SOIL SURVEY
of
YOHO NATIONAL PARK
CANADA

Alberta Soil Survey Report No. 37

THE ALBERTA INSTITUTE OF PEDOLOGY

Advancing Soil Science in Alberta

Canada Department of Agriculture
(Alberta Pedology Section)
The University of Alberta
(Soil Science Dept., Fac. of Agr. & For.)
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November 28, 1977

Mr. W.C. Turnbull
Director
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Dear Mr. Turnbull:

I am pleased to enclose the Soil Survey of Yoho National Park. Major funding for this project was supplied by Parks Canada, through contracts with the Alberta Institute of Pedology, and Agriculture Canada, Soil Research Institute, Alberta Soil Survey.

This report, and maps provide information on soils and landforms in Yoho National Park. References are made to important studies which provide auxillary and background information necessary to the full understanding of the information contained in the report. Section IV also provides an example of the kinds of specialized uses the report and maps can be put to. The information in Section IV is derivative and by nature partially value judgement. We hope and expect that comments and criticism provided by you or your staff will assist in improving this section and thus making it more relevant to Parks Canada.

We thank you and your staff for assistance with this project and look forward to your comments.

Yours truly,

Gerald Coen

Gerald M. Coen

GMC:cil
Encl.

SOIL SURVEY OF YOHO NATIONAL PARK, CANADA

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ABSTRACT

The soil survey of Yoho National Park covers a roughly diamond shaped area of just over 1300 square kilometres situated around 50° 50' N latitude and 116° 30' W longitude in southeastern British Columbia. This rugged mountainous area west of the Continental Divide has peaks up to 3,540 m a.s.l. with most valley bottoms above 1000 m a.s.l.

Climate of the area is characteristically very changeable, being influenced by both dry Polar Continental and moist Polar Maritime air masses. Mean annual temperatures of 2.8° C and total yearly precipitation of about 560 mm (50% as snow) are reported in the valley bottoms with considerably colder and moister conditions prevailing near the tree line.

The contorted, mainly sedimentary geologic strata in Yoho have been strongly modified by glacial and post-glacial erosion. The resulting medium textured, calcareous till along with fluvial and colluvial deposits provide the parent materials for most of the soils in the Park.

Most of the Park falls within the subalpine vegetative zone. It is covered by spruce-fir forests and lodgepole pine forests which have regenerated after fires. Along the lower portions of the major valleys there is a montane zone characterized by aspen and Douglas fir stands, mixed with lodgepole pine. Relatively small areas of alpine vegetation occur above about 2100 m a.s.l. About 40% of the Park is ice, snow and rock or rock rubble with very sparse vegetative cover.

Calcareous parent materials restrict the depth and intensity of profile development. Variability in landforms and steep slopes result in highly contrasting soil units over short distances. Soils classified within the Podzolic, Brunisolic, Regosolic, Gleysolic and Organic Orders are found within Yoho National Park. The soil classification in general reflects the vegetative cover and thus indirectly the local climate. Podzolic soils tend to dominate the landscape near the tree line. Below this, in the montane and lower subalpine zone, Brunisolic soils are more prevalent.

Gleysolic and Organic soils occur in seepage and ponded areas, generally near the valley bottoms. Regosolic soils occur on unstable steep slopes and in snow avalanche areas.

Map delineations separate soils on the basis of texture, stoniness, calcareousness, drainage and slope as well as classification. These map units are characterized in the legend and in the map unit descriptions which also include information on landform and vegetation.

Detailed guidelines were established to assess the soil limitations of each map unit for various park land uses. The findings of this study are summarized in tables listing the nature and degree of soil limitations associated with each map unit within the Park. The tables provide a convenient format from which maps can be prepared depicting soil limitations for several specific uses.

ACKNOWLEDGEMENTS

The soil survey of Yoho National Park was conducted by Agriculture Canada, Soil Research Institute, Soil Survey, Edmonton, in cooperation with the other member agencies of the Alberta Institute of Pedology. Funding for additional personnel and for field expenses was provided by the Department of Indian and Northern Affairs, Parks Branch, Western Region to the Alberta Institute of Pedology. The University of Alberta provided laboratory and office space.

Assistance provided by Parks Canada, Western Regional office, in particular, D. L. Day, C. Zinkan and P. Benson, is acknowledged .

The authors also wish to express their appreciation to Park Superintendent J. R. Pilon and his staff in Yoho National Park for their cooperation and assistance. A special thank you is expressed to the Warden Service, especially H. Shepherd, J. Purdy and G. Rutherford for their extra efforts to assist the inventory program.

Thanks to Dr. P. Kuchar for assistance and discussions related to the vegetation distribution, and species composition within the Park.

Recognition is extended for the able assistance of T. Vold, D. E. Peters, G. N Johnston, N. L. Miller, J. Purdy and G. Rutherford during the field work, for assistance by Z. E. Widtman and J. Tajek in drafting the maps and illustrations, to J. C. Sproule and Associates Ltd. for the transfer of the soils information from the annotated aerial photographs to the base maps and for drafting, to W. C. McKean and A. Schwarzer for laboratory analyses, and to Margaret Anne Foster and Cecile Lirette for typing.

The support and cooperation of the members of the Alberta Institute of Pedology is recognized. The availability of a reservoir of professional expertise was invaluable to the authors in undertaking this project.

Dr. W. W. Pettapiece reviewed the manuscript, and his comments were greatfully received.

PREFACE

The soil survey of Yoho National Park was initiated at the request of Parks Canada as part of a systematic inventory of the natural resources in Canada's National Parks. It is anticipated that the information in this report, along with reports on other natural resource sectors, will assist in rational planning and management decisions. The systematic recording of observations relative to soil distribution within the Rockies will also contribute to understanding soil genesis and assist in predicting the response of soils to imposed uses.

Maps included in this report provide a mechanism for extrapolating site specific research data from the specific site to some manageable area and from an area of known response to another like area where experience is limited. For example, if a trail is to be rerouted or a new trail constructed, the planning team can examine the maps to determine over which map units an existing trail crosses and expect a similar response on the same map units for the proposed trail.

This report is arranged in four main sections. Part I provides a basic overview of some of the natural resources. Part II describes the methods used during the survey. Part III provides a key to the soil mapping units plus brief descriptions of pedon morphology and site characteristics. Part IV identifies the limitations of various land areas for selected uses, and in the process suggests one method of using the enclosed information. It should be pointed out that the limitations identified in Part IV are only relevant if the assumptions made in the Guides for assessing soil limitations are applicable to the problem as identified by the user. The appendices provide detailed specific information of interest to the in-depth reader.

Information in this report can be used at four levels of intensity. The colored map provides for a simplified overview of the soils within Yoho National Park. The four black and white maps plus the attached legend provide detailed map separations but only limited definition of map symbols. By referring to the map unit descriptions in Part III a limited concept of the map unit can be acquired. For a complete understanding of the map unit concepts the detailed map unit descriptions (which will be contained in a separate volume as Appendix E) should be consulted. Also, extensive analytical data are provided in Appendices A through D.

Field mapping was done on aerial photographs at a scale of about 1:25,000. This information was transferred to a 1:25,000 map and reduced to 1:50,000 for publication. The mapping scale was chosen as appropriate to provide the information which would assist in solving the problems identified through discussion with Parks Canada personnel. Even at this relatively detailed scale, many site specific questions cannot be answered. When considering specific sites smaller than 20 to 30 acres, on-site examination by a qualified soils specialist is still necessary.

When soils and vegetation, or other resource information is to be compared for interrelationships the most useful correlations are obtained by examining the annotated aerial photographs (desk copies can be examined by contacting the authors). Lack of precision in the base maps and problems with accurately transferring the soil and vegetation lines from the aerial photographs to the base maps makes comparisons of the soils and vegetation maps inconclusive in some areas.

How to use this report

This report is written so that it will not be necessary for the casual reader to digest it from cover to cover. It should be possible for users to obtain the information applicable to their needs with an amount of effort in proportion to the complexity of their problem. How to use this report depends on the questions being asked. Perhaps the best way to illustrate some of the ways in which this report can be used is to cite some hypothetical examples.

Example 1. A master planner wishes to gain an overview of the soils within the Park. First he should consult the colored map at a scale of 1:125,000. Reading the introductory sections of interest in Part I will help fill in the background of other resources, and the section on soil genesis will help clarify the map concepts. This material is of a generalized nature, but not necessarily easily understood. Minimally, at least a passing acquaintance with the Canadian System of Soil Taxonomy is required.

