BIOPHYSICAL SOIL RESOURCES AND LAND EVALUATION

of the northeast coal study area

1976 – 1977

Volume One

Province of
British Columbia
Ministry of the
Environment

COVER PHOTO: ROCKY MOUNTAINS, HOMINKA VALLEY

The valley bottom of the Hominka River contains poorly drained organic and mineral soils. Lower slopes are within the Subboreal white spruce - alpine fir zone, while upper slopes lie within the Subalpine Engelmann spruce - alpine fir zone. Slopes are dominantly shallow colluvium over metamorphic rock.

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BIOPHYSICAL SOIL RESOURCES AND LAND EVALUATION OF THE NORTHEAST COAL STUDY AREA 1976-1977

VOLUME ONE

A TECHNICAL SUPPLEMENT TO THE

NORTHEAST COAL STUDY
PRELIMINARY ENVIRONMENTAL REPORT ON
PROPOSED TRANSPORTATION LINKS AND TOWNSITES

PREPARED FOR

THE ENVIRONMENT AND LAND USE SUB-COMMITTEE
ON NORTHEAST COAL DEVELOPMENT

BY

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VICTORIA

DECEMBER 1977

Province of British Columbia

Ministry of the Environment

Resources Analysis Branch
Parliament Buildings
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V8V 1X4

March 9, 1978

Dr. Jon O'Riordan, Chairman
Environment and Land Use Sub-Committee
on Northeast Coal Development
c/o E.L.U.C. Secretariat
Parliament Buildings

Dear Dr. O'Riordan:

I hereby submit to you the report entitled "Biophysical Soil Resources and Land Evaluation of the Northeast Coal Study Area 1976 - 1977, Volume One", which has been prepared by my staff for the Northeast Coal Study. Volume Two is now in an advanced state of preparation and should be conveyed to you during the summer of 1978.

In the longer term, it is planned that a report on the soil resources of the area south and east of the 1976 - 1977 Study Area will also be submitted to you. However, this report is not scheduled for completion until 1979.

Yours sincerely,

W. Arthur Benson

W. Arthur Benson
Director
Resource Analysis Branch

WAB:jl

TABLE OF CONTENTS

CHAPTER FOUR (CONT'D) PAGE

VOLUME TWO

LIST OF FIGURES

LIST OF PLATES

LIST OF TABLES

ACKNOWLEDGEMENTS

Special thanks go to Robert Maxwell, who shared in coordination of field work and map preparation; and to Ruth Hardy who assisted in preparing soil descriptions and interpretations.

Acknowledgements are due to field personnel, especially to Ken Webb, Tom Cooper, Tom Ovanin, Ruth Hardy, Rob Kline, and Rob Hinkley. Thanks also to V.E. Osborne and staff for soil analyses performed.

The able assistance of Agriculture Canada, especially Keith Valentine and Terry Lord, is gratefully acknowledged here for soil correlation efforts.

Recognition is due to Neville Alley, Ray Crook, Bob Reid, and Ted Baker (B.C. Forest Service) of the editorial committee who reviewed drafts of this report. The author also wishes to thank the many other individuals who reviewed earlier drafts of the report, especially Herb Luttmerding and Mark Walmsley.

Appreciation is extended to Boyd Porteous, and other members of the drafting staff, who provided invaluable assistance in producing the graphic material; and to Mariette Klassen for an excellent job of typing.

Many other individuals made this report possible and are gratefully acknowledged here for their efforts.

Terje Vold
Resource Analysis Branch
B.C. Ministry of the Environment

introduction

INTRODUCTION

Biophysical soil resources of the Northeast Coal Development Study Area were inventoried and mapped to provide basic data for environmental impact assessments and support data for other resource disciplines. The rationale for a soil resource inventory is threefold:

(i) Considerable financial savings can result if the most appropriate soils are used for land use developments. For instance, roads built on soils with few physical limitations cost less to construct than roads built on soils with several limitations.

(ii) All renewable resources are dependent upon soil, which is a non-renewable resource. This fact necessitates soil conservation in order to provide sustained yields of agricultural crops, timber, and forage for wildlife.

(iii) Understanding of soil capability for various land uses is necessary in order to help answer problems associated with land resource allocation.

The terms "biophysical soil" and "soil" are used interchangeably since the soils described in this report were differentiated by integrating both physical and biological components of land.

The three main objectives of the biophysical soil resource and land evaluation program are:

(i) to describe and map the soils of the study area at scales of 1:50,000 and 1:250,000; and

(ii) to interpret the soils with respect to their suitability for various land uses including agriculture, forestry, wildlife, recreation, engineering, and visual resources; and

(iii) to provide basic data for environmental impact assessment of development proposals, including various railway, highway, pipeline, and townsite locations.

The report is written for land use planners and resource managers. Volume One provides generalized soil descriptions and land use interpretations suitable for regional resource planning. These generalized soil units, known as Biophysical Groups, are mapped at a scale of 1:250,000; the map is located in the back pocket of this volume.

The appendices in Volume Two include more detailed soil descriptions and interpretations for resource managers. The appendices are especially intended for readers interested in fully understanding how to use the 1:50,000 scale soils maps. These maps are available upon request by contacting the Resource Analysis Branch Librarian; one sample map is presented in the pocket of Volume Two.

The biophysical soils program, initiated in May, 1976, was part of a broad environmental inventory and assessment study initiated by the Environment and Land Use Sub-Committee on Northeast Coal Development. The third objective of the biophysical soil program was met in submissions to the Sub-Committee's recent environmental report (E.L.U.S.C., 1977). Other programs in the study area include climate, terrain, vegetation, aquatic, wildlife, recreation, visual, and heritage resources. As with the other resource programs, study of the soil resources will continue through 1977-78 for the Northeast Coal "extension area", with a final report for this area expected in 1979. The "extension area" is located south of the study area.

chapter one

FIGURE 1.1 LOCATION OF NORTHEAST COAL STUDY AREA

CHAPTER ONE

GENERAL DESCRIPTION OF AREA

1.1. STUDY LOCATION

The study area is located northeast of Prince George and southwest of Dawson Creek, between 54°30' and 55°45' north latitude, and 120° and 122°30' west longitude. The location of the study area is shown on Figure 1.1.

The size of the study area is approximately 12,000 square kilometres (4,500 square miles) or nearly 1.2 million hectares (3 million acres). Soils were mapped on the following seventeen 1:50,000 scale National Topographic Series (N.T.S.) map sheets: 93I/9 to 16; 93P/2W, 3, 4; and portions of 93P/5, 6, 7, 10, 12 and 93J/9.

1.2. PHYSIOGRAPHIC REGIONS AND BEDROCK GEOLOGY

Physiographic regions are characterized by the distinctive distribution of surficial materials (soil parent materials), bedrock geology, and macroclimate which all affect soil development. Thus, physiographic regions are an important conceptual tool for understanding the regional distribution of soil resources in the study area. The study area has been divided into six physiographic regions (see Figure 1.2.): the Alberta Plateau Plains, the Alberta Plateau Benchlands, the Rocky Mountain Foothills, the Rocky Mountains, the Rocky Mountain Trench, and the McGregor Plateau (adapted from Holland, 1964).

The Alberta Plateau Plains region is characterized by flat-to-gently-rolling upland topography which is underlain primarily by carbonaceous sandstones and shales. The region has a general elevation of between 550 and 840 metres (1,800 and 2,750 feet) above sea level and occurs only in the extreme northern portion of the study area.

The Alberta Plateau Benchlands region consists of rolling upland topography which is also underlain by carbonaceous sandstones and shales with minor conglomerates. Elevation ranges from 760 to 1,380 metres (2,500 to 4,500 feet) above sea level. The region is restricted to northeastern and eastern portions of the study area (see Plate 1).

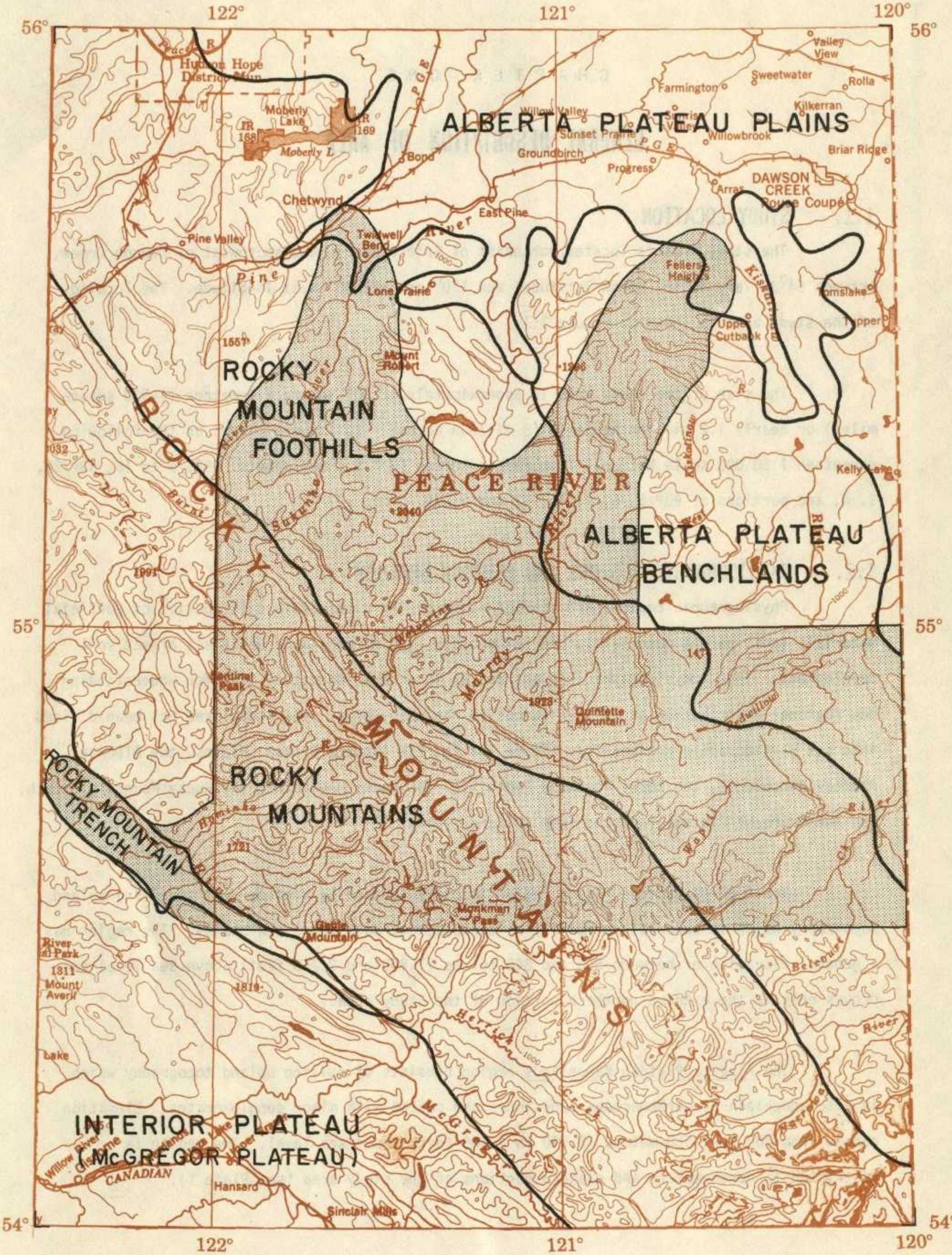

FIGURE I.2 PHYSIOGRAPHIC REGIONS

Plate 1: Alberta Plateau Benchlands

Muskeg Lake, located within the Boreal white spruce zone, is surrounded by seral stands of aspen and lodgepole pine. Some edaphic black spruce stands are also shown.

Plate 2: Rocky Mountain Foothills

Coal exploration roads on Quintette Mountain have been developed within the krummholz subzone of the Subalpine zone and the Alpine tundra zone.

(Photo by T.K. Ovanin)

PLATE 3: ROCKY MOUNTAINS

The extensively burned Hook Lake area is located within the forested sub-zone of the Subalpine Engelmann spruce - alpine fir zone.

The Rocky Mountain Foothills region is characterized by a series of subparallel ridges and valleys which are dissected by major northeasterly-flowing rivers (i.e. the Wolverine, Sukunka, and Murray Rivers). The foothills are underlain by faulted and folded shales and sandstones and have a general elevation of between 600 and 1,800 metres (2,000 and 6,000 feet) above sea level. The Foothills occupy central and northwestern portions of the study area, and include most of the proposed coal developments (see Plate 2).

The Rocky Mountains region is characterized by a series of parallel and subparallel ridges and valleys which trend predominantly northwest to southeast. The mountains are underlain by complex faulted and folded sequences of limestone, dolomite, quartzite, conglomerate, schist, sandstone and shale. Elevations range from 730 to 2,200 metres (2,400 to 7,200 feet) above sea level. The Rockies occupy central and some southwestern portions of the study area (see Plate 3).

The Rocky Mountain Trench region is a structurally-controlled erosional feature which also trends northwest to southeast. The region varies in elevation from 730 to 920 metres (2,400 to 3,000 feet) above sea level, and is restricted to the extreme southwestern portion of the study area along the Parsnip River.

The McGregor Plateau region, which is part of the Interior Plateau, is typically flat to gently rolling and is underlain by rocks of volcanic and sedimentary origin. Elevations range from 760 to 1,220 metres (2,500 to 4,000 feet) above sea level. The region forms only a negligible portion of the study area.

A generalized bedrock map of the study area was prepared for the Northeast Coal Study by Reimchen (1977). A reduced version of the map is shown in Figure 1.3.

Previous bedrock information for portions of the study area includes work by Stott (1960), Stott (1961), Stott (1967), Hughes (1967), and Irish (1968).

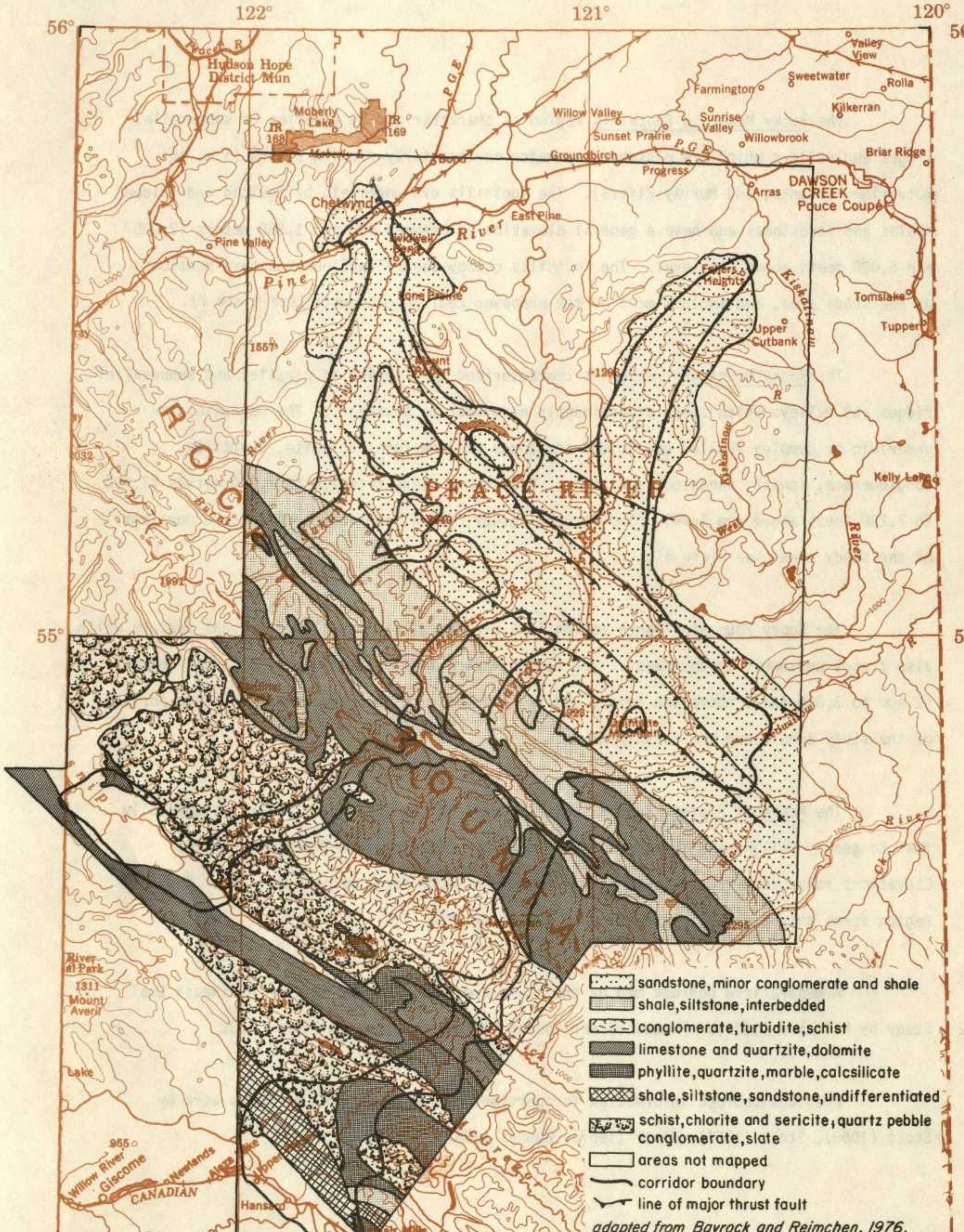

FIGURE 1.3 BEDROCK GEOLOGY

1.3. REGIONAL CLIMATE[1]

The climate of the study area is greatly influenced by the Rocky Mountains. Coastal air masses travel from the west, rise as they approach this natural barrier, and are thereby forced to release considerable quantities of moisture as rain and snow on the western slopes of the mountains. Consequently, the descending air which crosses the eastern flanks of the mountains is drier and, in some cases, warmer. During the winter months, the study area is frequently subjected to arctic air from the northeast. The Rockies act as a barrier which often prevents the westward movement of this cold stable air. The combined effect of these climatic influences is a tendency for lower annual precipitation and lower annual temperatures on the eastern side of the Rockies than on the western side.

