	+ 20	+ 34	+ 67	+109	+169
SE/SW	PPT	403	403	403	403	403
	PET	383	402	389	354	291
	CMB	+ 20	+ 1	+ 14	+ 49	+112
SOUTH	PET	403	403	403	403	403
	PET	383	414	401	365	291
	CMB	+ 20	- 11	+ 2	+ 38	+112

Table C.5i.

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 1670 m IN THE WESTERN PEND-D'OREILLE VALLEY

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	428	428	428	428	428
	PET	365	309	216	112	13
	CMB	+ 63	+119	+212	+316	+415
NE/NW	PPT	428	428	428	428	428
	PET	365	321	247	174	102
	CMB	+ 63	+107	+181	+254	+326
EAST/WEST	PPT	428	428	428	428	428
	PET	365	352	320	279	222
	CMB	+ 63	+ 76	+108	+149	+206
SE/SW	PPT	428	428	428	428	428
	PET	365	383	371	337	277
	CMB	+ 63	+ 45	+ 57	+ 91	+151
SOUTH	PET	428	428	428	428	428
	PET	365	394	382	349	277
	CMB	+ 63	+ 34	+ 46	+ 79	+151

Table C.6a.

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 610 m BETWEEN 7 MILE AND LIMPID CREEKS

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	272	272	272	272	272
	PET	450	384	274	152	34
	CMB	-178	-112	- 2	+120	+238
NE/NW	PPT	272	272	272	272	272
	PET	450	397	310	225	140
	CMB	-178	-125	- 38	+ 47	+132
EAST/WEST	PPT	272	272	272	272	272
	PET	450	434	397	349	281
	CMB	-178	-162	-125	- 77	- 9
SE/SW	PPT	272	272	272	272	272
	PET	450	471	456	417	345
	CMB	-178	-199	-184	-145	- 73
SOUTH	PET	272	272	272	272	272
	PET	450	484	470	431	345
	CMB	-178	-212	-198	-159	- 73

Table C.6b.

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 910 m BETWEEN 7 MILE AND LIMPID CREEKS

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	326	326	326	326	326
	PET	431	366	260	142	28
	CMB	-105	- 40	+ 66	+184	+298
NE/NW	PPT	326	326	326	326	326
	PET	431	380	295	213	130
	CMB	-105	- 54	+ 31	+113	+196
EAST/WEST	PPT	326	326	326	326	326
	PET	431	415	379	332	267
	CMB	-105	- 89	- 53	- 6	+ 59
SE/SW	PPT	326	326	326	326	326
	PET	431	450	437	399	329
	CMB	-105	-124	-111	- 73	- 3
SOUTH	PET	326	326	326	326	326
	PET	431	464	450	412	329
	CMB	-105	-138	-124	- 86	- 3

Table C.6c.

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 1220 m BETWEEN 7 MILE AND LIMPID CREEKS

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	380	380	380	380	380
	PET	407	345	243	130	22
	CMB	- 27	+ 35	+137	+250	+358
NE/NW	PPT	380	380	380	380	380
	PET	407	358	277	198	119
	CMB	- 27	+ 22	+103	+182	+261
EAST/WEST	PPT	380	380	380	380	380
	PET	407	392	358	313	251
	CMB	- 27	- 12	+ 22	+ 67	+129
SE/SW	PPT	380	380	380	380	380
	PET	407	420	413	374	310
	CMB	- 27	- 46	- 33	+ 6	+ 70
SOUTH	PET	380	380	380	380	380
	PET	407	439	425	389	310
	CMB	- 27	- 59	- 45	- 9	+ 70

Table C.7a

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 610 m IN THE REMAC AREA

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
	PPT	282	282	282	282	282
NORTH	PET	450	384	274	152	34
	CMB	-168	-102	+ 8	+130	+258
	PPT	282	282	282	282	282
NE/NW	PET	450	397	310	225	140
	CMB	-168	-115	- 28	+ 57	+142
	PPT	282	282	282	282	282
EAST/WEST	PET	450	434	397	349	281
	CMB	-168	-152	-115	- 67	+ 1
	PPT	282	282	282	282	282
SE/SW	PET	450	471	456	417	345
	CMB	-168	-189	-174	-135	- 63
	PET	282	282	282	282	282
SOUTH	PET	450	484	470	431	345
	CMB	-168	-202	-188	-149	- 63