Example 2. A manager may wish to know the landform and slope along a given section of a valley. He should locate the valley on one of the four black and white maps that cover the Park. By referring to the map symbols and the legend, the information is readily obtained.

Example 3. A manager wishes to assess the soil limitations which would likely affect the installation of a septic tank filter field in a given area. He should first locate the site in question on the appropriate black and white map and then record the map symbol that applies to the site. By then turning to Table 67 in Part IV of the report and locating the map symbol and slope in the left column and reading across the lines to "septic tank filter field" the appropriate degree and kind of limitation can be found (map symbols are placed in alphabetical order, and landforms are not included because they are co-varying properties). Caution: because the map symbol does not suggest any limitation does not mean that there will not be inclusions of unsuitable soil of less than approximately 20 acres. Care must still be exercised in choosing the exact location of the installation. Also the user should read Table 62. which provides the background assumptions leading to the limitation(s) identified.

Example 4. A manager wishes to assess the impact of a major development on the soils of an area. It will likely be necessary to gain a thorough understanding of not only the soils in the area, but a knowledge of their interrelationships. In this case the user should read all of Part I in order to familiarize himself with the background natural resource information. Then by consulting the black and white maps he can record the map units which occur in the area to be examined. He should then systematically read the appropriate generalized (Part III) and/or detailed (Appendix E) map unit descriptions to gain a concept of the map unit and its variability. If the chemical and physical data are required such analyses are presented for each type pedon in Appendices A and B (The analyses apply to the central concept of the map unit but may be inappropriate for map areas that are near the limits of the concept). Now by examining the appropriate guidelines for interpretations and perhaps by developing his own guidelines, the analyst can assess the limitations (or suitabilities) of given soils (or land areas) for specific proposed uses. The analytical data is thought to be representative of the map areas, but the proposed limitations are, to a considerable extent, value judgments and any improvements are welcomed and indeed urged.

Example 5. A manager wishes to assess a relatively extensive area for primitive campsites. The simplest approach would be to delimit the area under study on the black and white maps and then, by referring to Table 67, color these areas with slight limitations green, moderate limitations yellow, severe limitations orange and very severe limitations red. As with Example 3, the reader should consult Table 59 and assess whether the background assumptions lead to the limitations that would be anticipated in the users experience. Engineering data presented in Appendix B can be used to supplement the background information on limitations.

A couple of closing comments are warranted. It is our expectation that most of the basic data used to prepare the soils maps will be definitive. The interpretations in Part IV should, and must, be continually reviewed so that they reflect the current concepts and values governing land use. The main value of this report is that it allows an experienced user to transfer his experience from an area with which he is familiar to an area where he has little experience. This is accomplished by the user examining the map units in the area for which he has familiarity and extrapolating the responses to unfamiliar areas by associating the responses with appropriate map units.

PART I

GENERAL DESCRIPTION OF THE AREA

LOCATION AND EXTENT

Yoho National Park is located in southeastern British Columbia (Figure 1). The Park is shaped roughly like a diamond with its northernmost point at approximately 51° 48' N. latitude, its most easterly point at approximately 116° 15' W. longitude, its southernmost point at approximately 50° 57' N. latitude and its most westerly point at approximately 116° 49' W. longitude. The northeastern Park boundary is situated on the Continental Divide coincident with the British Columbia - Alberta border. Yoho National Park is bounded on the Alberta side of the border by Banff National Park, and to the southeast, Yoho National Park is bounded by Kootenay National Park along a portion of its border.

The area of the Yoho National Park is about 507 square miles. It is about 22 miles wide at its widest east-west dimension and about 35 miles at its longest north-south dimension.

HISTORY, DEVELOPMENT, AND PRESENT CULTURAL FEATURES

Among the first known "visitors" to the area which is now known as Yoho National Park were the Kootenai Indians from interior British Columbia and the Cree and Stony Indians from the plains of Alberta. A thorough review of the history of Yoho National Park was prepared by Getty (1972). Archaeological evidence indicates that the Kootenai Indians used the Ottertail and Amiskwi valleys when travelling to Howse Pass to meet the Plains Indians for trading purposes. Yoho is the Cree word for wonder or astonishment while the spectacular Takakkaw falls in the Yoho valley is named after the Stony word for "it is wonderful".

In 1807, David Thompson travelled down the Blaeberry River to the Columbia River where he established several trading posts. There is however, no word of Thompson leaving his route to explore the Amiskwi or Kicking Horse River valleys.

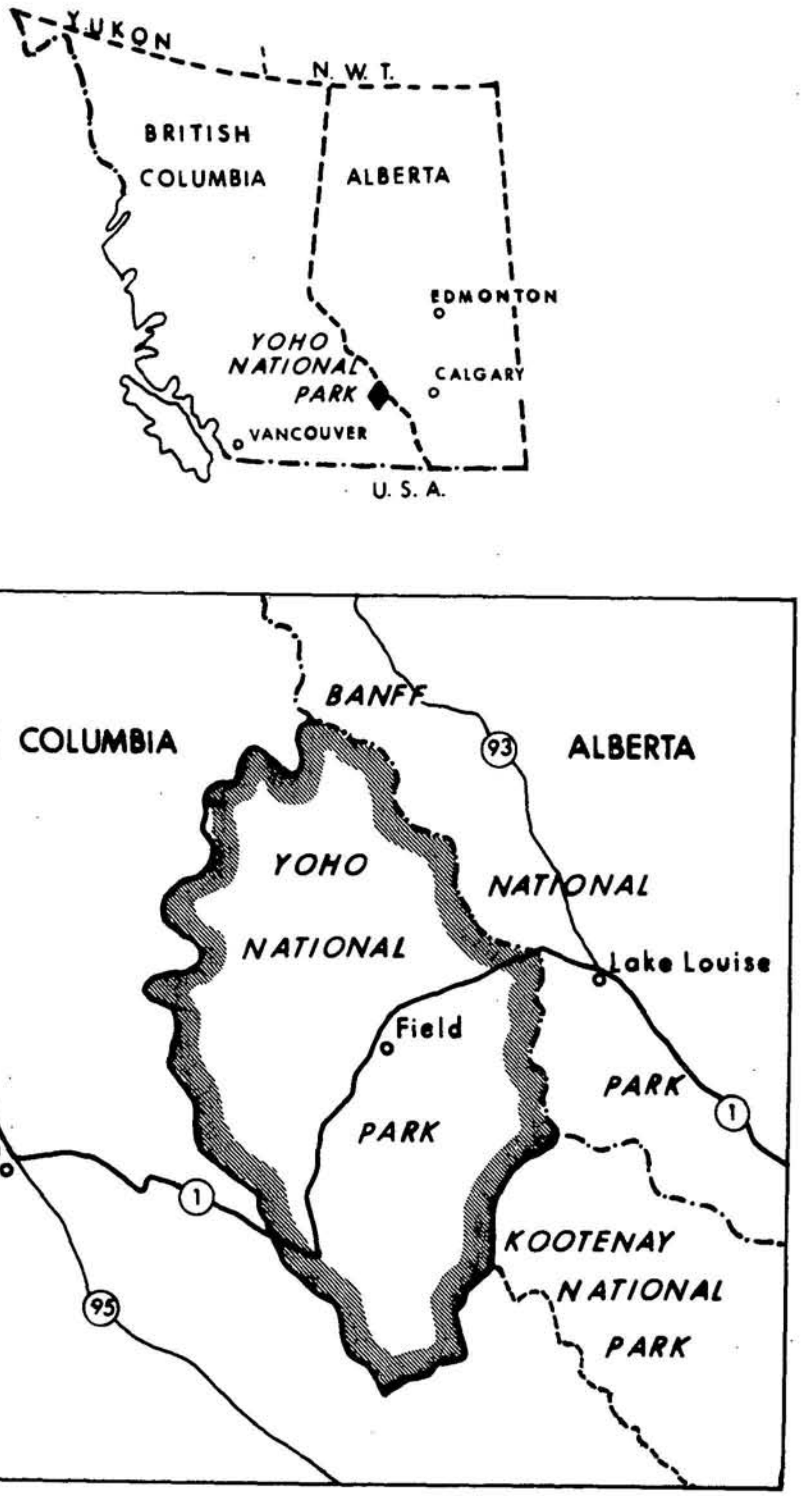


Figure 1. Location of Yoho National Park.