A network of climate stations was established in the study area in May, 1976 as part of the Northeast Coal Development Study. During the following discussion of regional climate, comparisons are made between climatic conditions at Dawson Creek (see Table 1.1.) for which considerable data are available, and conditions elsewhere in the study area. These comparisons are very preliminary since they are based on only three months (May to July) climate data; it may be three to four years before reasonably reliable comparable estimates can be produced for these stations.

All stations exhibited lower average temperatures than Dawson Creek, generally in the order of $2^{o}C$ to $4^{o}C$. The average frost-free period at Dawson Creek is 78 days, with the last spring frost normally occurring around June 4th, and the first fall frost normally occurring around August 22nd. The lower temperatures in the study area could result in a decrease of 10 to 30 days in the frost-free period. However, these figures must be treated with extreme caution since data are not yet available from the new stations for one complete growing season.

Initial data also indicate that stations to the east of the Rockies receive substantially less rainfall than Dawson Creek. This pattern may not be truly characteristic, but if the relative patterns of precipitation are duplicated in coming years, moisture deficiency will probably inhibit the revegetation of disturbed soils. Stations to the west of the Rockies do not indicate moisture deficiency limitations to revegetation.

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[1]For further information regarding climate for the study area, contact: Climatology Section, Resource Analysis Branch, B.C. Ministry of the Environment, Victoria, B.C. V8V 1X4. This section was adapted from their submission to the E.L.U.S.C. (1977).

TABLE 1.1

SUMMARY OF CLIMATOLOGICAL STATISTICS FOR DAWSON CREEK(1)

CLIMATIC PARAMETER \ MONTH	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	YEAR
Mean Daily Temperature (^{o}C)(2)	-18	-13	- 7	2	9	13	15	14	10	4	- 6	-14	1
Mean Daily Maximum Temperature (^{o}C)(2)	-12	- 6	- 1	8	16	20	22	21	16	10	- 1	- 8	7
Mean Daily Minimum Temperature (^{o}C)(2)	-24	-19	-13	- 4	2	7	8	7	4	- 1	-11	-19	- 5
Extreme Maximum Temperature (^{o}C) (Years of Record)	11.1 (11)	15.6 (11)	13.9 (11)	21.7 (11)	30.0 (11)	31.7 (11)	32.2 (11)	32.2 (11)	28.3 (11)	26.7 (12)	17.8 (11)	11.1 (10)	32.2
Extreme Minimum Temperature (^{o}C) (Years of Record)	-48.3 (11)	-47.2 (12)	-42.8 (12)	-38.3 (12)	-11.7 (12)	- 2.2 (12)	- 1.1 (11)	- 1.7 (11)	-10.0 (11)	-25.0 (11)	-41.7 (11)	-44.4 (11)	-48.3
Mean Rainfall (mm)	T(3)	1.3	0.5	5.1	37.1	57.2	48.0	37.3	39.1	19.8	7.1	0.5	253.0
Mean Snowfall (cm)	29.7	30.2	24.4	9.1	5.3	T	0.0	T	1.3	15.2	24.9	26.9	167.0
Mean Total Precipitation (mm)	31.8	31.5	27.4	14.2	42.4	57.2	48.0	37.3	40.4	35.1	32.0	27.4	424.7
Greatest Rainfall in 24 Hours (mm) (Years of Record)	T (11)	11.7 (12)	3.3 (11)	12.7 (11)	38.9 (12)	66.5 (12)	58.7 (11)	33.0 (10)	18.3 (10)	18.3 (11)	8.9 (11)	2.0 (10)	66.5
Greatest Snowfall in 24 Hours (cm) (Years of Record)	15.2 (11)	17.8 (12)	22.9 (11)	22.9 (11)	16.5 (12)	T (12)	0.0 (11)	0.0 (11)	5.8 (11)	36.3 (11)	17.8 (11)	15.2 (10)	36.3
Greatest Precipitation in 24 Hours (mm) (Years of Record)	15.2 (11)	17.8 (12)	22.9 (11)	22.9 (11)	55.4 (12)	66.5 (12)	58.7 (11)	33.0 (10)	18.3 (10)	36.3 (11)	22.9 (11)	15.2 (10)	66.5
Number of Days with Measurable Rainfall	0	0	0	2	6	10	10	8	8	4	1	0	49
Number of Days with Measurable Snowfall	10	8	7	3	1	0	0	0	0	3	6	8	46

(1)From: Canadian Normals, Volume 1 - SI, Temperature 1941-1970, Environment Canada, 1975; and Canadian Normals, Volume 2 - SI, Precipitation 1941-1970, Environment Canada, 1975.

(2)From: Dawson Creek Airport, rounded to nearest degree.

(3) T = Trace.

1.4. VEGETATION[1]

Four major vegetation zones are recognized in the study area. These zones are believed to represent major macro-climatic conditions, since they are based on climatic climax vegetation as defined by van Barneveld (1976). The four zones recognized are:

(i) Boreal white spruce zone (BwS)

(ii) Subboreal white spruce - alpine fir zone (SBwS-alF)

(iii) Subalpine Engelmann spruce - alpine fir zone (SAeS-alF)

(iv) Alpine tundra zone (AT)

The division of the study area into vegetation zones is illustrated in Figure 1.4. The vegetation zones described below are similar to Krajina's (1969) Biogeoclimatic Zones. Refer to Taylor and MacBryde (1977) for scientific names of common plant names given. It should be noted that the overall forest region framework within which the four zones have been organized in E.L.U.S.C. (1977) is considered too generalized for the purposes of the present report and is not employed in the ensuing discussion.

BOREAL WHITE SPRUCE ZONE (BwS)

The zone extends up to 1,200 metres (4,000 feet) above sea level in the Alberta Plateau, and is also present in the Rocky Mountain Foothills, where it reaches slightly lower elevations (approximately 1,080 metres or 3,600 feet).

Climatic climax stands are characterized by a mature forest of white spruce. Most areas, however, are in various seral stages, dominantly due to fire history. Trembling aspen is the common seral species on medium to fine textured materials, whereas lodgepole pine is dominant on medium to coarse textured materials. Balsam poplar is often mixed with the aspen on moister sites. Black spruce forms edaphic climaxes with tamarack larch on poorly drained soils and pure stands on very coarse-textured soils.

SUBBOREAL WHITE SPRUCE - ALPINE FIR ZONE (SBwS-alF)

The zone occurs in the Rocky Mountain Trench, and portions of the Rocky Mountains and Rocky Mountain Foothills. The zone rises to about 1,150 metres (3,800 feet) on south aspects and 1,020 metres (3,400 feet) on north aspects. Climatic conditions within the Subboreal zone are milder than the Boreal zone, with warmer temperatures and greater precipitation. Frost penetration is usually less as a result of greater snow depths.

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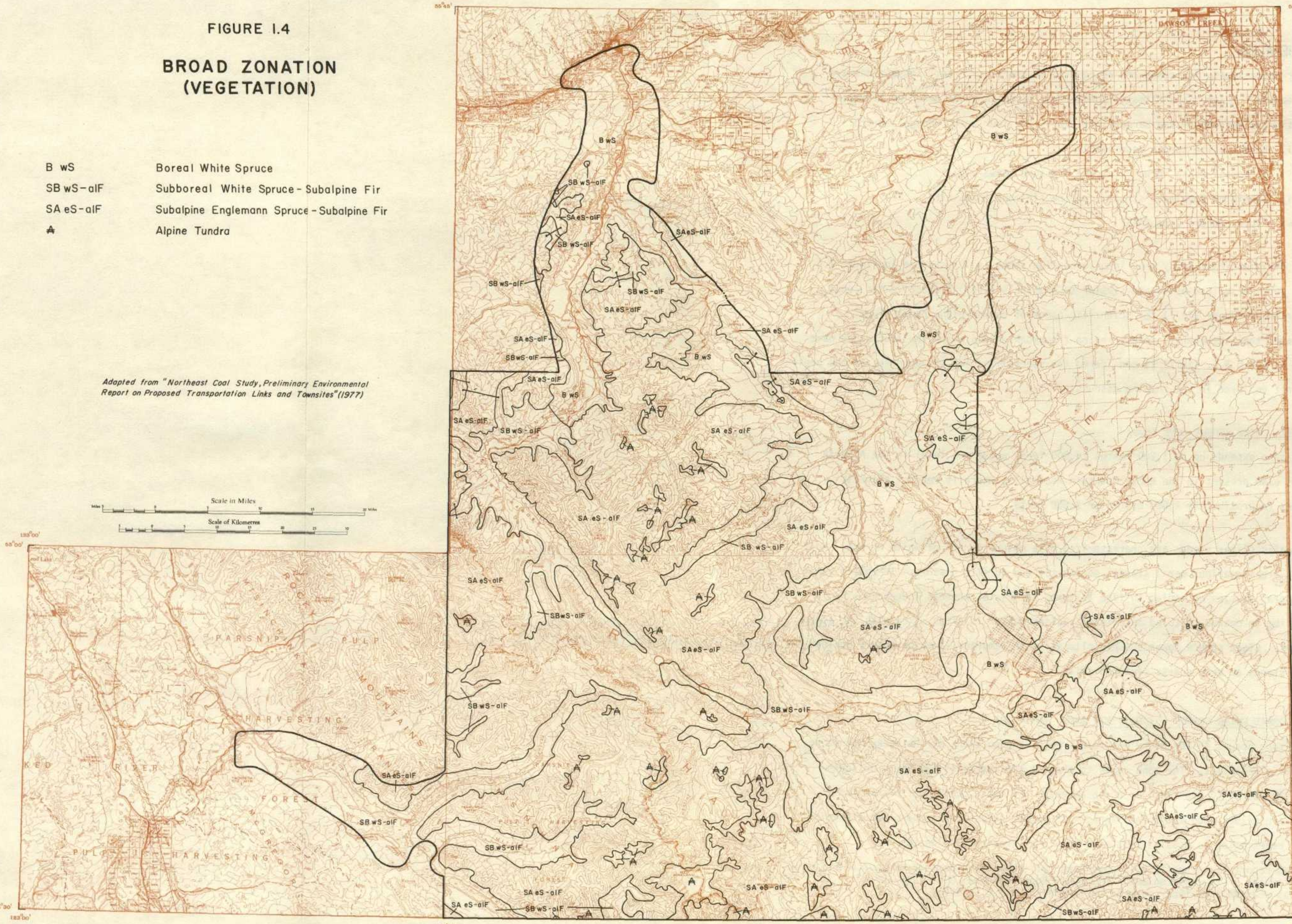
[1]A more detailed report is currently being prepared by: Vegetation Section, Resource Analysis Branch, B.C. Ministry of the Environment, 1873 Spall Road, Kelowna, B.C. V1Y 4R2. This section was adapted from their submission to the E.L.U.S.C. (1977).

FIGURE 1.4

BROAD ZONATION (VEGETATION)

B wS	Boreal White Spruce
SB wS-alF	Subboreal White Spruce-Subalpine Fir
SA eS-alF	Subalpine Englemann Spruce-Subalpine Fir
A	Alpine Tundra

Adapted from "Northeast Coal Study, Preliminary Environmental Report on Proposed Transportation Links and Townsites" (1977)



Climax stands are characterized by white spruce and alpine fir. The former is commonly hybridized with Engelmann spruce above 690 metres (2,300 feet) elevation. Lodgepole pine and western white birch are two common trees comprising seral stands in the study area.

Two subzones are distinguishable, depending upon the potential occurrence of Douglas-fir as a seral component. The subzone with Douglas-fir does not occur in the study area.

SUBALPINE ENGELMANN SPRUCE - ALPINE FIR ZONE (SAeS-alF)

This zone occurs in the higher elevations of the study area, in the Rocky Mountains and Rocky Mountain Foothills, and in small isolated areas within the Alberta Plateau. It generally occurs above 1,020 metres (3,400 feet) on north aspects and 1,150 metres (3,800 feet) on south-facing slopes, although minimum elevations may be reduced in areas of cold air drainage. The maximum elevation is approximately 1,800 metres (6,000 feet) above which the Alpine tundra zone occurs. The maximum elevation varies considerably depending upon local conditions. This zone experiences cooler year-round temperatures and deeper snow conditions than the previous two zones.

Climax stands are characterized by Engelmann spruce and alpine fir with an understory shrub layer dominated by white rhododendron. The zone is divided into forested and krummholz subzones, based on tree physiognomy (form).

ALPINE TUNDRA ZONE

This zone occurs in the very high elevations of the Rocky Mountains and Rocky Mountain Foothills, usually above 1,740 metres (5,800 feet) elevation. Climatic conditions are so severe that trees are unable to become established and cold climate (periglacial) processes such as frost churning (cryoturbation), solifluction, and nivation are quite active. Common plants include white and red heather, mountain-avens, crowberry, willows, and lichens.

chapter two

CHAPTER TWO

SOIL MAPPING AND SURVEY METHODS

2.1. SURVEY PROCEDURES

Prior to fieldwork, surficial materials were pretyped on aerial photographs using the B.C. Resource Analysis Branch's (1976) terrain classification. Aerial photographs at an approximate scale of 1" = 1 mile (80 chains ± 10%) and 2" = 1 mile (40 chains ± 10%) were used.

Field survey by truck on existing roads and by helicopter in relatively inaccessible areas provided field checking of air-photo interpretation. Soils were examined at each stop and field descriptions were recorded on such internal soil properties as horizonation, depth, colour, texture, pH, and drainage. External soil characteristics such as slope, elevation, rockiness, aspect, and associated vegetation were also noted on field cards. Soil development was taxonomically described using The System of Soil Classification for Canada (Canada Department of Agriculture, 1974).

Following field examination in several locations, a soils legend for the study area was developed. This legend was updated throughout the field season. The final legend is presented in Appendix A (Volume Two) and is attached to each 1:50,000 scale biophysical soils map.

Representative soils in the study area were sampled and morphologically described in detail and analyzed with respect to their physical and chemical characteristics. Detailed soil profile descriptions and laboratory analysis are available for most soil associations by contacting the Resource Analysis Branch (Attention: B.C. Soil Data File).

Field checking resulted in modification of pre-typing, with final lines being plotted on aerial photographs. These boundaries were then transferred to 1:50,000 scale topographic base maps for compilation.

Two separate sets of maps resulted:

(i) terrain maps, indicating distribution of surficial materials, surface expression, and modifying processes; and

(ii) biophysical soil maps, directly indicating soil parent material (surficial material), soil development, vegetation zone, drainage class, depth to bedrock, rockiness, and topographic (slope) classes. Indirectly, from Volume Two of this report which serves as an expanded legend, much more data regarding each soil can be gained, including texture, coarse fragment content, horizonation, colour, pH, structure, and other physical and chemical properties. In addition, when the vegetation sector completes its report for the study area, soil map units will be described with respect to typical seral communities leading to climatic climax conditions (termed vegetation types).

Both sets of 1:50,000 maps are available upon request by writing to the Resource Analysis Branch (Attention: Librarian).