Table C.7b

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 910 m IN THE REMAC AREA

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	338	338	338	338	338
	PET	431	366	260	142	28
	CMB	- 93	- 28	78	+196	+310
NE/NW	PPT	338	338	338	338	338
	PET	431	380	295	312	130
	CMB	- 93	- 42	43	+125	+208
EAST/WEST	PPT	338	338	338	338	338
	PET	431	415	379	332	267
	CMB	- 93	- 77	- 41	+ 6	+ 71
SE/SW	PPT	338	338	338	338	338
	PET	431	450	437	399	329
	CMB	- 93	-112	- 99	- 61	+ 9
SOUTH	PET	338	338	338	338	338
	PET	431	464	450	412	329
	CMB	- 93	-126	-112	- 74	+ 9

Table C.7c

AVERAGE SEASONAL PRECIPITATION (PPTmm), POTENTIAL EVAPOTRANSPIRATION (PETmm) AND CLIMATIC MOISTURE BALANCE (CMBmm) TOTALS AS A FUNCTION OF SITE ASPECT AND INCLINATION FROM HORIZONTAL AT AN ELEVATION OF 1220 m IN THE REMAC AREA

A Climatic Moisture Deficit is Denoted as a -CMB and a Climatic Moisture Surplus as a +CMB

		SITE INCLINATION FROM HORIZONTAL				
ASPECT		0°	15°	30°	45°	60°
NORTH	PPT	394	394	394	394	394
	PET	407	345	243	130	22
	CMB	- 13	+ 49	+151	+264	+372
NE/NW	PPT	394	394	394	394	394
	PET	407	358	277	198	119
	CMB	- 13	+ 36	+117	+196	+275
EAST/WEST	PPT	394	394	394	394	394
	PET	407	392	358	313	251
	CMB	- 13	+ 2	+ 36	+ 81	+143
SE/SW	PPT	394	394	394	394	394
	PET	407	426	413	374	310
	CMB	- 13	- 32	- 19	+ 20	+ 84
SOUTH	PET	394	394	394	394	394
	PET	407	439	425	389	310
	CMB	- 13	- 45	- 31	+ 5	+ 84

Table C.8

MEAN ANNUAL SOIL TEMPERATURE (MAST), MEAN SUMMER SOIL TEMPERATURE (MSST), SOIL THERMAL PERIOD (DAYS) GREATER THAN 5°C and 15°C, AND SOIL TEMPERATURE DEGREE DAYS (DD) GREATER THAN 5°C and 15°C, LISTED WITH THE PREDICTED SOIL TEMPERATURE CLASSES, AS A FUNCTION OF ELEVATION AT A SOIL DEPTH OF 50 CM.

ELEVATION (cm)	MAST	MSST	DAYS >5°C	DAYS >15°C	DD >5°C	DD >15°C
460	10.5 Mild	20.9 Mild	240 Mild	129 Mild	2 396 Mild	627 Mild
610	9.9 Mild	19.2 Mild	239 Mild	115 Mild	2 197 Mild	441 Mild
760	8.9 Mild	17.3 Cool	227 Mild	95 Mild	1 857 Mild	229 Mild
910	7.6 Cool	15.1 Cold	212 Cool	52 Cold	1 474 Cool	50 Cool
1 060	6.8 Cool	13.8 Cold	201 Cool	<52 Cold	1 235 Cold	0
1 220	5.9 Cool	12.5 Cold	186 Cool	0 V.Cold	973 Cold	0
1 370	4.8 Cold	10.6 Cold	166 Cold	0 V.Cold	657 Cold	0
1 520	3.7 Cold	9.1 Cold	143 Cold	0 V.Cold	446 V.Cold	0
1 670	3.1 Cold	7.7 V.Cold	99 V.Cold	0 V.Cold	153 V.Cold	0
1 820	2.6 Cold	6.4 V.Cold	73 V.Cold	0 V.Cold	144 V.Cold	0

Appendix D

HISTORY

Historical Land Use and Use by Native Peoples of the Pend-d'Oreille Valley, B.C.