The Kicking Horse River and Kicking Horse Pass apparently weren't explored by Europeans until the arrival of Dr. James Hector with the Palliser Expedition of 1857 - 1860. Hector followed the Vermilion River to the Kootenay River basin and from there followed the Beaverfoot River to its confluence with the Kicking Horse River. It was there that he was kicked by his horse which led to the naming of the river. After his accident, he travelled up the Kicking Horse River, found the Kicking Horse Pass and descended to the Bow River.

In 1881, the Canadian Pacific Railway decided to route its rail line through the Kicking Horse Pass. Survey work started almost immediately and by 1885 the railway line was completed. The building of the railway was perhaps the most important event in the history of Yoho. With the railway construction there was an influx of workers, lumber was cut for ties, mineral deposits were discovered and a small townsite was formed. In addition, there was the legislation concerning the land ownership in the "Railway Belt" (a zone of land, 20 miles wide on each side of the rail line) which enabled the Federal Government to establish Yoho National Park.

In 1886, the Federal Government established a park reserve of ten square miles encompassing Mount Stephen, which was known as the Mount Stephen Reserve. This was expanded to 825.5 square miles in 1901, and was renamed the Yoho Park Reserve. The area was fomally declared a National Park in 1911 and its boundaries were changed several times until in 1930 the present Park area of 507 square miles was established.

Under the terms of the transfer of the Railway Belt, the Federal Government had control over the administration of the timber rights in the Railway Belt. The first timber berths were alloted to the C.P.R. in 1884, 1886, and 1887, and by the late 1890's a total of 117 timber berths were licenced within the Railway Belt. Lumbering operations in Yoho were centered on the Kicking Horse, Beaverfoot, and Ottertail Rivers. With the establishment of the Park Reserve, regulations restricting cutting of green timber were introduced so that very little green timber was cut after the early 1900's. A notable exception to this was the lumbering operation in the Amiskwi Valley where approved cutting began in 1952 and continued on a sporadic basis until 1968.

The first mineral claim was made on Mount Stephen in 1884 by Tom Wilson and led to the establishment of the East Monarch Mine. Many claims followed in the surrounding area, but few of them proved to be productive. The mining activity centered around Mount Stephen, the Ottertail River and Upper Ice River. The only productive mines however, were the East and West Monarch Mines in Mount Stephen and the Kicking Horse Mine in Mount Field. Mining continued until 1952. In 1969, the title to the lands and material was transferred to the Crown so that there is now no mining in Yoho.

The first commercial accommodation in the Yoho area was the Mount Stephen House which was built by the C.P.R. in 1886. This was followed by the Emerald Lake Chalet in 1901 and the Wapta Lake Lodge, Yoho Valley Lodge and Lake O'Hara Lodge in 1920's. As well as these, several tea houses and rest houses were constructed by C.P.R. for hikers. During the 1950's, most of the C.P.R. owned lodges, tea houses, and rest house were sold or torn down so that at the present time, none of the tourist accommodation facilities in the Yoho are owned by the C.P.R. The Alpine Club of Canada also built and still maintains huts in the O'Hara Meadows and Little Yoho Valley areas.

The first roads in Yoho were wagon roads built by mining and lumbering companies in the late 1800's. Automobiles were first permitted in Yoho in 1919 and the road to Lake Louise was completed in 1926. By 1938 a first class highway ran through Yoho. The Trans Canada Highway through Yoho was completed in 1958.

With the coming of automobiles, even more people were passing through Yoho, so campgrounds were set up to accommodate them. The first campground was built on the outskirts of Field in 1925. This was soon followed by the popular Kicking Horse campground. Today there are five campgrounds including the Kicking Horse campground, Takakkaw Falls campground, Hoodoo Creek campground, Chancellor Peak campground, and Lake O'Hara campground. The Kicking Horse, Hoodoo Creek and Chancellor Peak campgrounds are situated close to the Highway while the Takakkaw Falls campground serves campers in the Yoho Valley and the Lake O'Hara campground serves hikers in the Lake O'Hara area. As well as these, there are primitive campsites along the many trails in Yoho. There are also several picnic areas along the highway.

Access to Yoho is by means of the C.P.R. which has a station at Field and by the Trans Canada Highway which follows the Kicking Horse River through Yoho. Motorized transportation is limited to the main roads which include the highway, the road to Takakkaw Falls and the road to Emerald Lake.

Field is the only town which is located within Yoho National Park. It started as a small settlement of railway workers and slowly grew to its present size. The size of the town has been severely limited by the steep mountain walls behind it and by strict Parks legislation contolling its growth.

Yoho National Park has some of the most magnificent scenery to be seen anywhere, including such attractions as Takakkaw Falls, Emerald Lake, the Lake O'Hara area. With attractions like these, Yoho National Park is being subjected to ever higher numbers of tourists each year, and it is becoming increasingly important that we have an inventory of the natural resources upon which to base planning and management decisions.

PHYSIOGRAPHY

Yoho National Park is situated in the Continental Ranges of the Southern Rocky Mountains which is within the Eastern System of the Cordilleran Physiographic Region (Bostock 1968). The rugged terrain of Yoho National Park was sculptured from stratified sedimentary rocks by extensive alpine glaciers. Vestiges of these glaciers remain scattered throughout the higher elevations within the Park (Figure 2).

The landscape is extremely variable, ranging from relatively flat alluvial floodplains and gently sloping alluvial fans of limited extent, to steeply sloping morainal and colluvial slopes, and dominated by towering mountain peaks. The Kicking Horse Valley bisects Yoho National Park perpendicular to the northwest-southeast trend of the mountain ranges.

The lowest elevation in the Park is about 1,000 m a.s.l., near the western entrance to the Park, while the highest point in the Park is the south tower of Mount Goodsir which has an elevation of 3,540 m a.s.l.

GEOLOGY

Bedrock Geology

The mountains of Yoho National Park are formed from complexly deformed sedimentary, metasedimentary, and igneous rocks (Douglas et al. 1968). Cook (1975) has described the sedimentary and metasedimentary rocks ranging in age from lower Cambrian(Gog Group) to lower Ordovician (Survey Peak Formation). Igneous rocks in Yoho are most likely mid-Paleozoic in age (Balkwill 1969). The exposed cumulative thickness in Yoho is approximately 12,500 feet (3,820 m). Sedimentary and metasedimentary rocks are divided into an Eastern Facies and a Western Facies which are separated by a narrow geographic zone, known as the Kicking Horse Rim (Aitken 1971). The shallow water deposits of the Eastern Facies are of the same age as, and can be correlated with the deep water deposits of, the Western Facies.

The Eastern Facies is composed of the Gog Group and the Mount Whyte, Cathedral, Stephen, Eldon, Pika, Arctomys, Waterfowl, Sullivan, Lyell, Bison Creek, Mistaya, and Survey Peak Formations. The Gog Group, which outcrops mainly in the Cataract Brook - Lake O'Hara area, is composed of massive thick bedded, clean quartz sandstones or quartzites, with shale interbeds. Remaining formations, which overlie the Gog Group, are dominated by massive limestone and dolomite units, but also contain some slate and shale units (Cook 1975).

The Western Facies are made up of the Chancellor Formation, the Ottertail Formation and the McKay Group. The stratigraphic units which are associated with the Western Facies are dominantly argillaceous (shales and slates), but also contain some carbonate units. As well, the lowermost unit of the Chancellor Formation has been altered to massive hornfels by recrystallization of the argillaceous rocks under static conditions and elevated temperatures. With the exception of very localized outcrops, most of the hornfels outcrops are in the Upper Porcupine Creek Area (Balkwill 1969).

Igneous rocks are exposed only in the Ice River area (with the exception of some very small alkali dikes and sills), where they comprise an area of about 12 square miles (Allan 1914, 1954). This is the largest known exposure of igneous rocks in the Rocky Mountains. Igneous rocks present are leucocratic types (nepheline syenite), transition types (ijolites and urtilites), and melanocratic types (jacupirangites and alkali pyroxenites).