2.2. MAPPING METHODS

Soils in the study area were mapped and interpreted using a hierarchical scheme of biophysical classification (see Figure 2.1.). Biophysical Groups represent the most general level of classification and are mapped at a scale of 1:250,000 (see back pocket, Volume One). A biophysical group is defined as similar parent materials occurring under similar climatic conditions as expressed by vegetation zone. Since vegetation zones are differentiated on the basis of major changes in the potential climatic climax vegetation, they are considered to express macroclimatic conditions. Biophysical groups are important insofar as they provide a regional perspective and have many similar interpretive characteristics for land use. Biophysical groups are described in Chapter Three and interpreted for selected land uses in Chapter Four.

Soils in the study area were mapped using Soil Associations. A soil association is defined as a sequence of soils derived from similar parent materials, occurring under similar climatic conditions as expressed by vegetation zone, and having similar modal soil development. Soil associations, however, have different characteristics due to variation in relief and drainage. Essentially, soil associations are biophysical groups which are further differentiated by differences in modal soil development (see Figure 2.1.). Soil associations are described in detail in Appendix B (Volume Two) and are shown on the 1:50,000 scale soil maps (see back pocket, Volume Two for sample map).

Soil Association Components are the basic mapping units. They are shown on the 1:50,000 scale soil maps as symbols (i.e. M05, the fifth component of the Moberly Association). Components of an association are separated on the basis of drainage, depth to bedrock, texture, or associated soil development. Soil association components are discussed in more detail in Appendix B (Volume Two). Relatively detailed interpretations are provided in Appendices C, D, E, and F (Volume Two) for forestry, wildlife, recreation, and engineering respectively for each soil association component.

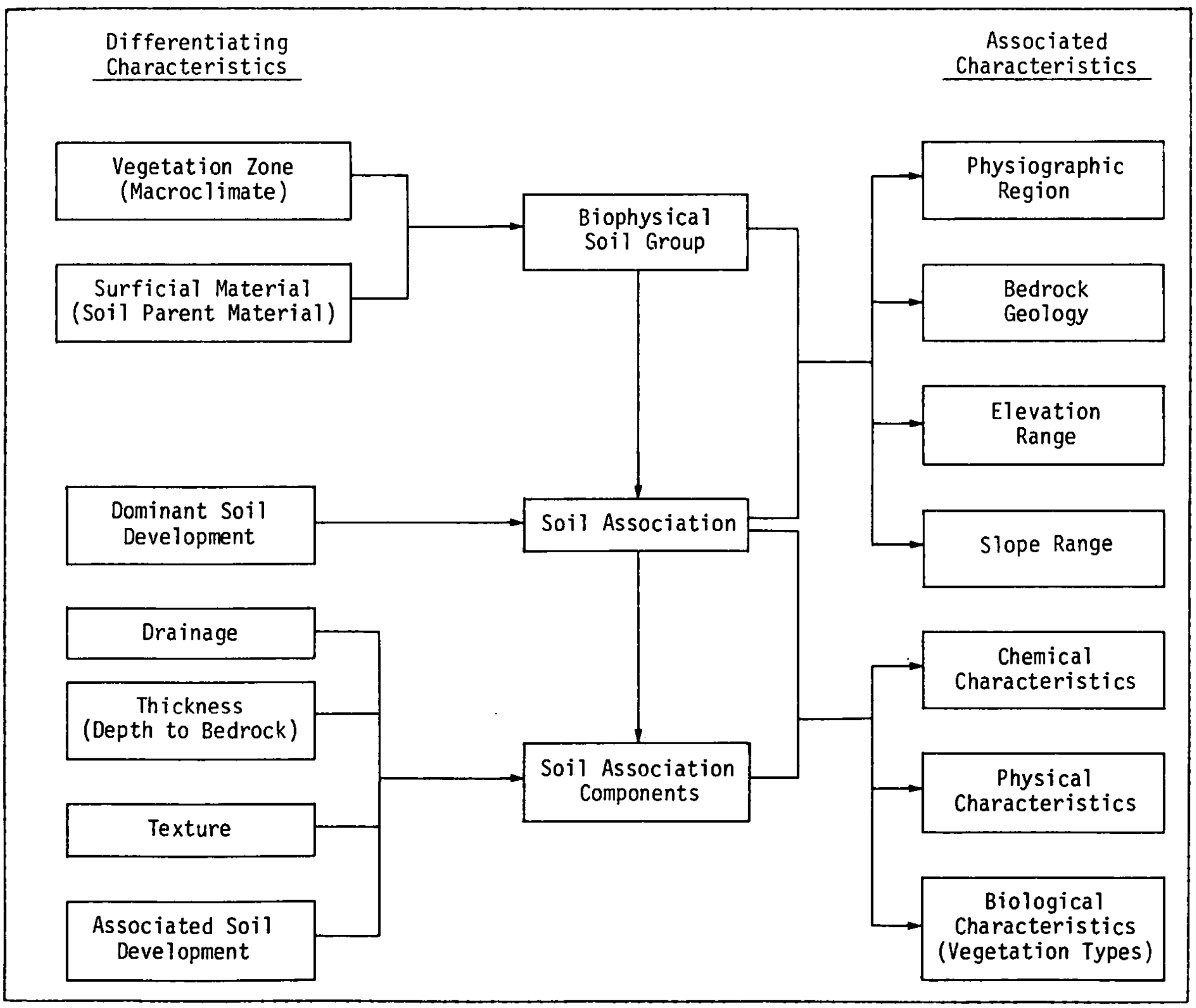


Figure 2.1. Hierarchical Biophysical Soil Classification Scheme, Northeast B.C. Coal Area

chapter three

CHAPTER THREE

BIOPHYSICAL SOIL RESOURCES

3.1. INTRODUCTION

The soil resources of the study area are described in relative detail in Appendix B (Volume Two). These descriptions are presented for the seventy-five soil associations identified and are particularly useful for managers and planners using the 1:50,000 scale soils maps. A discussion of the types and distribution of soil development occurring in the study area precedes these soil association descriptions in Appendix B.

This chapter will not go into as much technical detail. Rather, soil parent materials and biophysical groups are described in general so that an overview or regional perspective of the study area may be gained. Soil resources are first described in section 3.2. with respect to the types and distribution of soil parent materials (surficial materials) found in the study area. Biophysical groups are discussed in section 3.3. with a map showing their distribution presented in the back pocket of this volume.

3.2. SOIL PARENT MATERIALS (SURFICIAL MATERIALS)

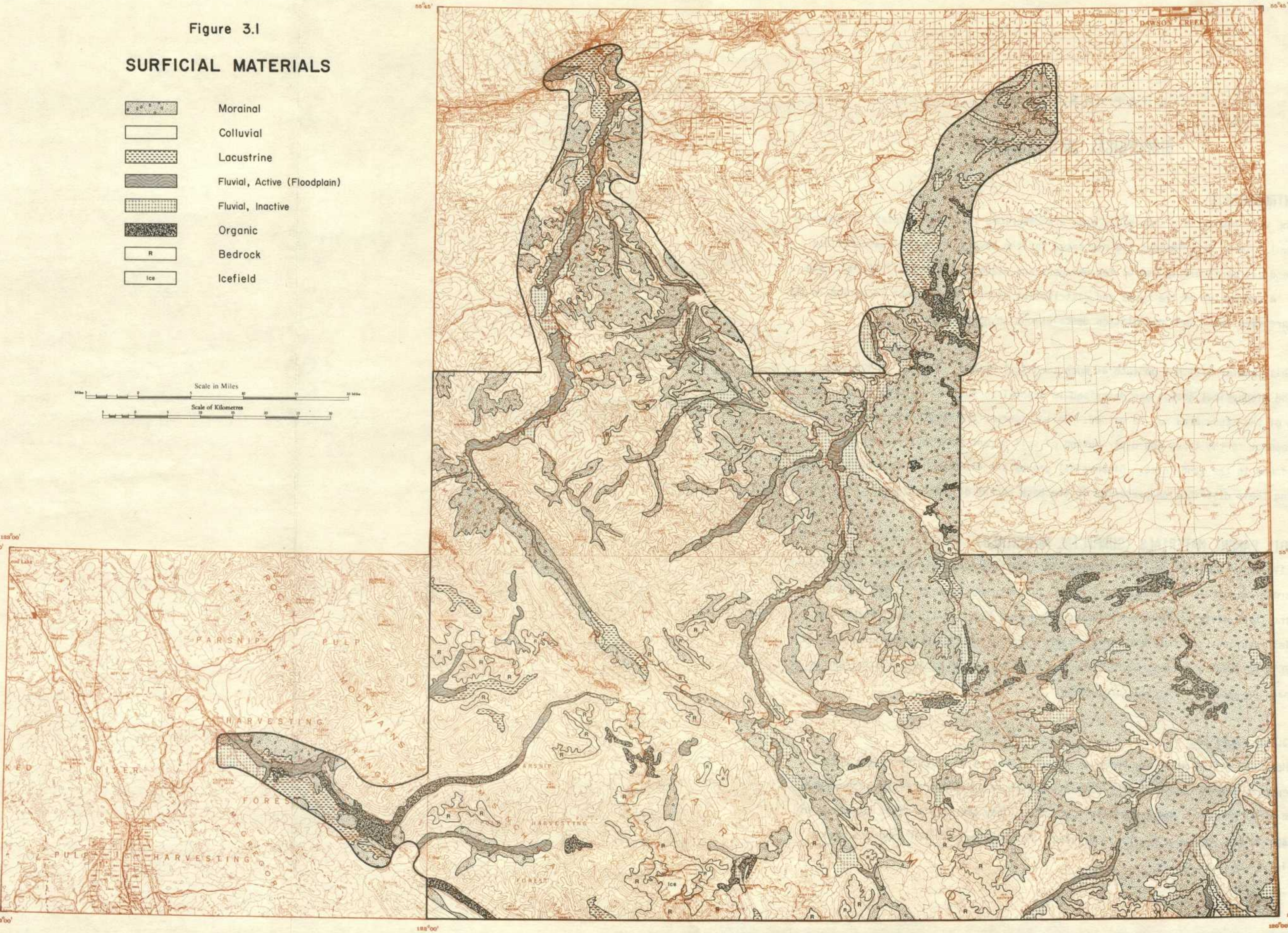
Five major types of soil parent materials (surficial materials) were identified in the study area: morainal, colluvial, lacustrine, fluvial, and organic. These parent materials and their distribution are discussed below (see Figure 3.1). Definitions used for surficial materials are from the Terrain Classification System (B.C. Resource Analysis Branch, 1976); textural and topographic terms are from The System of Soil Classification for Canada (Canada Department of Agriculture, 1974).

3.2.1. MORAINAL

Morainal (till) materials refer to materials deposited directly from glaciers. Morainal deposits are the dominant soil parent material in the Alberta Plateau Benchlands and eastern portions of the Rocky Mountain Foothills. They are only a minor component of the landscape in the remainder of the study area. Many of the morainal deposits have a sandy fluvial or eolian capping.

Figure 3.1

SURFICIAL MATERIALS



Morainal materials are subdivided primarily on the basis of texture, and depth to or absence of carbonates. Reimchen et. al. (1977) provide a discussion of the possible origin of the morainal deposits in the study area; they conclude that the age of cordilleran tills are largely correlated with depth to carbonates.

Fine-textured (clayey), relatively stone-free, morainal deposits occur in the extreme northeast portion of the study area between Arras and Fellers Heights. These deposits occur below 850 metres elevation on undulating topography with depth to carbonates being approximately one metre. These morainal deposits are believed to have been derived from continental ice sheets.

Fine-to-medium-textured (silty-clayey), and deeply weathered (depth to carbonates greater than one metre) morainal deposits also occur in the northeast portion of the study area, just southwest of the continental tills previously described and northeast of Muskeg Lake. These tills occur on undulating topography on top of the plateaus between 800 and 1,230 metres elevation and are believed to be old (Pre-Classical Wisconsin Age) cordilleran tills.

Stony, medium-textured, and shallowly weathered cordilleran tills are the most widespread morainal deposits in the study area. They occur throughout the Rocky Mountain Foothills and Alberta Plateau Benchlands on undulating to hilly topography. Depth to carbonates is usually about 50 centimetres from the surface. These tills are believed to be of Classical Wisconsin Age.

Very stony, medium-to-coarse-textured cordilleran tills occur in the central portions of the study area in the Rocky Mountains and Rocky Mountain Foothills. These tills generally occur above 1000 metres elevation on dominantly hilly topography; they are generally thin on side slopes, where they are commonly intermixed with colluvial deposits, but can be thick in some valley bottoms.

Non-calcareous, morainal veneers occur in localized areas and strongly reflect the bedrock type which they overlie. In the eastern portion of the study area, in the Alberta Plateau Benchlands, a coarse-textured till overlies sandstone. In the central portion of the study area, near the confluence of Imperial Creek and Murray River, a very shallow, fine-textured till over deeply weathered siltstone occurs. In the Hominka River valley, above 1170 metres elevation, shallow till occurs over fine-grained metamorphic bedrock consisting mainly of schists.

In the Rocky Mountain Trench, a deep, non-calcareous, coarse-textured till occurs. This till is deeply weathered due to high precipitation in this southwestern portion of the study area.

Tills of variable texture in relatively recently deglaciated areas occur in some high elevation areas (above 1600 metres), often near existing icefields. They are largely restricted to the Rocky Mountains near the Continental Divide.

3.2.2. COLLUVIAL

Colluvial materials are products of mass wastage and have reached their present position by direct, gravity-induced movement. Colluvium is the dominant soil parent material, covering over 50% of the study area. Colluvial materials are particularly dominant in the Rocky Mountains and western portions of the Rocky Mountain Foothills, but they are only a minor component of the Alberta Plateau Benchlands, the Rocky Mountain Trench, and eastern portions of the Rocky Mountain Foothills.

Colluvial materials are separated primarily on the basis of the type of bedrock from which they have been derived; this is because several properties such as texture and pH are largely inherited from the parent bedrock. Occasionally, unconsolidated fluvial and morainal materials have been sufficiently modified by mass wasting to be called colluvium; usually bedrock fragments are intermixed with these deposits. In higher elevations in the Alpine zone and Subalpine krummholz subzone, periglacial (cold climate) processes have modified, or are currently modifying, the colluvium. These processes include cryoturbation (frost churning), solifluction, and nivation.

Colluvium derived primarily from sandstone and shale occurs in the north, central and eastern portions of the study area in the Rocky Mtn. Foothills and Alberta Plateau Benchlands. These materials are usually medium-to-coarse-textured and non-calcareous.

Colluvium derived primarily from limestone and dolomite occurs in the central portions of the study area in the Rocky Mountains. These materials are usually coarse-textured and strongly calcareous.

Colluvium derived primarily from fine-grained metamorphic bedrock (mainly schists) occurs in the southwestern portion of the study area in the Rocky Mountains on the west side of the Continental Divide. These deposits are medium-to-coarse-textured and non-calcareous.

Colluvium derived primarily from conglomerate is coarse-textured and non-calcareous. These materials occur in relatively small, localized areas, for instance, on some south-facing slopes of Quintette Mountain.

Colluvium derived primarily from siltstone bedrock is fine-textured and non-calcareous. These materials occur in a relatively localized area near the confluence of Imperial Creek and Murray River.

3.2.3. LACUSTRINE

Lacustrine materials are sediments that have settled from suspension in lakes; most of these deposits are glacio-lacustrine in the study area since they were originally deposited in contact with glacier ice. In the study area, lacustrine materials are generally fine-textured, stone-free, and calcareous at depth.

The distribution of lacustrine deposits is important in two respects: (1) when climate is not restricting, they are usually the best materials for agricultural use; and (2) they are usually the most erodible materials. Some of the larger deposits of lacustrine materials in the study area occur in the:

i) northeast, along the Kiskatinaw River. These deposits are believed to be part of, or associated with, the large glacial Lake Peace.

ii) northwest, along the Pine and Sukunka Rivers from Chetwynd to Martin Creek. These deposits are believed to be part of a large glacial lake in the Chetwynd area.

iii) east, at the confluence of Flatbed and Hambrook Creeks (west of Thunder Mountain).

iv) southeast, at the confluence of Kinuseo and Onion Creeks (south of Quintette Mountain).

v) west, along the headwaters of the Sukunka, Anzac, and Table Rivers. These deposits are deeply gullied, vary from silt to fine sand in texture, and occur above 1150 metres elevation. Lacustrine sediments are common throughout most of the upper drainages on the west side of the divide to the southeast of the study area.

vi) southwest, along the Parsnip River in the Rocky Mountain Trench. These deposits are non-calcareous.

In the Tumbler Ridge area, at the confluence where Flatbed Creek, Bullmoose Creek, and Wolverine River merge with the Murray River, lacustrine sediments have been overlain by fluvial sediments. The lacustrine sediments are exposed by down-cutting of the Murray River and in actively slumping areas.