ETHNOGRAPHIC BACKGROUND: Use by Native Peoples

Although there is no known Indian use of the Study Area at present, in the past native people utilized the Pend-d'Oreille Valley in B.C. on a seasonal basis. A recent archeological investigation (Bussey, 1978) uncovered evidence of temporary camps where activities included hunting, fishing, food processing, and artifact manufacture. No evidence was found of permanent habitation in the Study Area by native people.

The Pend-d'Oreille Valley in B.C. is thought to lie within the hunting territory of the Kalispel people, members of the Interior Salish Family of languages. Their central villages tended to be located along the American portion of the Pend-d'Oreille River and near the larger lakes. Seasonal encampments were made in peripheral locations wherever needed resources were available (Bussey, 1978).

Fish were the principal subsistance resource in the Study Area during the summer months. Resident rainbow trout, whitefish, squawfish, and sucker were taken by dip-nets, hook and line, spears, weirs, and traps (Bussey, 1978). In season, migrating salmon and steelhead also must have been a major food source.

During the fall and winter seasons, the Pend-d'Oreille Valley served as a valuable hunting ground. Deer were a major winter resource and were taken with spears and arrows; they provided not only food, but also fibre (buckskin and sinew), bone, and antler. Bears, rabbits, elk, grouse, and other birds and small mammals were also hunted.

Plant foods also must have attracted Indian use of the valley. In the spring, when supplies of preserved foods were dwindling, green vegetables, tender undergound plant parts, and sweet, succulent cambium of lodgepole and ponderosa pine, western larch, cottonwood, and aspen were highly sought nutritious, fresh foods. Among the green vegetables available in April and May were sprouts and young leaves of cow parsnip, balsamroot, and fireweed. Underground plant parts were also sought before spring flowering; these included bulbs of tiger lillies, wild onions, and blue camas, corms of mariposa lillies and yellow avalanche lillies, and roots of balsamroot and bitter-root (Turner, 1978).

The summer harvest consisted predominantly of berries, although some seeds were also collected (such as balsamroot seeds), and several species of wild cherries were available. Among the berries known to be gathered were Saskatoons, soapberries, wild gooseberries and currants, wild strawberries, raspberries, blue elderberries, thimbleberries, blueberries, huckleberries, Oregon grape berries, and black hawthorne berries. These fruits were eaten fresh and also dried for winter use.

During the fall hunting season, late-ripening berries were collected, such as highbush cranberries, "red willow" berries, and kinnikinnick berries. Mushrooms, hazelnuts, pine seeds (ponderosa and whitebark), and rose hips were also harvested then and could be dried for winter use. Kinnikinnick leaves, "Indian tobacco", were usually gathered in the fall (Turner, 1978).

Other plants present in the Study Area and possibly sought in the past by the Kalispel people are red cedar trees (roots split and woven to make baskets), white birch trees (bark shaped into containers), and willow shrubs (bark woven to make bags) (Turner, 1978).

HISTORICAL LAND USE

As detailed by Bussey (1978), the earliest historic influences felt in the southern interior of B.C. were those of fur traders and explorers. The Columbia River served as a natural highway for the transportation of furs and trade goods. The discovery of gold on the Pend-d'Oreille in 1855, combined with the custom duties levied when crossing the border to trade at Fort Colville, led to the 1856 construction of a Hudson's Bay post north of the boundary, known as Fort Pend-d'Oreille and later as Fort Shepherd. Fort Shepherd was located on the west bank of the Columbia River, upstream from its confluence with the Pend-d'Oreille, and served as a post on the trails to the Big Bend and Wild Horse Creek gold fields until 1870.