Surficial Geology

The Pleistocene glaciers were one of the major factors in shaping the landscape of Yoho National Park (Figure 2). Rutter (1972), working in the Bow Valley just to the east of Yoho, found evidence of at least three and possibly four major Wisconsin age ice advances. Fox (1974) also found evidence of four ice advances in the Cataract Brook valley of Yoho National Park, the earliest of which he tentatively correlated with Rutter's latest advance. Rutter (1972) and Fox (1974) both indicate that the later advances were

Figure 2. Vestiges of alpine glaciers such as the Hanbury Glacier occur throughout Yoho National Park. The rugged terrain provides striking evidence of their influences on the landscape.

less extensive than the early advances. At present, relatively extensive ice fields cover much of the Waputik Mountains and there are many glaciers in the bordering valleys. As well, much of the summit area of the President Range and the Ottertail Range is ornamented by cliff glaciers.

Besides leaving glacial features such as pyramid shaped peaks or "horns" (Figure 2), ice-carved passes or cols, cirques (Figure 3), rock-basin lakes, U-shaped valleys (Figure 4) and hanging valleys (Figure 5), the glaciers left behind numerous deposits. The most extensive of these are the moraines or glacial till deposits, but glaciofluvial and glaciolacustrine deposits also owe their origins to the glaciers. As a result of the mixing action of glaciers, most of the glacial deposits contain a mixture of the stratigraphic units over which the ice passed. Compositional

Figure 3. A cirque; typical of many in Yoho National Park.

Figure 4. McArthur Creek; a typical U-shaped valley.

Figure 5. Twin Falls; an illustration of a hanging valley

differences among the till materials are not as evident as the range of exposed stratigraphic units would suggest they might be. Observations made during the course of the soils inventory indicate that the majority of the glacial deposits found in Yoho are derived from limestones and shales. In the Eastern Facies, the mixture is dominated by carbonate rocks, while in the Western Facies, the mixture is dominated by argillaceous rocks, but in either case, the result is usually a medium textured, calcareous material. Exceptions to this are the glaciofluvial deposits which are coarse textured, reflecting their mode of deposition and some of the glacial till deposits which are discussed below.

It was observed during the course of the soils inventory that the till deposits in the vicinity of quartzite exposures are coarse textured and non-calcareous, resulting in the soils characteristic of the Lake O'Hara area. Till deposits which are further north of the Lake O'Hara area are finer and more calcareous as a result of admixture with limestone and shale materials over which the ice has passed. These observations are in agreement with work by Fox (1974) which indicates that the majority of the till deposits in the Cataract Brook area are the result of two of the four separate ice advances which he recognizes. The first of these two, which Fox named the Early Intermediate, was fairly thick and deposited till along the whole length of the Cataract Brook valley. The second advance, which Fox named the Late Intermediate, was thinner and left localized till deposits. Observations made during the soils inventory indicate that the Early Intermediate Advance mixed Gog Group materials with other stratigraphic materials which gave rise to the till which is characteristic of the Cataract Brook Valley, while an area of ice associated with the Late Intermediate advance would only have been in contact with the Gog Group and thus left the coarser till deposits, characteristic of the Lake O'Hara area.

The till deposits associated with the hornfels unit in the Porcupine Creek valley, are also coarser and less calcareous than the till deposits which are typical of Yoho.

Glacial processes are not however, the only factors which have influenced the landscape of Yoho. Water erosion and mass wasting processes have also been important since the retreat of the glaciers, and are still actively changing the landscape. Drew (1975) indicates that the glacial activity was less extensive in the western portions of Yoho Park. Consequently, the valleys in the western portion of the Park show more effects of water erosion and less of ice erosion than the valleys in the eastern portions of the Park, and there is a change from predominantly U-shaped valleys in the east to predominantly V-shaped valleys in the west.

As with the glacial deposits, alluvial and colluvial deposits generally contain a mixture of materials from various stratigraphic units. These deposits are generally calcareous, reflecting the dominant bedrock. Textures of the alluvial deposits vary with the mode of deposition and the nature of the source materials, but in general are coarser than silt loam, and usually are gravelly and cobbly. Textures of the colluvial deposits are influenced by the softness and composition of the local bedrock, but again are usually coarser than silt loam and generally have abundant coarse fragments. Exceptions to the usually calcareous fans are found in the Lake O'Hara area where our observations indicate that there are alluvial fans whose compositions are dominated by Gog Group materials. These alluvial fans are coarse textured and non-calcareous. Also, in the Ice River area, there are alluvial fans which are composed mainly of igneous rocks. These fans are coarse textured and non-calcareous and are unique to the Ice River area in Yoho. However the more usual (for Yoho) medium textured calcareous fans are also found in the Ice River Valley adjacent to, and to some extent alternating with, the igneous fans.

A recent report on the surficial geology of Yoho National Park by Drew (1975) provides a map at a scale of 1:50,000 and a generalized discussion of materials.

DRAINAGE

Yoho National Park is located within division 8 NA on the drainage basin map published by the Water Resources Branch of the Department of the Environment (Canada). The eastern boundary of the Park is coincident with the divide between the water flowing to the Pacific Ocean, and that flowing to the Atlantic Ocean. The Park is drained by the upper Kicking Horse River and its tributaries, which are part of the Columbia river drainage system. The Kicking Horse River joins the Columbia River at Golden. Four major tributary valleys, oriented parallel to the main ranges, enter the Kicking Horse Valley from the north (Figure 6). These are, from east to west, the Yoho Valley, The Amiskwi Valley, the Otterhead Valley, and the Porcupine Creek Valley. Three major valleys, again oriented parallel to the main ranges, enter the Kicking Horse Valley from the south. These are, from east to west, the Cataract Brook Valley, the Ottertail Valley and the Beaverfoot Valley. Other major perennial rivers and streams in Yoho include the Ice and Kiwetinok Rivers, Otto Creek, Boulder Creek, McArthur Creek, and Goodsir Creek. Most of the headwaters have their origins at 1,800 to 2,100 m a.s.l. and join the Kicking Horse River or its tributaries at elevations between 1,100 and 1,600 m a.s.l.

The majority of the streams and rivers in Yoho have relatively steep gradients with Oesa and Hoodoo Creeks having gradients of 246 and 206 m/km respectively and the Yoho and Ottertail Rivers having gradients of 46 and 42 m/km respectively (Mudry and Anderson 1975). These steep gradients result in actively eroding stream beds. Exceptions to this are the Beaverfoot River with a gradient of only 11 m/km (Mudry and Anderson 1975) and portions of the Kicking Horse River where there are relatively extensive accumulations of alluvial sediments (Figure 7).

Many of the streams (Takakkaw Creek being a notable example), are directly or indirectly glacier fed and consequently have a variable, often diurnal, discharge rate which is related to atmospheric temperatures and cloud cover.