3.2.4. FLUVIAL

ACTIVE FLUVIAL (FLOODPLAIN)

Floodplain (active fluvial) materials are those which are actively transported and deposited by streams and rivers. Most deposits are level, but some develop a fan-shape. Floodplain materials are generally calcareous when limestone and dolomite bedrock occur in their watersheds; and non-calcareous when these bedrock types are not present.

Sandy, calcareous floodplain deposits occur adjacent to the lower Sukunka and Murray Rivers. These deposits are most extensive north of Burnt River along the Sukunka River and in the Tumbler Ridge area along the Murray River.

Gravelly, calcareous floodplain deposits occur adjacent to the Sukunka and Murray Rivers in the upper portion of their drainages. These deposits are also present alongside several other rivers and creeks, including the Wolverine and Wapiti Rivers, and Monkman Creek.

Sandy and gravelly, non-calcareous floodplain deposits usually occur alongside tributary creeks and streams to the Sukunka and Murray Rivers (e.g. Meikle Creek).

Silty-to-fine-sandy, non-calcareous floodplain deposits occur alongside the Parsnip River in the Rocky Mountain Trench.

INACTIVE FLUVIAL

Inactive fluvial materials occur above contemporary floodplains; many of these deposits are glaciofluvial since they were originally deposited in contact with glaciers. These deposits occur in localized areas, usually in valley bottoms adjacent to streams. They generally occur on level topography, but may be hummocky, ridged (e.g. eskers), fan-shaped, or kettled. Occasionally, these fluvial sediments occur as blankets over till.

The distribution of inactive fluvial materials is important in two respects: (1) they represent primary sources of sand and gravel; and (2) they are generally the most suitable materials for intensive development (e.g. dwellings, campgrounds, roads).

Sandy, calcareous, fluvial materials dominantly occur in the northern portions of the study area. They are largest in extent in the lower Sukunka River valley, in the Tumbler Ridge area, and north of Tumbler Ridge in the Alberta Plateau area to Fellers Heights.

Gravelly, calcareous, fluvial materials occur in central portions of the study area, in the Rocky Mountain Foothills and Rocky Mountains. There are particularly large deposits at the confluence of the Burnt and Sukunka Rivers; in the Tumbler Ridge area; alongside the upper Flatbed Creek, Belcourt Creek, Bullmoose Creek, and Wapiti River; and, in the Kinuseo Falls area along the Murray River.

Sandy and gravelly, non-calcareous glaciofluvial deposits occur in the Rocky Mountain Trench in the Tacheeda Lakes area. Silty-to-fine-sandy, non-calcareous fluvial fans are present in the Hominka River valley.

3.2.5. ORGANIC

Organic materials are deposits which have resulted from vegetative growth, accumulation, and decay, and result when the rate of accumulation exceeds decay. In the study area, these deposits generally occur in small, localized areas such as small peat bogs. A major exception is the extensive area of organic deposits in the Rocky Mountain Trench and portions of the Rocky Mountains along the Parsnip and Hominka River valleys.

Other large organic deposits occur in the Muskeg Lake area, in the Monkman Creek area near Monkman Pass (south of Monkman Lake), in the Kinuseo Creek area (due south of Quintette Mountain), and in the east along Thunder Creek and South Redwillow River.

3.3. BIOPHYSICAL SOIL GROUPS

The 25 biophysical groups in the study area are indicated in Table 3.1 and are mapped at a scale of 1:250,000 (see back pocket, Volume One). Generalized land use interpretations are indicated on the expanded legend which accompanies the map; these interpretations are discussed in Chapter Four. Four biophysical groups are shown on Plates 4 to 7.

As mentioned in Chapter Two, biophysical groups represent a broad level of classification which simply integrates soil parent materials (surficial materials) and vegetation zones. Since biophysical groups have regionally similar interpretive characteristics for land use, they are useful in that they provide a regional understanding of the extent and distribution of resource values in the study area. This overview perspective is considered essential for regional resource planning.

Seven of the biophysical groups occur exclusively in the Boreal white spruce zone. Lacustrine, colluvial, active fluvial (floodplain), inactive fluvial (including glaciofluvial), fine-textured morainal, medium-textured morainal, and poorly drained mineral deposits represent distinct biophysical groups. Morainal deposits are differentiated on the basis of texture which significantly influences their suitability for use. Poorly drained mineral soils developed on morainal, lacustrine, and fluvial materials are grouped together because of the predominant effect that poor drainage has on land use interpretations.

PLATE 4: BIOPHYSICAL GROUP 2

Medium-textured morainal materials within the Boreal white spruce zone. Also shown is the veneer of sandy material which often occurs. Seral lodgepole pine stands are common.

(Photo by T.K. Ovanin)

PLATE 5: BIOPHYSICAL GROUP 11

Coarse-textured colluvial materials within the Subboreal white spruce - alpine fir zone. The angularity and downslope orientation of coarse fragments is characteristic of colluvium.

(Photo by T.K. Ovanin)

PLATE 6: BIOPHYSICAL GROUP 23

Coarse-textured colluvial materials in the krummholz subzone of the Subalpine Engelmann spruce - alpine fir zone.

(Photo by T.K. Ovanin)

PLATE 7: BIOPHYSICAL GROUP 24

Coarse-textured colluvial material in the Alpine tundra zone. The presence of erratics indicates that this high elevation area was glaciated.

(Photo by T.K. Ovanin)

TABLE 3.1

LEGEND FOR BIOPHYSICAL GROUPS

Biophysical Group	Parent Materials (Surficial Materials)	Vegetation Zones
1	Morainal, fine-textured	Boreal
2	Morainal, medium-textured	Boreal
3	Variable, poorly drained	Boreal
4	Lacustrine	Boreal
5	Colluvial	Boreal
6	Fluvial, active (floodplain)	Boreal
7	Fluvial, inactive (incl. glaciofluvial)	Boreal
8	Organic	All zones
9	Morainal*	Subboreal
10	Lacustrine*	Subboreal
11	Colluvial*	Subboreal
12	Fluvial, active (floodplain)*	Subboreal
13	Fluvial, inactive (incl. glaciofluvial)	Subboreal
14	Morainal**	Subboreal
15	Lacustrine**	Subboreal
16	Colluvial**	Subboreal
17	Fluvial, active (floodplain)**	Subboreal
18	Morainal	Subalpine, forested subzone
19	Lacustrine	Subalpine, forested subzone
20	Colluvial	Subalpine, forested subzone
21	Fluvial, active (floodplain)	Subalpine, forested subzone
22	Fluvial, inactive (incl. glaciofluvial)	Subalpine, forested subzone
23	Colluvial (incl. some morainal)	Subalpine, krummholz subzone
24	Colluvial	Alpine
25	Colluvial (talus)	Subalpine and Alpine

*East side Continental Divide in Rocky Mountain Foothills and Rocky Mountains.
**West side Continental Divide in Rocky Mountain Trench and Rocky Mountains.

All organic deposits, regardless of vegetation zone, are placed into one biophysical group. These areas have similar interpretive characteristics due to organic accumulation and poor drainage and are also relatively minor in extent.

Nine biophysical groups occur in the Subboreal white spruce - alpine fir zone; four on the west side of the continental divide, four on the east side, and one occurring on both sides. The west side of the divide, as mentioned previously in the Climate section (1.3), tends to have greater precipitation and temperatures which leads to greater biological growth, including higher forest capabilities.

Six biophysical groups occur exclusively in the Subalpine Engelmann spruce - alpine fir zone. Five occur in the forested subzone on morainal, lacustrine, colluvial, inactive fluvial, and active fluvial materials. One biophysical group occurs in the krummholz subzone on dominantly colluvial material. Small, localized areas with morainal materials are also included in this biophysical group.

One biophysical group occurs exclusively in the Alpine tundra zone on colluvial material. Rubbly and blocky colluvial deposits, known as talus, are placed into one biophysical group regardless of vegetation zone.

chapter four

C H A P T E R   F O U R

LAND EVALUATION

4.1. INTRODUCTION

Biophysical groups are interpreted in this chapter for various land uses including agriculture, forestry, wildlife, recreation, engineering, and visual resources. The last section of this chapter summarizes the key interpretations for each of the 25 biophysical groups so that some relative comparisons can be made at the regional planning level. It is important to realize, however, that these comparisons are based on an analysis of biophysical soil characteristics only and that other considerations, including socio-economic factors, must also be assessed before more meaningful comparisons can be made.

Soil associations and soil association components are described in Appendix B (Volume Two) and interpreted in more detail for forestry, wildlife, recreation, and engineering in Appendices C to F (Volume Two) respectively. These interpretations are intended for those who use the 1:50,000 scale soil maps.

4.1.1. BIOPHYSICAL SOIL INTERPRETATIONS AND LAND USE

Soils are one of the basic resources to consider when planning land use activities. If soil resources are properly used and managed, construction and maintenance costs, as well as the costs of environmental degradation, can be kept minimal.

Soils vary in the type and severity of limitations as sites for forestry, wildlife, recreational and engineering activities. Some soils have severe limitations for one or more uses, while others may be well suited for a number of uses. Therefore, knowledge of soil characteristics is basic to good planning and management which attempts to optimize the mix of resource uses.

Biophysical soil interpretations provide relative predictions of soil performance based on field observations and laboratory information. These predictive ratings are intended to serve as input into the planning process and are not intended as recommendations for land use.

When using soil interpretive ratings, the following must be considered:

1. Interpretations do not eliminate the need for on-site evaluations by qualified professionals.
2. Biophysical soil interpretations only consider those parameters implicit in the definition of each biophysical group or soil association. Other important limitations may exist that were not considered.
3. When applying soil interpretations to map units, users must realize that, due to the variable nature of soils, small inclusions of unmappable (due to scale) soils may be present.
4. 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.
5. Methods or criteria used to interpret soils for most land uses are an approximation based on current information available. Users are encouraged to modify or change these methods when further experience warrants it.

4.1.2. SOIL INTERPRETIVE CLASSES

Biophysical 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, low, or nil; or, as good, fair, poor, or unsuited. Ratings of slight, moderate, and severe are used to designate the degree of soil limitations. The latter interpretive ratings can be summarized as follows:

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

ii) moderate limitations: recognized in soils that have properties with some significant limitations for 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 ill-suited for the rated use because of one or more unfavourable soil properties. Limitations are difficult and costly to modify or overcome, requiring special design, major soil reclamation, or intense maintenance.

Soil capability ratings are also provided for some land uses, either by using generalized high, moderate, or low ratings or by using the seven capability classes defined by the Canada Land Inventory (1970). These and other interpretations are discussed in more detail in each interpretive section.

4.2. AGRICULTURE

4.2.1. INTRODUCTION

The only agricultural interpretations provided are generalized soil capability for agriculture ratings (see Table 4.1). The apparent low agricultural potential of the study area and the relative lack of reliable climatic data[1], which is essential for reliable capability ratings, meant that it was neither necessary nor feasible to provide more sophisticated agricultural interpretations. Thus, no detailed capability ratings for agriculture are provided in Volume Two.

Capability classes for agriculture were grouped into four generalized ratings: High (Classes 1 and 2); Moderate (Classes 3 and 4); Low (Classes 5 and 6); and Nil (Class 7). Classes 1 to 7 are defined by the Canada Land Inventory (1972). High capability land has none to slight limitations to the growth of regionally adapted crops; moderate capability land has moderate to moderately severe limitations; low capability land has severe to very severe limitations; while nil capability soils have extreme limitations. It is important to remember that the agricultural capability classification system takes into account the range of crops possible, and not productivity of any one crop.

Runka (1973), Canada Land Inventory (1972), and E.L.U.C. Secretariat (1976) provide additional discussion with respect to what the agricultural capability ratings mean. The latter report also provides a generalized agricultural capability map for the Peace region, which includes portions of the study area.

[1]With the existing climatic network established in the study area (as mentioned in section 1.3.), relatively reliable climate data should be available in approximately three years.

Agricultural capability maps are already available for 93P (N.T.S. sheets in 93P) at a scale of 1:50,000. These maps were prepared by Canada Department of Agriculture (1970); they are available from the Resource Analysis Branch. The 93P/SE (Bedwany and Farstad, 1970) and 93P/SW (Watt and Farstad, 1970) agricultural capability maps have been published. This information was based on the limited soils and climate data available at the time.

4.2.2. METHODS

Soil/agriculture capability rating relationships were established for areas where agricultural capability maps (i.e. 93P and 93J/S½) were available. These relationships were extended into the remainder of the study area (93I/N½) where similar soils occur.

It is important to remember that the generalized agricultural capability ratings presented in Table 4.1 do not represent an updating of information, but do provide information for previously unmapped areas.

4.2.3. RESULTS

Lacustrine deposits in the northern and eastern portions of the study area (in the Boreal zone) have the highest capability rating, varying from moderate to high. Adverse climate is the only major limitation. These areas, however, are very limited in extent and most are already cultivated.

Floodplain soils in the Boreal zone and lacustrine soils in the Subboreal zone have moderate to low capabilities. Inundation and adverse climate are the main limitations respectively.

Fine-textured morainal soils in the Boreal zone in the northeast portion of the study area, and floodplain deposits in the Subboreal zone have low to moderate capabilities for agriculture. The former soils have adverse climate, stoniness, and topographic limitations, while the latter soils are limited due to inundation, stoniness, and adverse climate.

The aforementioned soils represent only approximately 5% of the study area. The remainder of the area has low or nil capability for agriculture due primarily to adverse climate, stoniness, and steep topography.

TABLE 4.1

GENERALIZED SOIL INTERPRETATIONS FOR AGRICULTURE*

BOREAL ZONE

BIOPHYSICAL** GROUPS		AGRICULTURAL CAPABILITY	DOMINANT LIMITATIONS	SOIL*** ASSOCIATIONS
Lacustrine Materials	4	Moderate to High	Climate	Devereau (DU) Dickebusch (DB) Tri-Creek (TC)
Fine-Text. Morainal Materials	1	Low to Moderate	Climate Stoniness Topography	Edson (ED) Fellers (FE)
Medium-Textured Morainal Materials	2	Low	Topography Stoniness Climate	Moberly (MO) Lodge (LG)
Colluvial Materials	5	Low to Nil	Topography Stoniness	Septimus (SS) Squaw Mountain (SQ) Zonnebecke (ZB)
Active Fluvial (Floodplain) Materials	6	Moderate to Low	Inundation Stoniness Climate	Oetca (OE) Meikle Creek (ME) Windfall Creek (WF)
Inactive Fluvial Materials	7	Low	Droughtiness Stoniness	Jarvis (JR) Neumann (NE) Portage Creek (PC) Sundance (SU)
Organic and Poorly Drained Materials	8 3	Low	Wetness	Eaglesham (EG) Kenzie (KZ) Gunderson (GN) Smoky (SY) Snipe (SN)

SUBBOREAL ZONE

BIOPHYSICAL** GROUPS		AGRICULTURAL CAPABILITY	DOMINANT LIMITATIONS	SOIL*** ASSOCIATIONS
Lacustrine Materials	10 15	Moderate to Low	Climate	Bednesti (BD) Dokken (DK)
Morainal Materials	9 14	Low	Climate Stoniness Topography	Bulley (BL) Crum Mountain (CM) Lean-To (LT) Imperial Creek (IC) Dominion (DO)
Colluvial Materials	11 16	Low to Nil	Topography Stoniness	Barton (BT) Spieker Mountain (SP) Suprenant Mountain (ST)
Active Fluvial Materials	12 17	Low to Moderate	Inundation Stoniness Climate	Bullmoose (BM) Monkman Creek (MK) McGregor (MG) Mokus Creek (MU)
Inactive Fluvial Materials	13	Low	Droughtiness Stoniness Climate	Abbl Mountain (AB) Kinuseo (KO) Triad Creek (TC) Ramsey (RM) Toneko (TO)
Organic Materials	8	Low	Wetness	Mitska (MT) Whatley (WH) Chief (CF) Moxley (MX)

*Soils in the Subalpine and Alpine Zones have nil agricultural capability due mainly to adverse climate limitations; this includes Biophysical Groups 18 to 25.

**Biophysical Group numbers are explained in Section 3.3., pp. 24-26.

***These soil associations are described in Appendix B (Volume Two).

4.3. FORESTRY

4.3.1. INTRODUCTION

Generalized interpretations for forestry are provided in Table 4.5 at the end of this section for biophysical soil groups; these interpretations are useful for regional planning. Relatively detailed interpretations are provided in Appendix C (Volume Two) for biophysical soil association components and are meant to be used with the 1:50,000 scale soil maps for management unit[1] and watershed (folio) development planning. Interpretations provided in Appendix C only generally indicate potential problems at the operational planning level; for more exact information, on-site investigation is required.