The discovery of gold in 1863 on Wild Horse Creek near Cranbrook resulted in the reopening of the Dewdney Trail from Fort Hope to Osoyoos Lake (closed due to faltering supplies of gold), and stimulated Frederick Seymour (Governor of the Colony of B.C.) to commission the construction of an "all-British" route to the East Kootenays. Edgar Dewdney was again chosen to supervise construction, and agreed to build a trail four feet wide, suitable for men and mules but not wagons, from Osoyoos Lake to Fort Steele. Dewdney and his army of labourers completed the task in the autumn of 1865, over 200 miles of trail built in little more than six months (Dick et al., 1977).

The Pend-d'Oreille section of the trail ran from Fort Shepherd, along the north side of the Pend-d'Oreille, Salmo, and South Salmo Rivers to the junction with Lost Creek, eastward to the head of Lost Creek, and down Summit Creek to the Kootenay River at Creston. One of the major travel routes through the interior of the province in the late 1860's, the Dewdney Trail fell into disrepair soon after the gold supply dwindled. By the early 1880's some sections of trail through the West Kootenay were virtually impassable.

The first discovery of gold on the mainland of B.C. was reportedly made in 1855 at the mouth of the Pend-d'Oreille River (Little, 1960). Ten years later an attempt was made to recover placer gold (gold particles contained within fluvial or possibly morainal deposits) from the Salmo River, near its confluence with the Pend-d'Oreille. Nevertheless, little more was attempted until 1886 when placer claims were staked on the Pend-d'Oreille (Walker, 1934). Although the production of gold by recovery during washing was never great, placer-mining on the Pend-d'Oreille and Salmo Rivers attracted the most attention in the region until the 1890's, when lode gold (gold deposited in consolidated rock) was first produced at the Rossland camp (1894) and at Sheep Creek (1899) in the Nelson Range. Placer gold production in the Study Area apparently peaked in the period from 1941 to 1945, tapering off thereafter to one or two-man operations on the Pend-d'Oreille and Salmo Rivers as well as on Tillicum Creek (Little, 1960). Most of the gold from the Pend-d'Oreille seen by Walker (1934) was in flakes an eighth of an inch or less in diameter. It was found under large boulders in the river gravels and on bedrock.

Lode gold was mined at one location in the Study Area, the Bunker Hill property on the east side of Limpid Creek. Small quantities of gold and silver were recovered there from quartz veins in argillite, phyllite, and argillaceous limestone (Fyles and Hewlett, 1959).

Beginning about 1945, increased demand for base metals resulted in a shift of interest to these from gold. Promising lead-zinc deposits in the Study Area were discovered on the following properties: Red Bird (on Red Bird Creek, south side of Pend-d'Oreille River), Red Rock (in McCormick Creek drainage), and Reeves-MacDonald (on the Pend-d'Oreille River, 6.5 km west of Nelway). These old properties, first located in the 1920's or earlier, were of little economic interest initially because they were low in grade and contained mainly zinc. Development work occurred off and on at Red Bird, but no ore was produced. According to Fyles and Hewlett (1959), production at Red Rock, which occurred in the 1930's and '40's, was limited. Total ore shipments amounted to only 508 tons, yielding a trace of gold, 4781 ounces of silver, 180 748 pounds of lead, and 169 440 pounds of zinc.

The Study Area's principal lead-zinc producer was the Reeves Macdonald mine, brought into production in 1948. Construction of a mill and townsite (known as Remac) began in the same year; milling commenced in 1949. Production between 1949 and 1953 totalled 1 057 804 tons of ore, which yielded concentrates containing 85 626 ounces of silver, 19 394 092 pounds of lead, 72 076 495 pounds of zinc, and 455 051 pounds of cadmium (Fyles and Hewlett, 1959). Underground workings consisted of a main haulage adit (a horizontal passage from the surface) at the 1900 foot level, an upper adit at 2650 feet, and fourteen interior levels at 50-foot intervals between the 1900 and 2650 foot levels. Inclined shafts connected all levels and were extended below the 1900 foot level to reach deeper ore. Ore above the 2650 foot level was mined by open-pit and glory-hole methods (Fyles and Hewlett, 1959).