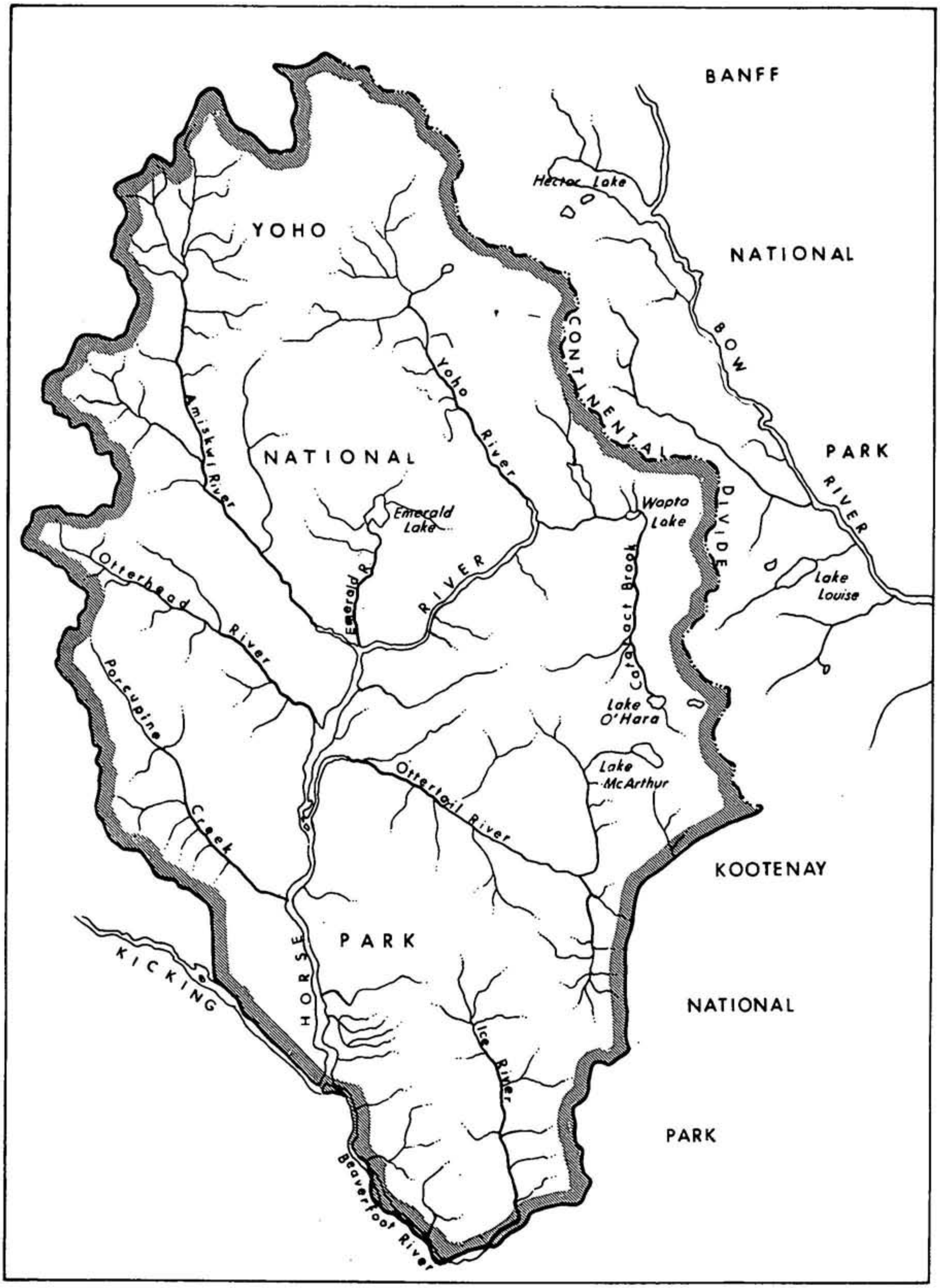


Figure 6. Drainage systems of Yoho National Park.

Smith (1972) found marked diurnal variations in the discharge of the Kicking Horse River at the Field bridge during the summer of 1972, with daily extremes varying by factors of 1.5 to 2.0. The melting glaciers also contribute large amounts of glacial silt which produces the high turbidity in the Yoho River and some of the other streams. In addition to the abovementioned streams, there are many minor perennial streams as well as numerous intermittent streams which flow only during snowmelt or occasionally after heavy rainstorms.

Because of the generally steep topography, most of the Park is well drained. However, in the Ottertail Flats areas along the Kicking Horse River, along the Beaverfoot River, and in the Narao Lakes area, there are fairly extensive floodplain areas with poor drainage. Seepage and groundwater discharge also cause small areas of imperfectly to poorly drained soils at the bases of a few mountain slopes. These areas are usually of limited extent, the exception being significant areas of seepage and groundwater discharge along benches above the Amiskwi River, along Cataract Brook and below the northeast face of Mount Hurd.

Sixty-four lakes and ponds have been identified in Yoho National Park with the majority of them lying in the northeast half of the Park. The lakes range in elevation from 1,118 m (Ottertail Flats Lake) to 2,455 m (Kiwetinok Lake). Most of the lakes are small, with over half of them having surface areas of less than 5 ha and depths less than 10 m. Only Emerald Lake and McArthur Lake are more than 75 ha in area and even these two lakes are small when compared with some lakes in other mountain National Parks. McArthur Lake is also the deepest lake, with a depth of 84 m (Mudry and Anderson 1975).

Most of the lakes in the Park are cirque lakes which have formed as the result of glacial action (Figure 8). In general, they have a very small amount of shoreline development; are oval or oblong in shape; occupy amphitheater shaped basins; and are found at heads of glaciated valleys. Examples of cirque lakes are McArthur, Oesa, Sherbrooke, Fairy, and Hamilton Lakes. A few lakes, such as Emerald, Wapta, Duchesnay, and Summit Lakes have formed in depressions in the main parts of glaciated valleys and are generally dammed by glacial morraines (Mudry and Anderson 1975; Drew 1975).

Figure 7. Gentle gradients in portions of the Kicking Horse River result in deposition of fluvial materials forming a braided stream

Figure 8. Opabin Lake; a small cirque basin lake.

The majority of the lakes and streams are aesthetically pleasing bodies of cold, clean mountain waters. Many of the streams and some of the lakes have coarse and highly permeable soils adjacent to them. If such soils are mismanaged through improper or over-use, then eutrification or siltation may occur and the clean attractiveness of these waters could be lost.

CLIMATE

Climate in Yoho National Park is determined by its position immediately west of the Continental Divide where conditions are moderated by the Maritime climate from the west Pacific coast (Figure 9).

The changeability of the weather is a very important climatic characteristic and is largely determined by the frequency and type of air masses affecting the area. In this portion of the Canadian Rockies, weather is determined mainly by two air masses:

(a) Polar Continental air masses which originate in the Yukon and Alaska. These air masses are cold and dry in winter and warm and dry in summer. Since they commonly move southeastward, parallel to the trend of the major valleys, their movement through the Rockies is comparatively unrestricted. During the winter these Polar Continental air masses may spill westward over the top or through the larger gaps of the mountain system and bring cold temperatures as far as the west coast (Chapman 1952; Heusser 1956).

(b) The Polar Maritime air masses which originate in the Pacific. As this moist warm air mass moves eastward across the mountain ranges, it becomes progressively cooler and dryer, so that east of the Rockies it may take on characteristics of Continental air masses. These masses follow one another from September to June, bringing precipitation to the mountains, particularly to the west facing slopes. In summer, the Polar Maritime air provides less precipitation to Yoho than in the winter. As the masses progress eastward the shallow surface layer warms up and after mixing with dry air aloft it becomes indistinguishable from dry Continental air east of the Rockies (Chapman 1952; Heusser 1956).

The effect of altitude on climate is of primary importance in Yoho. In general the temperature falls an average $\frac{1}{2}^{\circ}$ C per 100 m (3.3° F per 1,000 feet) of increase in altitude. However, in mountainous terrains, this estimated lapsed temperature should be used with caution except for general evaluations. The variations in lapse rate in mountain topography are of high significance as indicated by frequent temperature inversions, when cool air is trapped at lower elevations by overriding warm air masses.

Theoretically in humid regions, precipitation increases with increases in elevation, reaching a maximum at 1,000 to 1,700 m (Volobuev 1964). However, in the topographical conditions of British Columbia, as the moist Maritime masses move eastward they are forced to ascend on the windward side and may descend on the leeward side of the successive northwest-southeast ranges of mountains. This results in markedly higher precipitation on the windward slopes than on the lee slopes but also in a general decrease of precipitation from west to east as air becomes progressively drier (Chapman 1952).

The local climate of the Yoho National Park is characterized by a mean annual temperature of 2.8° C with five months of winter temperatures below 0° C and four months with a mean temperature higher than 5° C. In July the mean temperature is higher than 15° C. Total yearly precipitation is about 56 cm, of which 40% falls as snow (Table 1). The dryest month is April. June has the highest precipitation (about 70 mm), closely followed by December and January (Table 1, Figure 9). From given data the climate of Yoho National Park could be classified as dominantly humid to subhumid cold Cryoboreal (Soil Research Institute and Plant Research Institute Staff 1972). However great local variations result from the influence of topography on the distribution of solar radiation, precipitation and air flow patterns.

Detailed evaluation of local climate is very difficult because of the incompleteness and the discontinuity of the available meteorological data. Complete data are available for the period 1923 - 1936 from the station at Field. Later data are available from 1967 to 1971 for the Hector station located at 51° 25$'$ N and 116° 22$'$ W, altitude 5,225 ft (1,585 m); for the Ottertail station (located at 51° 19$'$ N and 116° 35$'$ W, altitude 5,000 ft (1,516 m)) which was relocated in 1971

Table 1. Mean monthly temperature[1], precipitation and snowfall for four long term weather stations in the vicinity of Yoho National Park.