Forest capability, dominant coniferous trees, limitations for regeneration, windthrow hazard, limitations for logging roads and erosion hazard are discussed.

Forest capability maps were available prior to the study for 93P. Kowall and Senyk's (1970) map of the Gwillim Lake map sheet (93P/SW), and Wood *et al*. (1970) map of the Kiskatinaw River map sheet (93P/SE) are published.

Reimchen *et*. *al*. (1977) have prepared erosion hazard potential maps for most of the study area. Erosion hazard potential was interpreted from surficial material (terrain) maps, with three classes recognized: high (unstable), moderate (metastable), and low (stable).

4.3.2. METHODS

FOREST CAPABILITY

Methods used to determine the forest capability classification for soils are explained by Kowall (1971). A general discussion of forest capability is available in a Canada Land Inventory publication by McCormack (1972).

Five generalized capability classes are recognized in Table 4.3: High (C.L.I. classes 1 and 2); Moderate (C.L.I. classes 3 and 4); Low (C.L.I. class 5); Very Low (C.L.I. class 6); and Nil (C.L.I. class 7). Complete forest capability ratings are given in Appendix C, Volume Two.

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[1]Planning terms used are from Pearse (1976), pp. 261-265.

DOMINANT CONIFEROUS TREES

Dominant coniferous tree occurrence is derived from forest zonation descriptions. The tree species indicated are listed in order of their relative dominance based on field observations on various soils. For example, glaciofluvial deposits in the Boreal zone have a soil moisture deficiency for forest growth; lodgepole pine can adapt to these conditions best and is therefore indicated first. The species listed are indicated as options for tree planting or seeding subsequent to forest harvesting and are based on species presently occurring. Exotic species may grow as well or better than indigenous species, thus additional options may exist.

LIMITATIONS FOR REGENERATION

Brush competition and potential frost action were the only factors considered in interpreting the limitations for regeneration. Brush competition for each soil type was assessed in the field. Frost action ratings were determined by modifying existing rating schemes by the USDA Soil Conservation Service (1971) and the Asphalt Institute (1963). The table used for determining potential frost action ratings and the ratings themselves are located in section 4.7. on engineering interpretations.

Other soil limitations which affect successful regeneration may be inferred from the forest capability classification in Appendix C. Factors such as soil moisture deficiency/excess, rooting depth, and fertility limitations affect both forest growth and regeneration success.

Several potentially significant limitations for regeneration have not been considered, including damping-off hazard, insect damage hazard, rodent damage hazard, and climatic hazards.

WINDTHROW HAZARD

Windthrow hazard ratings were determined by assessing edaphic factors only. Drainage, texture, and effective rooting depth were evaluated before arriving at an overall rating. The following table provides a guide for assessing soil limitations for windthrow hazard:

TABLE 4.2

GUIDE FOR ASSESSING SOIL LIMITATIONS FOR WINDTHROW HAZARD			
Item Affecting Use	Degree of Soil Limitation		
	Slight	Moderate	Severe
Drainage	Rapidly, well, and moderately well drained	Imperfectly drained	Poorly and very poorly drained
Texture[1]	Sandy loam, loam, loamy sand, sand	Silt loam, silty clay loam, silty clay	Clay, clay loam, silty clay
Effective Rooting Depth[2]	>100 cm	50-100 cm	<50 cm

[1]Gravelly soil materials would reduce textural limitations one degree.

[2]Depth to bedrock, depth to impervious layer (i.e. Bt), depth to Ck horizon, or restricting water table.

This guide does not take into account other (non-soil) limitations such as winds, stand composition, or management practices which may be critical in assessing windthrow hazard in a given area.

The U.S.D.I. Bureau of Land Management (no date) discusses several factors which are important to consider when evaluating windthrow hazard. For example, trees infected with root or butt rots are predisposed to windthrow. Poorly stocked or open stands are generally more windfirm and develop faster with exposure than old stands. Hardwood stands or mixed stands of hardwoods and conifers are generally wind resistant.

In British Columbia, Moore (1975) prepared a review of literature pertaining to blowdown, and Moore (1977) is studying blowdown on streamside leave strips on Vancouver Island.

LIMITATIONS FOR LOGGING ROADS

Soil limitation ratings for unsurfaced logging roads were developed by modifying an existing guide by Craul (1975). The modified guide (Table 4.3) reflects the information base available in the study area. Craul discusses the importance of soil items affecting logging roads.

TABLE 4.3

GUIDE FOR ASSESSING SOIL LIMITATIONS FOR LOGGING ROADS			
Item Affecting Use	Degree of Soil Limitation		
	Slight	Moderate	Severe
Drainage*	Rapidly, well and moderately well drained	Imperfectly drained	Poorly and very poorly drained
Flooding**	None	Occasional (less than once in 5 years)	Frequent (more than once in 5 yrs.)
Subgrade*** (a) AASHO Group Index	0-4	5-8	More than 8
(b) Unified Soil Classes	GW, GP, GM, GC, SW, SP, SM, SC.	ML CL (PI<15)	MH, CH, OH, OL, CL (PI>15)
Susceptibility to Frost Action***	Low	Moderate	High
Depth to Bedrock*	Deep (>1 meter)	Shallow (50-100cm)	Thin (<50cm)
Rockiness****	Bedrock cover <5% surface	Bedrock cover 5-20% surface	Bedrock cover >20% surface
Slope****	0-15% (ABCDE)	15-60% (FG)	>60% (H)

*These items directly available from soils legend.
**Flooding inferred from soil development and landscape position.
***These items are rated in engineering section.
****These items available from soil maps.

Limitation ratings indicate the relative cost and difficulty in constructing and maintaining unsurfaced logging roads. Where soil is rated as having severe limitations, this does not imply that logging roads cannot or should not be constructed, but does indicate that construction and maintenance costs are likely to be very high and alternate routes should be considered.

EROSION HAZARD

Erosion hazard ratings were determined by evaluating soil parent material (surficial material) with topographic classes (slope) as follows:

TABLE 4.4

GUIDE FOR ASSESSING SOIL EROSION HAZARD					
	Topographic Classes (Slope %)				
Surficial Material	ABCabc (0-5%)	Dd (5-9%)	EFef (9-30%)	Gg (30-60%)	Hh (>60%)
Lacustrine	Moderate	High	High	High	High
Organic	Moderate	High	High	High	High
Morainal (fine-textured)	Moderate	Moderate	High	High	High
Morainal (medium-textured)	Low	Low	Moderate	High	High
Colluvial (cryoturbated)	Low	Low	Moderate	High	High
Colluvial	Low	Low	Moderate	Moderate	High
Fluvial*	Low	Low	Low	Moderate	High

*Erosion by rivers and streams on floodplains is not evaluated here.

Erosion hazard was rated by modifying methods developed by Reimchen et. al. (1977) and Rutter (1968); they provide a discussion of how surficial materials and slope were assessed to determine erosion potential. Bayrock and Reimchen (in preparation) have conducted erosion potential studies in the Rocky Mountains and Rocky Mountain Foothills.

Erosion hazard ratings are based on evaluating the natural, undisturbed soil. Several studies, including Kochenderfer (1970), Fredriksen (1970), and Swanston (1971), have concluded that erosion problems in forestry are dominantly associated with forest roads. The relative rating of erosion hazard is assumed to remain valid even if modified by development.

4.3.3. RESULTS

The Subboreal zone generally has moderate to high forest capability, while land in the Boreal zone generally has moderate to low capability due to climatic aridity limitations. The variation in capability depends largely on the soil parent materials and drainage. Due to climatic constraints, land in the Subalpine zone has low to very low capability. Land in the Alpine zone has no capability for forestry.

The following discussion of capability of parent materials relates to the Boreal and Subboreal zones. Floodplain deposits generally have the highest forest capabilities in the study area, often C.L.I. class 1. Morainal deposits generally have moderate capability on the east side of the Continental Divide, and high capability on the west side of the Divide. Lacustrine deposits generally have moderate capability due to droughtiness and rooting depth limitations on the east side of the Divide, but high to moderate capability to the west of the Divide in the Rocky Mountain Trench area. Inactive fluvial deposits generally have moderate capability due to soil moisture deficiency associated with the low water holding capacity of the materials. Colluvial deposits east of the Divide generally have low capability due to soil moisture deficiencies associated with relatively rapid water runoff and shallow depth to bedrock, whereas colluvial deposits west of the Divide have moderate capability for forestry.

Limitations for regeneration are usually least on inactive fluvial deposits and greatest on lacustrine deposits. Lacustrine deposits are severely limited because of high frost action potential and high brush competition potential. Fine-textured morainal deposits in the Boreal and Subboreal zones have similar problems. Medium-textured morainal deposits in the Boreal, Subboreal and Subalpine zones have moderate limitations for regeneration due to frost action.

Regeneration on colluvial and floodplain deposits is moderately limited by brush competition and frost action.

Gravelly inactive fluvial deposits have slight limitations only, while sandy deposits have moderate limitations due to frost action and some brush competition.

Windthrow hazard based on soil characteristics is rated as moderate to severe on lacustrine and fine-textured morainal deposits in the extreme northeast portion of the study area in the Boreal zone. This is a result of a well-developed clay accumulation horizon (Bt) which restricts rooting depth.

Windthrow hazard is moderate on most morainal deposits due to a clay accumulation horizon and on floodplain deposits due to a relatively high water table which restricts rooting depth.

TABLE 4.5

GENERALIZED SOIL INTERPRETATIONS FOR FORESTRY

BOREAL ZONE

BIOPHYSICAL GROUPS*		FOREST CAPABILITY	DOMINANT CONIFEROUS TREES	LIMITATIONS FOR REGENERATION	WINDTRHOW HAZARD	LOGGING ROAD LIMITATIONS	EROSION HAZARD	SOILS** ASSOCIATIONS
Lacustrine Materials	4	Moderate	white spruce, lodgepole pine	Severe: - frost action - brush comp.	Moderate-Severe: - texture - rooting depth	Severe: - frost action - subgrade	Moderate-High (<5%) (>5%)	Devereau (DU) Dickebusch (DB) Tri Creek (TC)
Fine-text. Morainal Materials	1	Moderate	white spruce, lodgepole pine	Severe: - frost action - brush comp.	Moderate-Severe: - texture - rooting depth	Severe: - frost action - subgrade	Moderate-High (<9%) (>9%)	Edson (ED) Fellers (FE)
Medium-text. Morainal Materials	2	Moderate	white spruce, lodgepole pine	Moderate-Severe: - brush comp. - frost action	Moderate: - texture - rooting depth	Moderate-Severe: - frost action - subgrade	Low-Moderate (<9%) (9-30%)	Moberly (MO) Lodge (LG)
Colluvial Materials	5	Low	lodgepole pine, white spruce	Moderate: - brush comp. - frost action	Slight	Moderate: - slope (<60%) - frost action Severe: - slope (>60%)	Moderate-High (<60%) (>60%)	Septimus (SS) Squaw Mtn. (SQ) Zonnebecke (ZB)
Active Fluvial (Flood-plain) Materials	6	High	white spruce	Moderate: - brush comp. - frost action	Moderate: - rooting depth	Severe: - flooding	Low	Oetca (OE) Meikle Cr. (ME) Windfall Cr. (WF)
Gravelly Inactive Fluvial Materials	7	Moderate	lodgepole pine, white spruce	Slight	Slight	Slight	Low	Jarvis (JR) Neumann (NE) Portage Cr. (PC)
Sandy Inactive Fluvial Materials	7	Moderate	lodgepole pine, white spruce	Moderate: - brush comp. - frost action	Slight	Moderate: - frost action	Low	Sundance (SU)

SUBALPINE ZONE

BIOPHYSICAL GROUPS*		FOREST CAPABILITY	DOMINANT CONIFEROUS TREES	LIMITATIONS FOR REGENERATION	WINDTRHOW HAZARD	LOGGING ROAD LIMITATIONS	EROSION HAZARD	SOILS** ASSOCIATIONS
Lacustrine Materials	19	Low	Engelmann spruce, alpine fir, lodgepole pine	Severe: - frost action	Moderate: - texture - rooting depth	Severe: - frost action - subgrade	Moderate-High (<5%) (>5%)	Dudzic (DC)
Morainal Materials	18	Low	Engelmann spruce, alpine fir, lodgepole pine	Moderate: - frost action	Slight-Moderate: - rooting depth - texture	Moderate: - frost action - slope	Low-Moderate (<9%) (>9-30%)	Footprint (FT) Hambrook (HB) Onion Creek. (ON) Beauregard Mtn. (BG) Robb (RB) Thunder Mtn. (TH) Turning Mtn. (TM)
Colluvial Materials	20	Low	Engelmann spruce, alpine fir, lodgepole pine	Moderate-Severe: - frost action	Slight	Severe: - frost action - slope (>60%) Moderate: - frost action - slope (<60%)	Moderate-High (<60%) (>60%)	Blue Lake (BE) Dezaiko (DZ) Hedrick (HK) Horseshoe (HS) Merrick (MC) Quintette (QT) Wendt Mtn. (WT) Myhon (MH)
Active Fluvial (Flood-plain) Materials	21	Low	Engelmann spruce, alpine fir, lodgepole pine	Moderate: - frost action	Moderate: - rooting depth	Severe: - flooding	Low	Knudsen Creek (KN)
Inactive Fluvial Materials	22	Low	Engelmann spruce, alpine fir, lodgepole pine	Moderate: - frost action - brush comp.	Slight	Moderate-Slight: - frost action	Low	Five Cabin Cr. (FC) Holtslander (HO) Ovington Cr. (OV)

* Biophysical Group numbers are explained in Section 33, p. 24-26.
** These soil associations are described in Appendix B (Volume Two).

TABLE 4.5
(Continued)

GENERALIZED SOIL INTERPRETATIONS FOR FORESTRY

SUBBOREAL ZONE

BIOPHYSICAL GROUPS*		FOREST CAPABILITY	DOMINANT CONIFEROUS TREES	LIMITATIONS FOR REGENERATION	WINDTRHOW HAZARD	LOGGING ROAD LIMITATIONS	EROSION HAZARD	SOILS** ASSOCIATIONS
Lacustrine Materials (east of Divide)	10	Low	white spruce, lodgepole pine, alpine fir	Severe: - frost action - brush comp.	Moderate: - texture - rooting depth	Severe: - frost action - (subgrade)	Moderate-High (<5%) (>5%)	Dokken (DK)
Fine-text. Morainal Materials (east of Divide)	9	Moderate	white spruce, lodgepole pine, alpine fir	Severe: - frost action - brush comp.	Moderate: - texture - rooting depth	Severe: - frost action - subgrade	Moderate-High (<9%) (>9%)	Imperial Creek (IC)
Medium-text. Morainal Materials (east of Divide)	9	Moderate	white spruce, alpine fir	Moderate: - frost action	Moderate: - texture	Moderate: - frost action - subgrade	Low-Moderate (<9%) (>9%)	Bulley (BL) Crum Mtn. (CM) Lean-to (LT)
Colluvial Materials (east of Divide)	11	Low	lodgepole pine, white spruce, alpine fir	Moderate: - frost action - brush comp.	Slight	Moderate: - slope (<60%) - frost action Severe: - slope (>60%)	Moderate-High (<60%) (>60%)	Spieker Mtn. (SP) Suprenant Mtn. (ST)
Lacustrine Materials (west of Divide)	15	High	alpine fir white spruce	Moderate: - frost action	Moderate: - texture	Severe: - frost action - (subgrade)	Moderate-High (<5%) (>5%)	Bednesti (BD)
Morainal Materials (west of Divide)	14	High	alpine fir, white spruce	Moderate: - frost action	Slight	Moderate: - frost action	Low-Moderate (<9%) (>9%)	Dominion (DO)
Colluvial Materials (west of Divide)	16	Moderate	alpine fir, white spruce	Moderate: - frost action	Slight	Moderate: - slope (<60%) - frost action Severe: - slope (>60%)	Moderate-High (<60%) (>60%)	Barton (BT)
Active Fluvial (Flood-plain) Materials (east of Divide)	12	Moderate	white spruce, alpine fir	Moderate: - brush comp.	Moderate: - rooting depth	Severe: - flooding	Low	Bullmoose (BM) Monkman Cr. (MK)
Active Fluvial (Flood-plain) Materials (west of Divide)	17	High	white spruce, alpine fir	Moderate: - brush comp.	Moderate: - rooting depth	Severe: - flooding	Low	McGregor (MG) Mokus Cr. (MU)
Inactive Fluvial Materials	13	Moderates	lodgepole pine, white spruce, alpine fir	Slight-Moderate: - frost action	Slight - rooting depth	Slight-Moderate: - frost action	Low	Abbl Mtn. (AB) Kinuseo (KO) Triad Cr. (TC) Ramsey (RM) Toneko (TO)
OTHER LAND TYPES								
Alpine and Krummholz Soils	23 24	Very low to nil	N/A***	N/A	N/A	Severe: - frost action	Moderate-High (<30%) (>30%)	Paxton Mtn. (PX) Tsahunga (TS) Gable Mtn. (GM) Reesor (RR) Sheba (SB) Misinchinka (MS)
Talus	25	Nil	N/A	N/A	N/A	Severe: - slope	Moderate-High (<60%) (>60%)	Becker Mtn. (BC) Tlooki (OO)
Organic and Poorly Drained Materials	3 8	Very low to nil	None to some black spruce and tamarack	N/A	N/A	Severe: - wet - subgrade	Low (<5%)	Kenzie (KZ) Eaglesham (EG) Smoky (SY) Snipe (SN) Gunderson (GN) Mitska (MT) Whatley (WH) Chief (CF) Moxley (MX) Hominka (HA)

* biophysical Group numbers are explained in Section 3.3, p. 24-26.
** These soil associations are described in Appendix B (Volume Two).
*** N/A - not applicable.