Tailings from the milling operation, which was not finally closed down until April 3, 1975, were for the most part dumped directly into the Pend-d'Oreille River. Aquatic investigations downstream (Envirocon et al., 1975) discovered "a layer of thick, persistent silt" covering the river bottom, and apparently contributing to the river's low salmonid productivity. The sediment was attributed primarily to the discharge of mine tailings into the river at the lead-zinc operations at Remac and in Washington State. To stop this practice, a tailings pond was constructed opposite Remac on the southwest side of the Pend-d'Oreille River and put into operation on July 1, 1974. Despite the great expense involved (including construction of a bridge and pipeline across the river), the mine closed just nine months after the tailings pond had been put into use (Inspection Division, Ministry of Mines and Petroleum Resources, personal communication).

As a matter of interest, the ores of these three mines consisted mainly of the following three sulphide minerals in dolomite: sphalerite, (Zn,Fe)S, the principal ore of zinc and containing small quantities of cadmium; galena, PbS, the principal ore of lead; and pyrite, FeS_2, iron sulphide (Fyles and Hewlett, 1959).

Visitors to the Study Area will find that vehicular access to the Red Rock and Reeves MacDonald mines is still possible. One other easily accessible property of interest is the International (Lomond) iron-oxide mine, which lies in a dolomite exposure along Lomond Creek, east of the Pend-d'Oreille River and immediately north of the international boundary. Mineralization at the main showings consists of seams and pods of soft earthy limonite (a group of iron oxides with variable composition) containing the hard mineral goethite, FeO(OH), nodules of galena with thin coatings of anglesite ($PbSO_4$, altered galena), and crystals of cerussite ($PbCO_3$, another altered galena). Shipments of 7292 tons of iron oxide were made from the property between 1948 and 1950. The material was trucked to Metalline Falls, Washington, for use in the manufacture of cement. In the same period, 19 tons of hand-sorted lead ore containing 38 ounces of silver, 9702 pounds of lead, and 962 pounds of zinc were shipped to the Trail smelter, but since the ore contained iron oxides, a penalty was imposed by the smelter. (Sources: Fyles and Hewlett, 1959, and Little, 1960).

Apparently at least one hundred mineral claims and seven placer leases still exist in the Study Area (Dick et al., 1977). Nowadays, although minimal development work takes place from time to time at these claims (required to maintain mineral rights), most interest in the rocks, minerals, and old mines seems to be recreational. Weekend and summer visitors enjoy "discovering" and exploring the abandoned mining properties and panning for gold in the same way and in the same places as was done in the old days. With the flooding of the Pend-d'Oreille River, panning activities will be restricted to the Salmo River, above the reservoir.

Concerning logging history, when Fyles and Hewlett (1959) were carrying out geological mapwork in the Study Area between 1951 and 1956, they noted small sawmills located on McCormick Creek, Tillicum Creek, Slate Creek, near Charbonneau Creek, and near Church Creek. Although forest fires had swept over "the greater part of the district" in the 1890-1930 era, during his fieldwork Walker (1934) observed commercial stands of timber remaining in the valley of Tillicum Creek and south of the Pend-d'Oreille River. In reference to the region as a whole, he also noted that logging operations consisted mainly in cutting white pine for match blocks and red cedar for poles and fence posts. Early logging in the Pend-d'Oreille valley, however, may have been restricted to the supply of lumber for local construction of buildings and timbers for bridge and mine construction.

Concerning farming history, scattered weather-beaten buildings and abandoned clearings with fruit trees on the gently sloping south-facing benches above the Pend-d'Oreille River (particularly near Limpid Creek, Charbonneau Creek, and McCormick Creek) give testimony to early attempts at farming in the area. Old holdings in the most promising locations have been further developed and are still in use today. Notable examples are the small but attractive farms or ranches in the vicinity of Lomond Lake, up Nine Mile Creek, and along the old road between Waneta and Four Mile Creek. The Envirocon et al. (1975) study details the present extent of cattle grazing in the area.

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