	GOLDEN			YOHO[2]			LAKE LOUISE			BANFF		
Month	Mean Daily Temperature (deg.C)	Mean Total Precipitation (mm)	Mean Snowfall (cm)	Mean Daily Temperature (deg.C)	Mean Total Precipitation (mm)	Mean Snowfall (cm)	Mean Daily Temperature (deg.C)	Mean Total Precipitation (mm)	Mean Snowfall (cm)	Mean Daily Temperature (deg. C)	Mean Total Precipitation (mm)	Mean Snowfall (cm)
J	-10.8	61	57	-10.7	64	60	-14.6	83	82	-11.1	33	36
F	- 5.3	37	32	- 6.6	33	31	- 9.6	63	62	- 6.8	30	30
M	- 0.4	22	12	- 1.9	30	25	- 6.4	45	45	- 3.7	25	23
A	5.8	26	6	3.5	28	11	- 1.7	53	46	2.3	36	30
M	11.4	31	tr	8.1	46	1	5.9	51	18	7.5	46	9
J	15.2	40	0	12.0	68	0	9.6	62	1	11.2	64	1
Jy	18.0	35	0	15.1	43	0	12.4	59	tr	14.5	43	0
A	16.5	37	0	14.1	45	0	11.4	58	tr	13.4	51	tr
S	11.9	35	tr	9.7	41	0	7.2	50	4	9.1	36	6
O	5.6	36	6	3.7	43	7	1.8	60	41	4.2	41	18
N	- 2.3	47	33	- 4.2	53	42	- 7.1	85	84	3.7	33	32
D	- 7.8	65	56	- 8.7	66	46	-12.4	98	98	- 8.7	38	34
Yearly	4.8	472	204	2.8	558	223	0.3	766	481	2.3	477	219

1 Monthly mean temperatures are the average of the monthly average of the daily maximum and daily minimum temperatures at 4 feet above the ground (Environment Canada Staff (1941 - 1970a, b) Temperature and precipitation summary 1941 - 1970, British Columbia and 1941 - 1970, Prairie Provinces).

2 These values are calculated from data in the Monthly Record of Meteorological Observations in Canada (Environment Canada Staff). The Yoho (Field) values represent the means of data from 1965 to 1973 at which time the location of the recording station was changed.

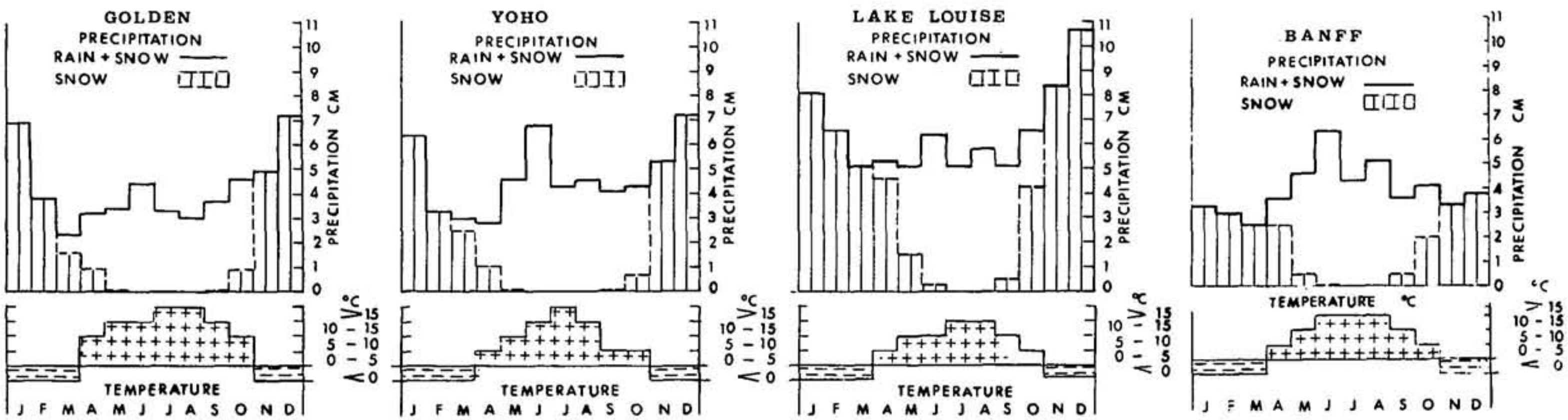


Figure 9. Mean monthly temperature and precipitation values used to classify the climate of Yoho National Park according to Soil Research Institute and Plant Research Institute Staff (1972).

to a new location (51° 24' N and 116° 33' W, altitude 3,800 ft (950 m)), and for a period from June 1970 to April 1971 for Leanchoil Station (located at 51° 4' N and 116° 34' W, altitude 3,740 ft (935 m)). At the present time the only station in Yoho National Park is located at the Boulder Creek compound.

Comparisons of data (Table 2) which were recorded at the same time for stations Ottertail, Hector and Lake Louise show a decreasing temperature and increasing precipitation from the west gate of Yoho National Park toward Continental Divide resulting from an increase in altitude. Temperature and precipitation at Lake Louise was lower than that at Hector station even though both stations were at similar altitudes and a few miles apart. Hector Lake is on the windward side of the mountain range whereas Lake Louise is on the leeward side and is in the path of cold air drainage from the nearby Victoria glacier. Landals and Scotter (1973) have found that in an upper subalpine environment the O'Hara Meadows have lower temperatures than the Schaffer Meadows which are approximately 100 m higher. Cold air drainage becomes ponded in the O'Hara basin forming a frost pocket. In spite of higher temperatures on Schaffer Meadows there is a shorter snow-free period than that on O'Hara Meadow because Schaffer Meadows are in the shade of Mt. Schaffer and Mt. Odaray for a large part of the day during the spring and fall.

The foregoing paragraph provides some specific examples of the climate of Yoho and also demonstrates the difficulty of extrapolating climatological information when recording stations are not available. Vegetation and soils respond to variations in climate, and to some extent it is possible to predict relative changes in climate by examination of the soils and vegetation. An understanding of the climate, where data is available, assists in understanding the relationships between soil and climate. A recent report by Janz and Storr (1977) from which Figure 10 was taken, provides some insight into local variations in climate and presents a discussion of climate in the mountain Parks.

Table 2. Comparison[1] of mean monthly temperature, precipitation and snowfall among three local recording stations.

	OTTERTAIL STATION[2]			HECTOR STATION			LAKE LOUISE STATION		
	Mean Monthly	Precipitation		Mean Monthly	Precipitation		Mean Monthly	Precipitation	
Month	Temperature (deg.C)	Total (mm)	Snow (cm)	Temperature (deg.C)	Total (mm)	Snow (cm)	Temperature (deg.C)	Total (mm)	Snow (cm)
J	-12.3	91	91	-13.9	142	142	-16.2	86	86
F	- 4.5	30	30	- 6.9	53	53	- 8.2	25	25
M	- 1.9	30	23	- 5.0	58	41	- 6.0	43	43
A	2.8	18	15	0.5	46	30	- 1.1	41	30
M	7.7	36	13	6.4	38	15	5.3	30	1
J	12.0	66	0	10.5	71	0	10.2	53	0
Jy	14.7	66	0	12.1	74	0	12.3	53	0
A	14.2	35	0	11.7	38	0	11.8	38	0
S	8.4	58	0	7.9	58	0	7.8	41	tr
O	3.7	48	tr	0.8	71	tr	0.7	43	33
N	- 3.9	41	41	- 6.9	81	81	- 7.3	63	63
D	-10.4	58	58	-12.3	78	78	-14.9	74	74

1 In calculating monthly temperature and precipitation values, only those months were used where data was complete for each station for the entire month. Each monthly mean represents a mean of no less than two years occurring within the period of 1965 to 1971. The data does not provide an accurate picture of the long-term weather and the values for Lake Louise do not agree with Table 1. The data is presented to show relative differences (readings taken at the same dates) in temperature and precipitation within Yoho National Park.

2 These values are calculated from data in the Monthly Record of Meteorological Observations in Canada (Environment Canada Staff).