Elsewhere, windthrow hazard is rated slight or slight to moderate. In the Subalpine zone, however, where relatively mature, old growth coniferous stands occur, vegetative cover conditions may result in some significant windthrow hazard conditions.

Logging road limitations are least on gravelly inactive fluvial deposits, where they are rated as slight. Sandy inactive fluvial deposits, medium-textured morainal deposits, and colluvial deposits on less than 60% slope are rated as having moderate limitations. The above-mentioned materials are dominant in the study area.

The remainder of the study area has severe limitations for logging roads. Floodplain deposits are limited by flooding hazard. Fine-textured morainal and lacustrine deposits serve as relatively unstable subgrades and are also subject to frost action. Colluvial slopes greater than 60% are generally unstable because of their steepness. Organic materials are limited because they are poorly drained and are unsuitable as subgrade.

Erosion hazard is rated as high on lacustrine deposits on slopes greater than 5% and on fine-textured morainal deposits on slopes greater than 9%. These areas occur primarily in the northeastern portion of the study area. Colluvial slopes greater than 60%, most of which occur in the Rocky Mountains and Rocky Mountain Foothills, are also rated as having a high erosion hazard. Colluvial deposits subject to churning by frost action in alpine and krummholz areas are rated high on slopes greater than 30%.

Moderate erosion hazards exist throughout most of the study area, including medium-textured morainal deposits on 9 to 15% slopes and most colluvial deposits on slopes below 60%.

Fluvial deposits and relatively gently sloping medium-textured morainal deposits are rated as having only a low erosion hazard potential. On the steep sides of fluvial terraces, however, erosion hazard may be moderate to severe.

4.4. WILDLIFE

4.4.1. INTRODUCTION

Because certain soils are capable of producing certain types of vegetation, biophysical soil groups and associations can be used as indicators of wildlife habitat. The general capability ratings included in this section are based on the ability of a particular soil to produce suitable food and cover for ungulates and upland game birds.

However, due to ongoing wildlife and vegetation field work in the study area, the capability ratings presented here represent only a preliminary indication of soil/wildlife/vegetation relationships. It is hoped that an addendum to this section will follow, which expresses more up-to-date information; for instance, a vegetation report for the study area is in preparation which will provide more detailed floristic descriptions of the various vegetation types representing early seral to climax stands found on each soil.

4.4.2. METHODS

Discussions with the wildlife team working in the study area resulted in the soil/wildlife interpretations presented here. Table 4.6 provides generalized interpretations for each biophysical soil group while Appendix D (Volume Two) provides more detailed interpretations for each biophysical soil association and for some components of associations which have significantly different habitats.

The capability ratings for wildlife are based on the most suitable vegetative conditions on the soils. For example, moose capability ratings assume early seral vegetation conditions while caribou ratings assume mature coniferous forest conditions.

Capability classes used have been generalized from Luckhurst's (1975) "Guidelines: Biophysical Land Capability Classification for Wildlife". The four capability classes used in this report are Very High, High, Moderate, and Low. They relate to the "Guidelines" indicated above as follows: "Very High" equals classes 1C and 1B; "High" equals classes 1A and 2; "Moderate" equals classes 3 and 4; and "Low" equals classes 5 and 6. For estimates of the numbers of animals per square kilometre which each class is capable of supporting under ideal vegetation conditions, please refer to the "Guidelines".

It must be remembered that these interpretations give only a general and interim idea of soil capability to support wildlife. The interpretations do not take into account factors such as proximity of a particular soil habitat to other habitats (e.g. escape terrain, winter range, natural movement corridors, mineral licks). For a better assessment of capability, each area should be individually rated.

4.4.3. RESULTS

MOOSE

Moose capability is high to very high on active fluvial (floodplain) deposits of the Boreal zone. Here, forage production is believed to be the highest in the study area. The lower Sukunka and Murray River floodplains are the most significant examples.

Moose capability is rated as high on lacustrine deposits in the Boreal zone, and moderate to high on morainal and colluvial deposits in the Boreal zone and on floodplain deposits in the Subboreal zone because of ample forage production. The lacustrine, colluvial, and morainal deposits mentioned occur dominantly in the north and northeast portions of the study area along the lower Sukunka and Murray valleys and on the high plateaus of the Alberta Plateau Benchlands.

Moose capability in the remainder of the study area is low or low to moderate because of limited forage production and snow depth limitations in some areas. This includes most of the Rocky Mountains, Rocky Mountain Trench, and portions of the Rocky Mountain Foothills.

DEER AND ELK

Mule deer and elk habitat occurs primarily in the Boreal zone and on active fluvial deposits in the Subboreal zone. Capability is highest on colluvial deposits, especially on south aspects, where the rating is moderate to high due to suitable forage production and relatively shallow winter snow depths. Elsewhere, the capability is rated as low, low to moderate, or moderate.

Whitetail deer habitat occurs primarily in the extreme northeast portion of the study area on lacustrine and active fluvial (floodplain) deposits in the Alberta Plateau

TABLE 4.6

GENERALIZED SOIL INTERPRETATIONS FOR WILDLIFE

BOREAL ZONE (600-1200 METRES ELEVATION)

BIOPHYSICAL* GROUPS		DOMINANT PLANT SPECIES	SERAL OR CLIMAX	RATE OF SUCCESSION	FORAGE QUANTITY	UNGULATE SPECIES	SEASONAL USE**	UNGULATE CAPABILITY	UPLAND GAME BIRDS AND THEIR CAPABILITY	COMMENTS	SOIL*** ASSOCIATIONS
Lacustrine Materials	4	Aspen Cottonwood Lodgepole Pine Viburnum Shepherdia Red-osier dog-wood	Fire Disclimax	Slow	High	Moose Mule Deer Whitetail Deer Elk	Y Y S Y	High Moderate Low to Moderate Low to Moderate	Ruffed Grouse -Moderate to High Sharp-tailed Grouse -Low to Moderate	Prone to gullying. Burning on moderate slopes may result in surface erosion.	Devereau (DU) Dickebusch (DB) Tri Creek (TC) Snipe (SN)
Morainal Materials	1 2	Aspen Cottonwood Willows Alder White Spruce Lodgepole Pine Viburnum	Fire Disclimax	Slow	High	Moose Mule Deer Elk	Y S S	Moderate to High Low to Moderate Low	Ruffed Grouse -Moderate to High Spruce Grouse -Low to Moderate	On steep slopes, burning which exposes mineral soil may result in surface erosion.	Edson (ED) Fellers (FE) Moberly (MO) Lodge (LG) Smoky (SY)
Colluvial Materials	5	Lodgepole Pine Aspen Shepherdia Kinnikinnick Twin Flower Grasses	Fire Disclimax	Slow to very slow	High	Moose Mule Deer Elk	W W W	Moderate to High Moderate to High Moderate to High	Ruffed Grouse -Moderate to High Blue Grouse -Low to Moderate		Septimus (SS) Squaw Mountain (SQ) Zonnebecke (ZB)
Active Fluvial (Flood-plain) Materials	6	White Spruce Cottonwood Red-osier dog-wood Alder Horsetails Viburnum	Climax to Late Seral	Normal	High	Moose Mule Deer Elk Whitetail Deer	Y S S S	Very High to High Moderate Low to Moderate Low to Moderate	Ruffed Grouse -High to Moderate Spruce Grouse -Low to Moderate		Oetca (OE) Meikle Creek (MZ) Windfall Creek (WF)
Inactive Fluvial Materials	7	Lodgepole Pine White Spruce Kinnikinnick Twin Flower Shepherdia Lichen	Fire Disclimax	Slow	Low to Moderate	Moose Mule Deer Caribou Elk	Y S Y S	Low to Moderate Low Low to Moderate Low	Spruce Grouse -Moderate Ruffed Grouse -Low to Moderate	Burning may result in leaching of nutrients and lower productivity.	Jarvis (JR) Newmann (NE) Portage Creek (PC) Sundance (SU) Gunderson (GN)

SUBBOREAL ZONE (750-1050 METRES ELEVATION)

BIOPHYSICAL* GROUPS		DOMINANT PLANT SPECIES	SERAL OR CLIMAX	RATE OF SUCCESSION	FORAGE QUANTITY	UNGULATE SPECIES	SEASONAL USE**	UNGULATE CAPABILITY	UPLAND GAME BIRDS AND THEIR CAPABILITY	COMMENTS	SOIL *** ASSOCIATIONS
Morainal and Lacus-trine Materials	9 10 14 15	White Spruce Lodgepole Pine Subalpine Fir Vaccinium Alders Honeysuckle	Climax to Late Seral	Normal	Moderate	Moose Caribou	S Y	Low to Moderate Low to Moderate	Spruce Grouse -Moderate	Snow depth for most wintering ungulates except moose.	Bulley (BL) Crum Mountain (CM) Lean-To (LT) Dominion (DO) Imperial Creek (IC) Bednesti (BD) Dokken (DK)
Colluvial Materials	11 16	White Spruce Lodgepole Pine Subalpine Fir Vaccinium Alders	Climax to Late Seral	Normal	Low	Moose	S	Low	Spruce Grouse -Moderate	Snow depth limita-tions.	Spieker Mountain(SP) Suprenant Mtn. (ST) Barton (BT)
Active Fluvial (Flood-plain) Materials	12 17	White Spruce Cottonwood Subalpine Fir Willows Alder	Climax to Late Seral	Normal	Moderate to High	Moose Mule Deer Elk	Y S S	Moderate to High Low to Moderate Low to Moderate	Spruce Grouse -Low to Moderate Ruffed Grouse -Low to Moderate	Deer and elk restricted to east side continental divide. Snow depth limitations.	Bullmoose (BM) Monkman Creek (MK) McGregor (MG) Mokus Creek (MU)
Inactive Fluvial Materials	13	Lodgepole Pine White Spruce Subalpine Fir Kinnikinnick Twin Flower	Fire Disclimax to Late Seral	Slow to Normal	Low	Moose	S	Low	Spruce Grouse -Moderate	Snow depth limitations.	Abbl Mountain (AB) Ramsey (RM) Toneko (TO) Kinuseo (KO) Triad Creek (TD)
Organics (incl. Boreal and Subalpine Zones)	8	Mosses Sedges Black Spruce Willows	Edaphic Climax	Normal	Low to Moderate	Moose Caribou	S Y	Low to Moderate Low to Moderate	Spruce Grouse -Low		Kenzie (KZ) Eagleshan (EG) Mitska (MT) Whatley (WH) Chief (F) Moxley (MX) Hominka (HA)

SUBALPINE ZONE (1050-1800 METRES ELEVATION)

BIOPHYSICAL* GROUPS		DOMINANT PLANT SPECIES	SERAL OR CLIMAX	RATE OF SUCCESSION	FORAGE QUANTITY	UNGULATE SPECIES	SEASONAL USE**	UNGULATE CAPABILITY	UPLAND GAME BIRDS AND THEIR CAPABILITY	COMMENTS	SOIL*** ASSOCIATIONS
Morainal, Lacus-trine and Fluvial Materials	18 19 21 22	Subalpine Fir Engelmann Spruce Lodgepole Pine White Rhodo-dendron Alders	Climax	Normal	Low	Moose Caribou	S Y	Low Low to Moderate	Spruce Grouse -Low	Snow depth limitations.	Beauregard Mtn. (BG) Knudsen Creek (KN) Footprint (FT) Hambrook (HB) Onion Creek (ON) Robb (RB) Thunder Mtn. (TH) Turning Mtn. (TM) Dudzic (DC) Holtslander (HO) Ovington Creek (OV) Five Cabin Ck. (FC)
Colluvial Materials (Forested Subzone)	20	Engelmann Spruce Subalpine Fir Lodgepole Pine White rhodo-dendron Vaccinium Alders False Helle-bore	Climax to Late Seral	Normal to Slow	Low to Moderate	Moose Goat Caribou	S Y Y	Low Low to Moderate Low to Moderate	Spruce Grouse -Low to Moderate Blue Grouse -Low to Moderate	Avalanche chutes have moderate capability for moose. (i.e. Myhon Assoc.)	Dezaiko (DZ) Blue Lake (BE) Horseshoe (HS) Myhon (MH) Hedrick (HX) Merrick (MC) Quintette (QT) Wendt Mountain (WT)
Colluvial Materials (Krummholz Subzone)	23	Stunted Spruce and Fir Heathers Vaccinium Crowberry	Climax	Slow	Low	Moose Caribou Goats	S Y Y	Low to Moderate Low to Moderate Low to Moderate	Whitetailed Ptarmigan -Low to Moderate Blue Grouse -Low to Moderate	Snow limitations except for sites exposed by wind.	Misinchinka (MS) Rassor (RR) Sheba Mountain (SB) Paxton Mountain(PX) (morainal)
Talus	25	Lichen Shrubs	Edaphic Climax	Slow	Very low to Nil	Goats	Y	Low	None	Important escape terrain.	Tlooki (OO) Becker Mountain(BC)

ALPINE ZONE (>1650 METRES ELEVATION)

Colluvial Materials	24	Heathers Lichen Mosses	Climax	Slow	Low to Moderate	Caribou Goat	Y Y	Low to Moderate Low to Moderate	Whitetailed Ptarmigan -Low to Moderate	Snow depth limitations except for sites exposed by wind.	Tsahunga (TS) Palsson (PL) Gable Mountain (GM)

* Biophysical Group numbers are explained in Section 3.3., pp. 24-26

** S = Summer
Y = Year round

*** These associations are described in Appendix B (Volume Two).

Plains within the Boreal zone. Some wildlife biologists (Demarchi, pers. comm.) feel, however, that whitetail deer capability may be similar to that of mule deer.

CARIBOU

Caribou habitat occurs throughout the Subalpine and Alpine zones. It extends into the Boreal and Subboreal zones on inactive fluvial and organic deposits, and on lacustrine and morainal deposits in the Subboreal zone. The capability throughout most of this broad-ranging habitat is low to moderate.

GOAT

Suitable goat habitat appears to be restricted to rock outcrops and colluvium. These steepland areas in the Subalpine and Alpine zones of the Rocky Mountains and Rocky Mountain Foothills occur predominantly in the central portion of the study area where the capability rating is low to moderate. Smaller areas of high capability also occur.

UPLAND GAME BIRDS

Habitat exists in the study area for a wide variety of upland game birds including ruffed grouse, sharp-tailed grouse, blue grouse, spruce grouse, and whitetailed ptarmigan. The extent and importance of each bird's habitat is given in Table 4.6.

4.5. RECREATION

4.5.1. INTRODUCTION

Generalized interpretations for recreation are provided in Table 4.10 at the end of this section for major surficial materials and biophysical soil groups and are useful for regional planning. The relatively detailed interpretations provided in Appendix E (Volume Two) for biophysical soil association components are meant to be used with 1:50,000 scale soil maps and are useful for recreation management. However, specific sites must be investigated before operational decisions are made.

The interpretations provided for campgrounds and picnic sites, trails and paths, and recreational carrying capacity are expressed in terms of soil limitations which restrict use and do not take into consideration recreational features[1] which may attract use.

[1]A recreational features program was undertaken in the study area in 1976; 1:50,000 scale feature maps are available as well as a report by Block (1977). The recreation sector also intends to produce recreation carrying capacity maps which take into consideration soil, vegetation, wildlife, and hydrologic limitations for use.

Several of the engineering interpretations given in section 4.7, such as those for septic tanks, influence soil suitabilities for intensive forms of recreational use and should be consulted.

4.5.2. METHODS

Interpretive methods of determining soil limitations for campgrounds and picnic sites, and trails and paths, were adapted from Montgomery and Edminister (1966). Coen and Holland (1976), Vold (1975), and Brocke (1970) discuss how soil characteristics affect recreational use. Tables 4.7 and 4.8 illustrate ratings for significant soil characteristics in terms of their limitations for use: slight, moderate or severe.

Interpretations used to assess recreational carrying capacity were adapted from Block and Hignett (1976) and reflect information available from the biophysical soil resource inventory; they are presented in Table 4.9. Block and Hignett provide a discussion of how soil characteristics affect physical carrying capacity and explain the nature of carrying capacity classes. Basically, Class 1 soils have the highest physical carrying capacity and thus are suitable for intensive recreational use. Class 2 soils have few soil limitations. Class 3 soils have soil limitations which restrict most forms of intensive recreational activity (e.g. developed campgrounds). Class 4 soils have major soil limitations which restrict both intensive and extensive recreational use. Class 5 areas have the lowest carrying capacity with severe limitations affecting most forms of use (i.e. steep rock faces which can only be used for rock climbing).

4.5.3. RESULTS

For a general discussion of soil interpretations for recreation, it is possible to rate soils that have similar interpretive characteristics. Ten interpretive groupings of soil parent materials are identified in the study area (see Table 4.10) and are discussed below.

Coarse-textured inactive fluvial and glaciofluvial deposits have the fewest soil limitations for recreational use. These soils have a high to very high (Class 1 to 2) physical carrying capacity, slight limitations for trails, and slight to moderate limitations for campgrounds and picnic areas.

TABLE 4.7

SOIL LIMITATIONS FOR CAMPGROUNDS AND PICNIC SITES*

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

TABLE 4.8

SOIL LIMITATIONS FOR TRAILS AND PATHS*

SOIL PROPERTY AFFECTING USE	DEGREE OF SOIL LIMITATION SLIGHT	MODERATE	SEVERE
Drainage Class[1](Wet)[2]	Well to Moderately Well Drained	Imperfectly Drained	Poorly and Very Poorly Drained
Flooding (Flood)	None	Light Floods can occur every 3-4 years	Floods more frequently than every 3-4 years
Slope	0-15%(A-E)	15-60%(A-G)	60% + (H)
Texture[1]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS	SC, SiC, C, S, organic
Coarse Fragments (CF)	0-50%	50-75%	75% +
Rockiness[3](Rock)	Rock exposures cover <20% of area	Rock exposures cover from 20-50% of area	Rock exposures cover >50% of area
Depth to Bedrock (depth)	>50cm	10-50cm	—

*These tables adapted from Montgomery and Edminister (1966).

[1]See "The System of Soil Classification for Canada", Canada Dept. Agriculture (1974) for definitions.

[2]The abbreviations in brackets are used in Table 4.10 to indicate limitations.

[3]Each mapping unit must be considered separately to determine the amount of rock in the unit, therefore, rockiness is not considered in the soil ratings.

TABLE 4.9

LIMITATION CLASSES FOR RECREATIONAL CARRYING CAPACITY*

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

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

Other Limitations:

- S^{u}: unspecified soils or landform factor; slight to severe (i.e. soil chemical property). Further description required.
- L^{g}: gullying; moderate to severe.
- L^{f}: failing slope; severe.
- L^{a}: avalanching; severe.
- L^{p}: periglacial processes; moderate to severe.
- L^{u}: unspecified landform modifying process; slight to severe. (i.e. piping, karst). Further description required.

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

[1]See " The System of Soil Classification for Canada", Canada Dept. Agriculture (1974) for definitions on texture symbols.

[2]The symbols for limitation classes (e.g. S^{f1}) are used in Table 4.10.

[3]Each mapping unit must be considered separately to determine the amount of rock in the unit, therefore, rockiness is not considered in the soil ratings.

Medium-textured morainal materials have a high to moderate carrying capacity (Class 2 to 3), slight to moderate limitations for trails, and moderate to severe limitations for campgrounds and picnic areas. Steepness of slope is the main limitation for use.

The above-mentioned materials are the only ones that do not have severe limitations for intensive forms of recreational use such as campgrounds. Because of fine textures, steep slopes, poor drainage, and frost action, the remaining materials have severe limitations for intensive recreational use.

Fine-textured morainal and lacustrine materials have a moderate carrying capacity and moderate limitations for trails. Their use is limited by low bearing strength and high erosion potential.

Medium-to-coarse-textured colluvial deposits have a moderate to low carrying capacity and are rated as having moderate to severe limitations for trails due to slope steepness.

Colluvial deposits in the Alpine zone or Krummholz subzone have low to very low physical carrying capacities and moderate to severe limitations for trails due to frost heaving and steep slopes, both of which tend to increase soil erosion potential.

Talus slopes are rated as having a low to very low carrying capacity with moderate to severe limitations for trails because of steep slopes and stoniness or coarse fragment limitations. In addition, rockfalls associated with talus may be hazardous to recreational users.

Floodplain deposits are also rated as having a low to very low carrying capacity with moderate to severe limitations for trails. Flooding hazard is the main limitation affecting the rating. However, detailed on-site studies of the river flooding characteristics of an area could reveal that specific areas flood relatively infrequently.

Organic deposits and poorly drained mineral soils have a low to very low carrying capacity with severe limitations for trails due to wetness.

TABLE 4.10

GENERALIZED SOIL INTERPRETATIONS FOR RECREATION

Biophysical Groups		Degree and Kind of Limitation for ... Campgrounds & Picnic Sites[1]	Trails & Paths[2]	Recreation Physical Carrying Capacity[3]	Soil** Associations
Active Fluvial (Floodplain) Materials	6 12 17 21	Severe: Flood	Severe: Flood	4 Hi3	Bullmoose (BM) Knudsen Creek (KN) McGregor (MG) Meikle Creek (ME) Mokus Creek (MU) Monkman Creek (MK) Oetca (OE) Windfall Creek (WF)
Inactive Fluvial Materials	7 13 22	Slight to Moderate: Texture	Slight to Moderate: Texture	1 - 2 Sc2	Abbl Mountain (AB) Five Cabin Creek (FC) Holtslander (HO) Jarvis (JR) Kinuseo (KO) Neumann (NE) Ovington Creek (OV) Portage Creek (PT) Ramsey (RM) Sundance (SU) Toneko (TO) Triad Creek (TD)
Colluvial Materials, Alpine and Krummholz (Active Frost Heaving)	23 24	Severe: Slope, depth	Moderate to Severe: Slope, depth	4 Lp Ts2-4 sk2-3 - 5 Ts5 Lp Sk2-3	Gable Mountain (GM) Misinchinka (MS) Palsson (PL) Paxton Mountain (PX) Reesor (RR) Sheba Mountain (SB) Tsaahunga (TS)
Poorly Drained Mineral Materials	3	Severe: Wet	Severe: Wet	4 Sw3	Gunderson (GN) Smoky (SY) Snipe (SN)
Organic Materials	8	Severe: Wet	Severe: Wet, texture	5 Sw3 So3	Chief (CF) Eaglesham (EG) Hominka (HA) Kenzie (KZ) Mitska (MT) Moxley (MX) Whatley (WH)
Fine-text. Lacustrine Materials	4 10 15 19	Severe: Texture	Moderate: Texture	3 Sf2 Ss2	Bednesti (BD) Devereau (DU) Dickebusch (DB) Dokken (DK) Dudzic (DC) Tri Creek (TC)
Fine-text. Morainal Materials	1 2* 9* 18*	Severe: Texture	Moderate: Texture	3 Sf2 Ss2 Ts2-3	Bulley (BL) Edson (ED) Fellers (FE) Hambrook (HB) Imperial Creek (IC) Moberly (MO)
Medium-textured Morainal Materials	2* 9* 18* 14	Moderate to Severe: Slope, (texture)	Slight to Moderate: Slope	2 Ts2 - 3 Ts3	Beauregard Mountain (BG) Crum Mountain (CM) Dominion (DO) Footprint (FT) Lean-to (LT) Lodge (LG) Onion Creek (ON) Robb (RB) Thunder Mountain (TH) Turning Mountain (TM)
Colluvial Materials	5 11 16 20	Severe: Slope	Moderate to Severe: Slope	3 Ts3 - 5 Ts5 Sk2-3	Barton (BT) Blue Lake (BE) Dezaiko (DZ) Horseshoe (HS) Merrick (MC) Myhon (MH) Quintette (QT) Septimus (SS) Spieker Mountain (SP) Suprenant Mountain (ST) Squaw Mountain (SQ) Wendt Mountain (WT) Zonnebecke (ZB)
Talus	25	Severe: Slope, CF	Moderate to Severe: Slope, CF	4 Sb3 Ts3-4 - 5 Ts5 Sb3	Becker Mountain (BC) Tlooki (OO)

*Portions only of these biophysical soil groups are included here.

[1]See Table 4.4

[2]See Table 4.5

[3]See Table 4.6

**These associations are described in Appendix B (Volume Two).

4.6. VISUAL ABSORPTION CAPABILITY

4.6.1. INTRODUCTION

Generalized interpretations for the visual absorption capability of biophysical groups are provided in Table 4.11. Visual absorption capability (VAC) is defined as the biophysical capability of land to maintain visual integrity while supporting management activities (Anderson, 1976). These interpretations are to be used with the biophysical soil group map (in pocket), and are useful for regional resource planning. The methods explained below, however, have application for resource managers.

Systems are available for inventorying and mapping visual landscapes (Litton, 1968; U.S.D.A. Forest Service, 1973, 1974). A visual inventory system has been developed for the study area by Tetlow and Sheppard (1977). The major objective of visual inventories is to assess the relative importance of scenery, based on the land's intrinsic scenic quality and its sensitivity to public viewing pressures.

The objective of VAC is to determine land's intrinsic ability to absorb modification and meet visual quality objectives.

4.6.2. METHODS

Methods used to determine visual absorption capability of biophysical groups were adapted from Anderson (1976). Biophysical factors considered are: slope, revegetation potential, soil erosion hazard, and vegetation diversity.

As slope increases, the VAC decreases. As Litton (1974) points out, on gentle slopes there is more screening by overlapping objects, whereas on steeper slopes we see increasingly more of the slope surface.

As revegetation potential increases, VAC increases. Revegetation potential affects a landscape's ability to recover following disturbance, with the duration of impact greater on soils with a low revegetation potential. Forest capability ratings (see section 4.3) were used to determine revegetation potential.

As soil erosion hazard increases, VAC decreases. Soil erodibility affects the susceptibility of a landscape to visual change. Soils with a high erosion potential are likely to be significantly disturbed following modification, thus exposing soil colours often in sharp colour contrast to adjacent vegetation. Erosional patterns can also result in lines and shapes that are in sharp contrast to natural landscape conditions. Also, most erosional disturbances along roads are viewed in sensitive foregrounds. Soil erosion hazard ratings were explained in section 4.3.

As vegetation diversity increases, VAC increases. Areas with low vegetation diversity, such as continuous mature subalpine forests of spruce and fir, have simple textures and colours which are difficult to "borrow" from when modifying an area. On the other hand, areas with high vegetation diversity have a variety of colours and textures which can aid in the design of alterations (Litton, 1974).

In order to rate each biophysical group with respect to VAC, each biophysical factor was given a numerical rating as follows:

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

A simple formula was used to determine numerical VAC scores for each biophysical group:

VAC = slope X (Revegetation Potential + Soil Erosion Hazard + Vegetation Diversity).

Numerical VAC scores were subjectively rated as follows:

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

For example, biophysical group 1 refers to fine-textured morainal deposits in the Boreal zone. Slopes are typically less than 30%; revegetation potential is moderate; soil erosion hazard is high; and vegetation diversity is generally moderate. Therefore,

$$\text{VAC score} = 3\ (2 + 1 + 2) = 15,$$

which gives a moderate VAC rating with erosion hazard as the main limitation.

Some important biophysical factors were not considered in determining VAC ratings. For instance, soil colour contrast was not considered because it was felt that the interaction between the colour of soil groups or associations and landscape characteristics requires further study.

Litton (1974) also points out that the visual vulnerability of landscapes requires more than just an assessment of inherent biophysical factors. Landscape compositional types (i.e. focal, enclosed, feature landscapes), sensitive landscape areas (i.e. ridgelines), and external influences such as lighting and climate should also be assessed.

4.6.3. RESULTS

Eight of the 25 biophysical soil groups are considered to have a high visual absorption capability. These biophysical groups are fluvial and medium-textured morainal deposits in the Boreal and Subboreal zones. These deposits have gentle slopes (less than 30%) and moderate to low erosion hazards. The Boreal and Subboreal zones generally have moderate to high vegetation diversity due to complex fire history.

Eight biophysical groups have a low visual absorption capability. These groups dominantly occur on colluvial deposits in the Subalpine and Alpine zones where vegetative diversity is typically low and slopes are steep. Steepness of slope also results in moderate to high soil erosion hazards. Very steep (>60%) colluvial slopes in the Boreal and Subboreal zones also have a low VAC. Lacustrine deposits in the Subalpine zone also have a low VAC due to low revegetation potential and high erosion hazard.

The remaining biophysical groups have a moderate VAC. These areas include poorly drained mineral soils, organics, most fine-textured morainal and lacustrine deposits, and morainal deposits in the Subalpine zone.

TABLE 4.11

GENERALIZED SOIL INTERPRETATIONS FOR VISUAL ABSORPTION CAPABILITY (VAC)

Boreal and Subboreal Zones

Biophysical* Groups		Visual ** Absorption Capability	Soil*** Associations
Fine-textured Lacustrine and Morainal Materials	1 4 10 15	Moderate -erosion	Devereau (DV) Dickebusch (DB) Tri Creek (TC) Dokken (DK) Bednesti (BD) Fellers (FF) Edson (ED)
Medium-textured Morainal Materials	2 9 14	High	Moberly (MO) Lodge (LG) Imperial Ck. (IC) Bulley (BL) Crum Mtn. (CM) Lean-to (LT) Dominion (DO)
Colluvial Materials	5 11 16	Moderate to Low -slope	Septimus (SS) Squaw Mtn. (SQ) Zonnebecke (ZB) Spieker Mtn. (SP) Suprenant Mtn.(ST) Barton (BT)
Fluvial Materials	6 7 12 13 17	High	Oetca (OE) Meikle Ck. (ME) Windfall Ck. (WF) Jarviw (JR) Portage Ck. (PT) Newmann (NE) Sundance (SU) Monkman Ck. (MK) Bullmoose (BM) Triad Ck. (TD) Kinuseo (KO) Abbl Mtn. (AB) Toneko (TO) Ramsey (RM) Mokus Ck. (MU) McGregor (MG)
Organic and Poorly Drained Materials	3 8	Moderate -reveg. -erosion	Smoky (SY) Snipe (SN) Gunderson (GN) Kenzie (KZ) Eaglesham (EG) Whatley (WH) Moxley (MX) Mitska (MT) Chief (CF)

* Biophysical Group numbers are explained in Section 3.3., pp. 24-26.

Subalpine and Alpine Zones

Biophysical* Groups		Visual** Absorption Capability	Soil *** Associations
Lacustrine Materials	19	Low -erosion -reveg. -veg.div.	Dudzic (DC)
Morainal Materials	18	Moderate -reveg. -veg.div.	Hambrook (HB) Footprint (FT) Onion Ck. (ON) Thunder Mtn. (TH) Robb (RB) Turning Mtn. (TM) Beauregard Mtn. (BG)
Colluvial Materials	20 23 24 25	Low -reveg. -veg.div. -erosion -slope	Wendt Mtn. (WT) Myhon (MH) Hedrick (HK) Quintette (QT) Merrick (MC) Horseshoe (HS) Blue Lake (BE) Dezaiko (DZ) Paxton Mtn. (PX) Reesor (RR) Sheba Mtn. (SB) Misinchinka (MS) Palsson (PL) Tsaahunga (TS) Gable Mtn. (GM) Becker Mtn. (BC) Tlooki (OO)
Fluvial Materials	21 22	Moderate -reveg.	Knudsen Ck. (KN) Five Cabin Ck.(FC) Holtslander (HO) Ovington Ck. (OV)
Organic Materials	8	Moderate -reveg.	Hominka (HA)

** Limitations are given as follows:
"Erosion" - high soil erosion hazard
"Slope" - steep slope limitations
"Reveg." - low revegetation potential
"Veg. Div." - low vegetation diversity

*** Soil associations are described in Appendix B (Volume Two).

4.7. ENGINEERING

4.7.1. INTRODUCTION

Generalized interpretations for various engineering uses of soil are provided in Table 4.12 at the end of this section for surficial materials and biophysical groups; these interpretations are useful for regional planning and are to be used with the 1:250,000 scale map provided in the back pocket of this volume. Relatively detailed interpretations are provided in Appendix F (Volume Two) for soil association components and are to be used with the 1:50,000 scale soils maps. These interpretations provide only a general indication of site characteristics, and on-site inspection is required. All comments made in the general introduction to this chapter (section 4.1.) apply here.