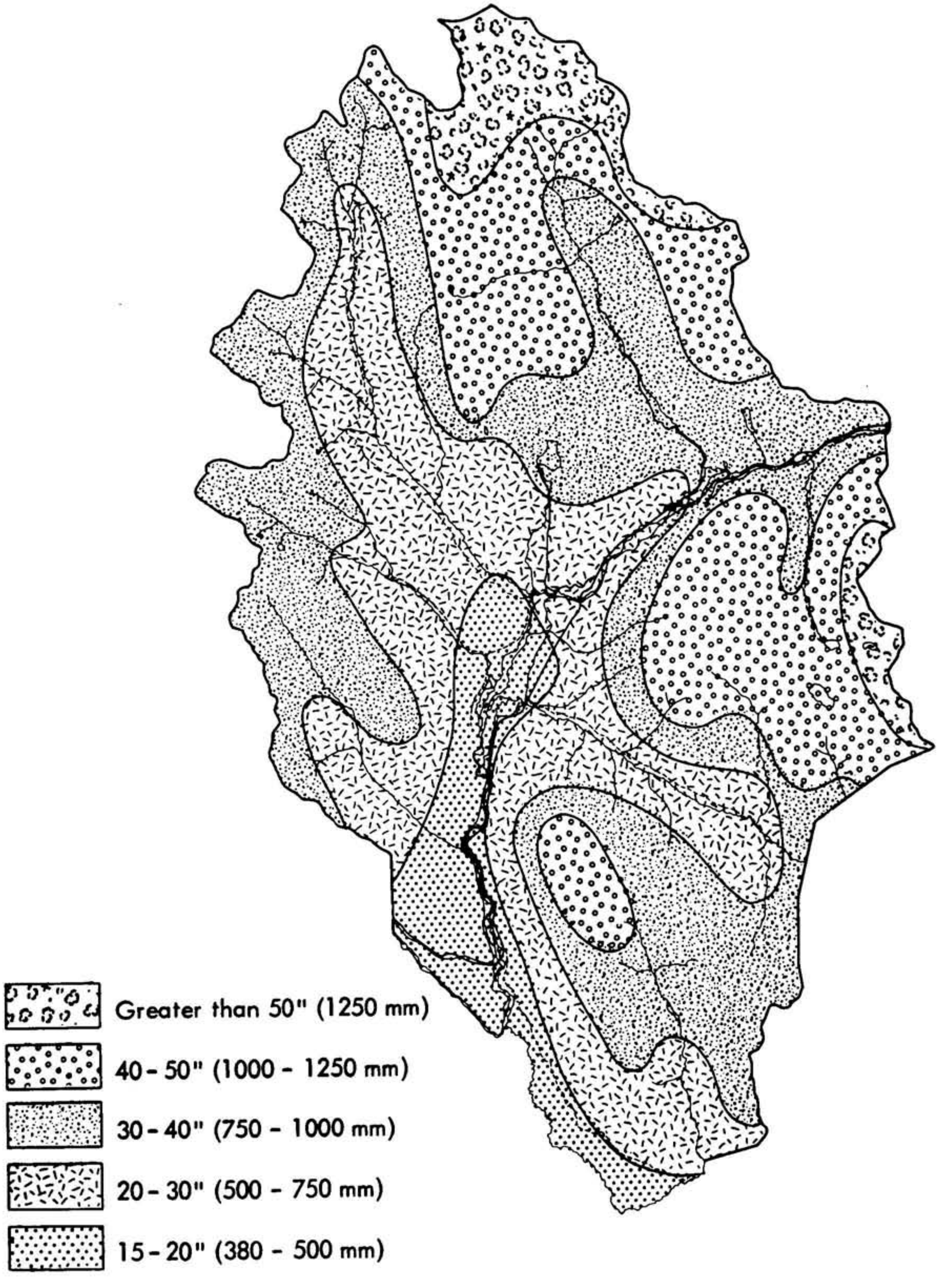


Figure 10. Average Annual Precipitation in Yoho National Park. Figure adapted from Janz and Storr (1977).

VEGETATION

General Vegetation Pattern

An extensive study of the vegetation throughout Yoho National Park has been conducted by Kuchar (1976). He reported that about 50% of the Park was covered by coniferous forest. Bare rock, mostly above timerline, occupied another 30%. Glaciers, ice and snow covered another 10% leaving only about 10% of the Park covered by non-forest vegetation.

Lodgepole pine and spruce forests were the most widespread vegetative types. Douglas fir, whitebark pine and subalpine fir and/or subalpine larch forests were less common. Western red cedar forests were of rare occurrence, generally in the western portion of the Park. Herb meadows and scrub were identified by Kuchar (1976) as the only important non-forest vegetation types, and occurred mainly in wetland areas, on snow avalanche slopes and in alpine sites.

Many stages of plant succession occur in the Park. Recent deglaciation, fires, slope instability and shifting patterns of alluvial deposition as well as human impacts, all result in vegetation disturbance or destruction. The predominance of Lodgepole pine throughout the Park indicates the large extent to which vegetation succession has been interrupted.

Vegetation Zonation

The traditional system of ecological zonation in the Canadian Rockies includes montane, subalpine and alpine zones (Daubenmire 1943 , Heusser 1956 and Beil 1966). As Kuchar (1976) pointed out, agreement was not unanimous as to the elevation at which the transitions occur. He feels that themontane -subalpine transition occurred at about 1,600 m a.s.l. which was in good agreement with the elevation where a major soil transition occurred from dominantly Brunisolic soils to soils with a transitional Brunisolic - Podzolic character respectively. Vegetation such as roughleaf ricegrass, Douglas fir and trembling aspen rarely occur above the 1,600 m a.s.l. elevation.

Natural timberline in Yoho occurs at about 2,100 m a.s.l. but there is some disagreement in the literature (Love 1970) as to what constitutes alpine vs. subalpine.

According to Kuchar (1976) the separation could be made quite distinctly using floristic criteria. Plants such as golden fleabane, alpine sandwort, black alpine sedges and western anemone were very rare in the subalpine zone whereas stickseeds, cow parsnip and meadow rue did not occur in the alpine zone.

The foregoing discussion provides an introduction to the vegetation within Yoho; further observations can be found in the discussion of the map unit descriptions.

SOIL FORMATION

Soil Forming Factors

The soil-forming factors of climate, living organisms, topography, nature of the parent material and time (Brady 1974) all contribute to the genesis of every soil (Figure 11). The relative importance of each factor differs from place to place; sometimes one is more important, sometimes another. Detailed discussions of the soil-forming factors and their interactions can be found in Buol et al. (1973).

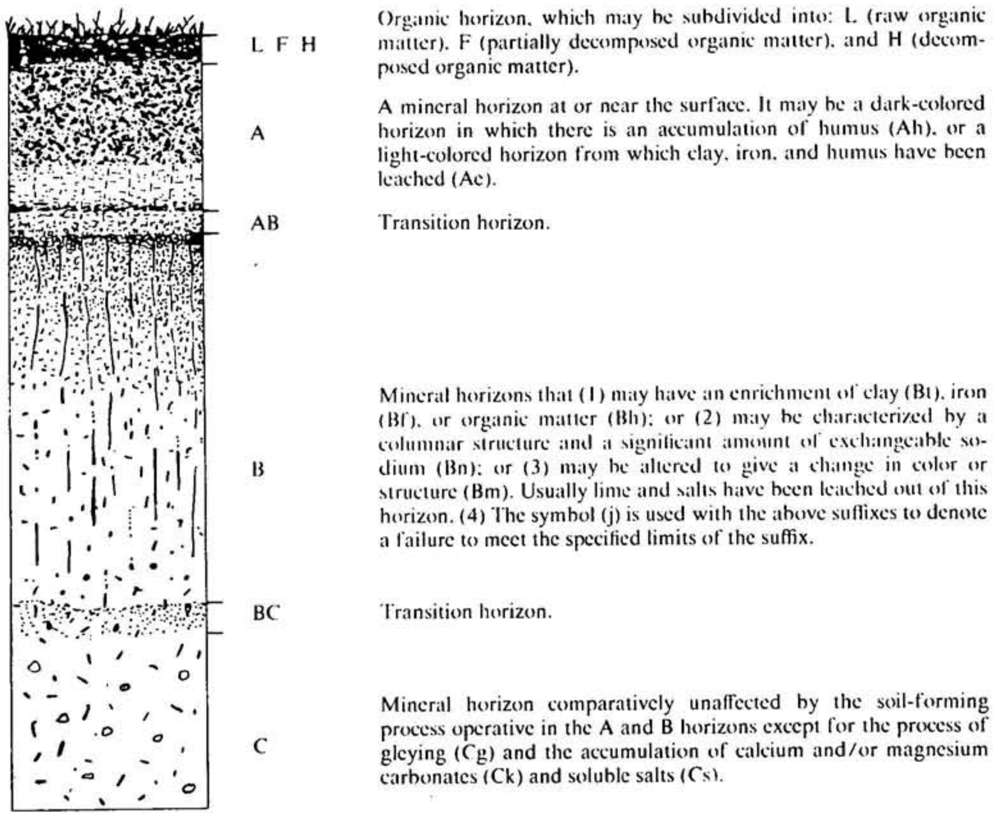


Figure 11. Schematic diagram of a soil profile showing various horizons. Some profiles may not have all these horizons clearly developed. Where it is necessary to subdivide a horizon, digits are used; for example, the Bf horizon may be subdivided into Bf1, Bf2, etc.