Soil limitation ratings are provided for septic tank absorption fields, shallow excavations, dwellings without basements, local roads and streets. Soil suitability ratings are also provided for road fill, gravel and sand sources, and topsoil. Soil parent material textures are also translated into the AASHO and Unified Soil Classification schemes.

Interpretations for erosion hazard potential and unsurfaced logging roads are provided on Table 4.5 in section 4.3. on forestry, and in Appendix C (Volume Two).

4.7.2. METHODS

All interpretations in this section are based on guidelines prepared by the U.S.D.A. Soil Conservation Service (1971); they provide guide sheets and text which explain in detail each interpretation provided in this section. Therefore, only a relatively brief discussion of each interpretation is provided.

SEPTIC TANK ABSORPTION FIELDS

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, hydraulic conductivity, percolation rate, flooding frequency, slope, stoniness and depth to an impervious layer (e.g. bedrock) as outlined in U.S.D.A. Soil Conservation Service (1971) Guide Sheet 3. It is assumed that the subsurface tile system is laid such as to uniformly distribute the effluent, and that, for slight limitations, the water table and/or impervious layer is at least 1.2 metres below the tile.

The guide was changed to include possible contamination of water courses and ground water, using texture and permeability as criteria. Contamination hazards are most likely in areas with a high permeability (i.e. greater than 12.7 centimetres/hour) adjacent to water courses, such as coarse-textured fluvial and glaciofluvial deposits, or in areas of seepage.

For the purposes of this study, permeability, hydraulic conductivity and percolation rate values were not measured, but were inferred from textural data, soil development and field inspection. The ratings do not preclude the necessity of on-site evaluation, nor does a severe rating mean septic tanks cannot be installed but rather indicates the degree of difficulty in installment and maintenance.

SHALLOW EXCAVATIONS

The ratings are designed to evaluate the soil for excavations or trenches to a depth of 1.5 to 1.8 metres, such as those needed for installation of underground utilities. Criteria are based on the ease of excavation, workability, resistance to sloughing and flooding hazard, and, therefore, consider drainage, seasonal water tables, flooding frequency, slope, texture, depth to bedrock and stoniness. The rating must be evaluated with respect to the specific use. For instance, additional information such as shrink-swell potential and corrosivity is needed for ratings for pipelines. U.S.D.A. Soil Conservation Service (1971) Guide Sheets were used to determine ratings.

DWELLINGS WITHOUT BASEMENTS

The ratings apply to single family dwellings without basements, or structures that require similar foundations. Buildings more than three stories or having greater foundation requirements are not considered. Factors considered important for the evaluation of the soils are drainage, seasonal water table, flooding frequency, shrink-swell potential, texture, potential frost action, stoniness and depth to bedrock. Rockiness is not included, but can be determined for a given map unit based on the amount of rock complexed with the soil. These factors, as outlined in Guide Sheet 6 (U.S.D.A. Soil Conservation Service, 1971) with the exception of shrink-swell potential, were used to determine the rating.

LOCAL ROADS AND STREETS

The ratings apply to construction and maintenance of local roads and streets that have all-weather surfacing. Highways designed for fast moving, heavy trucks are excluded from this rating. Properties that affect design and construction of roads and streets are:

(a) those that affect the load supporting capacity and stability of the subgrade; and,

(b) those that affect the workability and amount of cut and fill.

The AASHO and Unified Classification and the shrink-swell potential give an indication of traffic supporting capacity. Wetness and flooding affect stability. Slope, depth to bedrock, stoniness, rockiness and wetness affect the ease of excavation and the amount of cut and fill to reach an even grade. These factors, with the exception of shrink-swell potential, are considered in the ratings, as defined in the U.S.D.A. Soil Conservation Service (1971) Guide Sheet 10.

SOURCE OF ROAD FILL

The ratings apply to the suitability of the soil for use as road fill for low enbankments, where soil is removed from its original location. Criteria used to evaluate the material with respect to these considerations are texture, susceptibility to frost action, slope, stoniness and drainage. The U.S.D.A. Soil Conservation Service (1971) Guide Sheet 11 was employed to determine the ratings. Depth to bedrock is not listed in the Guide Sheet but the suitability was considered poor if the depth of material was less than one metre.

SAND AND GRAVEL SOURCE

The ratings are designed to point out the probability of sizable quantities of sand and/or gravel. Good or fair suitabilities must have probable sources greater than one metre thick. U.S.D.A. Soil Conservation Service (1971) Guide Sheet 12 was employed to determine ratings.

SOURCE OF TOPSOIL

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 in already established vegetation. The soils are rated in terms of characteristics which are favourable to plant growth, and the ease or difficulty of the actual excavation. Factors considered in the ratings include consistence, texture, thickness of suitable material, percent coarse fragments, stoniness, slope and drainage, as outlined in U.S.D.A. Soil Conservation Service (1971) Guide Sheet 13.

FROST ACTION

Frost action ratings were determined by modifying U.S.D.A. Soil Conservation Service (1971) guidelines as follows:

	Frost Action Class		
	Low	Moderate	High
Unified Soil Classes	GW, GP,[1] GW-GM, GP-GM, SW, SP, SW-SM, SP-SM	GM, GC,[2] SC, CH, SM (medium sands)	ML, MH, OL, OH, CL, SM (fine sands)

[1]These soils are rated as moderate in the Alpine zone or Subalpine krummholz subzone.

[2]These soils are rated as high in the Alpine zone or Subalpine krummholz subzone, or when imperfectly to poorly drained.

Frost action ratings are provided for each soil association component in Appendix F (Volume Two) and are used as limitations for several engineering interpretations in this section, and also for forestry interpretations in section 4.3.(Table 4.2).

4.7.3. RESULTS

Soil limitation ratings for septic tank absorption fields are slight on medium-textured morainal materials on less than 8% slopes, moderate on 8-15% slopes, and severe on steeper slopes. Moderate to severe limitations exist on lacustrine and fine-textured morainal materials because of slow permeability. Moderate to severe limitations also exist for inactive fluvial and glaciofluvial deposits, in view of rapid permeability, since pollution is a hazard to adjacent water bodies.

Soil limitation ratings for local roads and streets, shallow excavations and dwellings without basements are slight on inactive fluvial and glaciofluvial materials on slopes less than 8%. Moderate limitations exist on 8-15% slopes, while severe limitations exist on greater than 15% slopes or on shallow-to-bedrock materials. Moderate to severe limitations exist on fine-textured morainal and lacustrine materials where poor subgrade, and potential for slumping and erosion hazards exist.

All other surficial materials in the study area have severe limitations for the above mentioned interpretations, either because of excessive slopes, flooding hazard, or poor drainage.

Soil suitability ratings for road fill are good to fair on fluvial materials. Fair to poor ratings exist for colluvial materials because of steep slope limitations, and for medium-textured morainal materials due to textural limitations. Poor to fair ratings are given for fine-textured lacustrine and morainal materials.

Suitable sources of gravel and sand are primarily restricted to fluvial materials where ratings vary from good to poor depending on the particle sizes and sorting of particular deposits. Some fair ratings can occur on deep colluvial deposits that have developed primarily from coarse-grained bedrock, such as conglomerate or sandstone.

Suitable sources of topsoil are primarily restricted to inactive fluvial and glaciofluvial deposits with sandy loam textures. Gravelly fluvial deposits and most medium-textured morainal deposits are rated poor to unsuitable because of excessive amounts of coarse fragments. Fine-textured morainal and lacustrine deposits have fair to poor ratings because of very firm consistency.

TABLE 4.12

GENERALIZED SOIL INTERPRETATIONS FOR ENGINEERING USES

BIOPHYSICAL[4] SOIL GROUPS (Unified Soil Classification Range)		DEGREE AND KIND OF LIMITATION FOR:[1]				SUITABILITY AS A SOURCE OF:[1]			
		SEPTIC TANK ABSORPTION FIELDS	SHALLOW EXCAVATIONS	DWELLINGS WITHOUT BASEMENTS	LOCAL ROADS AND STREETS	ROAD FILL	GRAVEL AND SAND	TOPSOIL	SOIL[2] ASSOCIATIONS
Fine-text. Lacustrine (ML-CL)	4 10 15 19	Moderate to Severe: perm, text	Moderate to Severe: text, wet	Moderate: frost, wet, text	Moderate to Severe: text, frost	Poor to Fair: text, frost	Unsuited	Fair to Poor: consistence, (text)	Tri Creek Bednesti Devereau Dickebusch Dokken Dudzic
Fine-text. Morainal (ML-CL)	1	Moderate to Severe: slope, perm	Moderate to Severe: slope, text, (wet)	Moderate to Severe: slope, frost	Moderate to Severe: slope, text, frost	Poor to Fair: text, frost	Unsuited	Fair to Poor: consistence, text	Edson Fellers
Medium-text. Morainal (ML-CL to SM-SC)	2 9 18 14	Slight to Severe: slope, (perm)	Slight to Severe: slope	Slight to Severe: slope, frost	Slight to Severe: slope, frost	Fair to Poor: text	Poor to Unsuited	Fair to Poor: CF, slope	Bulley Hambrook Imperial Creek Moberly Beauregard Mtn. Crum Mountain Dominion Footprint Lean-To Lodge Onion Creek Robb Thunder Mtn. Turning Mtn.
Colluvium (SM to GP)	5 11 16 20	Severe: slope	Severe: slope	Severe: slope, (frost)	Severe: slope, (frost)	Fair to Poor: slope, (frost)	Fair to Unsuited	Poor: slope, CF	Barton Blue Lake Dezaiko Horseshoe Merrick Myhon Quintette Septimus Spieker Mtn. Suprenent Mtn. Squaw Mountain Wendt Mountain Zonnebecke
Talus Slopes (GP)	25	Severe: slope, perm	Severe: slope, text	Severe: slope	Severe: slope	Poor: slope	Good to Poor	Poor: slope, CF	Becker Mtn. Tlooki
Active Fluvial (Floodplain) (SM-GW)	6 12 17 21	Severe: flooding	Severe: flooding	Severe: flooding	Severe: flooding	Good to Fair: text	Good to[3] Poor	Poor: thin topsoil; (CF)	Bullmoose Knudsen Creek McGregor Meikle Creek Mokus Creek Monkman Creek Oetca Windfall Creek
Inactive Fluvial and Glacio-Fluvial (SM-GW)	7 13 22	Moderate to Severe: perm	Slight	Slight: (frost)	Slight: (frost)	Good to Fair: (text, frost)	Good to Poor	Good to Poor: (CF), (text)	Abbl Mountain Five Cabin Ck. Holtslander Jarvis Kinuseo Neumann Ovington Ck. Portage Creek Ramsey Sundance Toneko Triad Creek
Colluvium in Alpine, Krummholz (ML-GP)	23 24	Severe: slope, perm, depth	Severe: slope, depth	Severe: slope, frost, depth	Severe: slope, frost, depth	Fair to Poor: slope, frost	Fair to Unsuited	Poor: CF, slope	Gable Mountain Misinchinka Palsson Paxton Mtn. Reesor Sheba Mountain Tsahunga
Wet Soils (Gleysols) (ML-CL)	3	Severe: perm, WT	Severe: wet, WT	Severe: wet, frost	Severe: wet, frost	Poor: wet, frost	Poor to Unsuited	Poor: wet	Gundersen Smoky Snipe
Organics (Pt)	8	Severe: WT	Severe: wet, text, WT	Severe: wet, text, frost	Severe: wet, text, frost	Poor: wet, text, frost	Unsuited	Poor: wet	Chief Eaglesham Hominka Kenzie Mitska Moxley Whatley

[1]Limitation symbols are as follows: (Limitations in brackets are minor)
"perm" - permeability (rapid or slow)
"WT" - high water table
"wet" - excessive wetness
"frost" - high frost action
"depth" - shallow depth to bedrock
"text" - fine textures

[2]These associations are described in Appendix B (Volume Two)

[3]Unsuitable if fisheries conflict exists.

[4]Biophysical Group numbers are explained in Section 3.3., pp. 24-26.

4.8. SUMMARY

Generalized land use interpretations for each biophysical group are provided in Table 4.13 and on the legend for the 1:250,000 scale map in the back of this volume. Capability ratings for agriculture, forestry, and ungulates; suitability ratings for engineering uses; recreation physical carrying capacity assessment; and visual absorbtion capability ratings are summarized in Table 4.13. This summary allows for some degree of comparison of regional resource values for each biophysical group.

For a more complete comparison, the other environmental inventories conducted in the study area should also be assessed. For example, recreation and visual features, and aquatic resources need to be assessed. This information can be obtained by reviewing the other resource reports and maps for the Northeast Coal Study Area which are available from the Resource Analysis Branch.

Also, comparison of regional resource values requires socio-economic analysis. Nevertheless, biophysical soil resource inventories and their interpretation for various land uses are an important component of regional resource planning.

TABLE 4.13

GENERALIZED LAND USE INTERPRETATIONS

Biophysical Groups	Vegetation Zone	Parent Materials (Surficial Materials)	Capability ratings for:			Recreation Physical Carrying Capacity	Visual Absorption Capability	Engineering Suitability
			Agriculture	Forestry	Ungulates			
1	Boreal	Morainal, fine-textured	Low to Moderate	Moderate	Moderate to High	Moderate	Moderate	Low to Moderate
2	Boreal	Morainal, medium-textured	Low	Moderate	Moderate to High	Moderate	High	Moderate to Low
3	Boreal	Poorly Drained Materials	Low	Low	Moderate to High	Low	Moderate	Low
4	Boreal	Lacustrine	Moderate to High	Moderate	High	Moderate	Moderate	Low to Moderate
5	Boreal	Colluvial	Low to Nil	Low	Moderate to High	Low	Moderate to Low	Low
6	Boreal	Fluvial, Active (Floodplain)	Moderate to Low	High	High	Low	High	Low
7	Boreal	Fluvial, Inactive	Low	Moderate	Low to Moderate	High	High	High
8	All Zones	Organic	Low to Nil	Low to Nil	Low to Moderate	Low	Moderate	Low
9	Subboreal	Morainal[1]	Low	Moderate	Low to Moderate	Moderate	High	Moderate to Low
10	Subboreal	Lacustrine[1]	Moderate to Low	Low	Low to Moderate	Moderate	Moderate	Low to Moderate
11	Subboreal	Colluvial[1]	Low to Nil	Low	Low	Low	Moderate to Low	Low
12	Subboreal	Fluvial, Active (Floodplain)[1]	Low to Moderate	Moderate	Moderate to High	Low	High	Low
13	Subboreal	Fluvial, Inactive	Low	Moderate	Low	High	High	High
14	Subboreal	Morainal[2]	Low	High	Low to Moderate	High to Moderate	High	Moderate to Low
15	Subboreal	Lacustrine[2]	Moderate to Low	High	Low to Moderate	Moderate	Moderate	Low to Moderate
16	Subboreal	Colluvial[2]	Low to Nil	Moderate	Low	Low	Low	Low
17	Subboreal	Fluvial, Active (Floodplain)	Low to Moderate	High	Moderate to High	Low	High	Low
18	Subalpine, Forested Subzone	Morainal	Nil	Low	Low to Moderate	Moderate to High	Moderate	Low to Moderate
19	Subalpine, Forested Subzone	Lacustrine	Nil	Low	Low to Moderate	Moderate	Low	Low to Moderate
20	Subalpine, Forested Subzone	Colluvial	Nil	Low	Low to Moderate	Low	Low	Low
21	Subalpine, Forested Subzone	Fluvial, Active (Floodplain)	Nil	Low	Low to Moderate	Low	Moderate	Low
22	Subalpine, Forested Subzone	Fluvial, Inactive	Nil	Low	Low to Moderate	High	Moderate	High
23	Subalpine, Krummholz Subzone	Colluvial and Morainal	Nil	Nil	Low to Moderate	Low	Low	Low
24	Alpine	Colluvial	Nil	Nil	Low to Moderate	Low	Low	Low
25	Alpine and Subalpine	Colluvial (Talus)	Nil	Nil	Low	Low	Low	Low

[1] Rocky Mountain Foothills to Rocky Mountains (east side of Continental Divide)

[2] Rocky Mountain Trench to Rocky Mountains (west side of Continental Divide)

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