The interaction of these soil-forming factors, as observed in Yoho National Park, has resulted in many different kinds of soils. For the purpose of the Generalized Soils Map (found in the pocket at the back of this report) the kinds of soil are divided into four broad groups: Montane, Montane-Subalpine, Subalpine and Upper Subalpine and Alpine. The montane, subalpine and upper subalpine and alpine groups reflect changes in climate and the concomitant changes in vegetation. The soils of the montane-subalpine zone were established because the similarity of the parent materials and to some extent the shortness of time prevent climate and vegetation from imparting their influence on the soil morphology. Thus soils in this group are found in both the montane and subalpine vegetation zones.

Soils of the Montane Zone

Soils of the montane zone are largely confined to the lower portions of the major valleys (elevations generally less than 1,550 m a.s.l.). Brunisolic soils developed on till and sorted till are the most common. These soils typically have a thin leaf litter, 1 to 2 cm of Ae horizon and 45 to 50 cm of yellowish red to brownish yellow Bm horizon with lime occurring at 50 to 75 cm (see description of OL1). There are also small areas within the montane zone where Brunisolic soils have developed on shallow lacustrine deposits (see description DS 1). Climate and vegetation are the dominant factors controlling the differential genetic development of the soils in this zone from soils in adjacent zones.

Soils of the Montane-Subalpine Zones

Soils of this group are placed together for the purpose of the Generalized Soils Map (back pocket of this report) because the influences of topography and time prevent the profile morphology from reflecting the climatic and vegetational changes observed in the three other groups. These soils are developed on fluvial and glaciofluvial deposits located in the broader valley bottoms and on steep colluvial slopes in both the montane and subalpine vegetation zones.

Soils at or near the stream levels and in seepage positions fall within the Gleysolic order (see description BC 2). Here the soil-forming factor of topography dominates, controlling profile development.

At slightly higher positions and where seepage is not present the occurrance of free water does not control the profile development. However, temporary flooding on these sites causes frequent horizon disruption, through scouring and/or deposition of fluvial materials, resulting in soils classified within the Regosolic order (see description of KI 1). Time, or rather the lack of it, is the dominant soil-forming factor in this group of soils. Soils developed on steep colluvial slopes also occur in the two vegetation zones. In this case soil creep and downslope movement result in continuous profile disruption. Here again time is the dominant soil-forming factor (see description of BG 3).

Soils developed on well drained, gently sloping glaciofluvial and fluvial materials are closely related to soils on the adjacent fluvial landforms even though they reflect the soil-forming factors of climate and vegetation. This similarity in materials and landforms led to the grouping of these Brunisolic soils with the adjacent Regosolic and Gleysolic soils for the purposes of the Generalized Soils Map. These Brunisolic soils typically have a thin leaf litter, 1 to 2 cm of Ae horizon and 15 to 25 cm of yellowish red Bm horizon with lime occurring below (see description of TA 1).

Soils of the Subalpine Zone

Within this vegetation zone (elevations of approximately 1,550 to 2,000 m a.s.l.) the soil-forming factors of climate and vegetation control the differential genetic development except where the steepness of the slopes results in sufficient downslope movement to interrupt horizon development.

Where the climate and vegetation express themselves fully, soils of the Podzolic order are the result. When unusually calcareous or finer textured parent materials slow the rate of profile development soils of the Brunisolic order often occur intimately associated with the Podzolic soils.

The influence of the soil-forming factor of parent material under fairly constant climate and vegetation factors is shown by the contrasting soils in the Lake O'Hara area and in the upper Yoho valley. The parent materials in the Lake O'Hara area are coarse textured till materials which are non to slightly calcareous. In these soils profile development is frequently evident to at least 1 m from the surface, and lime was not encountered in erosion cuts or pits, some up to 2 m deep (see description of OH 1). The parent materials in the Yoho valley are calcareous medium textured till materials. In these soils profile development is frequently evident to only 25 to 50 cm at which depth strongly cemented calcareous till material is encountered (see description of OG 1).

Soils of the Upper Subalpine and Alpine Zone

The soils in this vegetation zone (generally greater than 2,000 m a.s.l.) are dominantly classified in the Podzolic order. Less than 30% ground cover is provided by trees, and the understory has a significant component of heathers. In exposed sites which have little available moisture dryas communities often occur and Brunisolic soils are commonly associated with these areas. The soil-forming factors of climate and vegetation result in soils with strongly developed horizon morphology. Also small changes in microclimate (and other elements of the microenvironment) result in significant changes in plant communities over short distances. Thus, a mosaic of soils ranging from strongly developed Podzolics to Brunisolics and some Regosolics (on steep slopes) and Gleysolics (in depressions) is the usual pattern of soil distribution in this vegetative zone. The Generalized Soils Map (in the pocket at the back of this report) shows this group of soils as being (1) mainly developed on till (see description of SK 1) with significant amounts of colluvium, and (2) mainly developed on colluvium (see description of OO 1) with significant amounts of till. A "turfy" Ah horizon, a thin, sometimes absent, light-colored Ae horizon and a dark reddish Bf horizon is the common horizon sequence. Depth to lime is quite variable but generally less than 1 m. Soils in this zone are often affected by frost phenomena, resulting in various forms of patterned ground such as earth hummocks and soil stripes.

General Comments

Although Luvisolic soils have been identified within 30 miles to the west of Yoho (Kelley and Holland 1961) and within about 5 miles to the east of Yoho (Walker et al. 1976) no significant areas were recognized within Yoho National Park.

Throughout much of Yoho National Park there is a ubiquitous shallow (less than 50 cm) silty surficial deposit. It is especially evident on stable slopes where there is apparently insufficient mixing or erosion to obliterate the deposit. Similar deposits have been observed in Waterton (Coen and Holland 1976), Banff (King and Brewster 1976; Walker et al. 1976), Jasper (Wells et al. 1976), Interior Plateau of British Columbia (Sneddon et al. 1972) and other reports of studies throughout the Cordillera.

The brightly colored Bf horizons generally occur within this surficial deposit with much paler colors occurring below the till contact. Because of "tree throw" and "frost heaving" causing mixing in the top 20 to 50 cm it is often difficult to identify the presence of a silty surficial deposit, but a coarse fragment estimate or weighing the 10 cm to 2 mm fraction generally shows a fairly distinct decrease near the surface. The higher amounts of silt in the surface horizons modifies both profile development and soil mechanical properties.

Layers of volcanic ash have been observed in several locations within Yoho National Park. It is suspected that the rather ubiquitous occurrence of this ash, which has easily weatherable minerals (Beke and Pawluk 1971; Pettapiece and Pawluk 1972) may contribute to the fairly strong horizon development throughout much of the Park.

PART II

METHODOLOGY

MAPPING

A good understanding of the relationships between soil changes and concomitant vegetation and landform changes is mandatory when mapping soils in mountainous wildlands. The most useful tool to extrapolate site information over and extended area is the aerial photograph. Since the ground can seldom be seen through the vegetative cover, and even then it is impossible to "see" the profile morphology and material, it is necessary to correlate the non-soil information of vegetation and landforms to soil information such as horizon sequence, reaction and material or texture. The introductory discussion of the natural resource information in Part I provides the background upon which the photo interpretations and consequently the soils maps are based.

Aerial photographs taken August 1973 at a scale of 1:25,000 were used as the basic field tool for delineating soilscape areas. An initial brief reconnaissance was used to set up a tentative legend for identifying map units. The reconnaissance experience was then used to delineate tentative areas by interpretation of aerial photographs and to name these according to the tentative legend. Field checking, using soil pits and any other available exposure, allowed refining of the aerial photographic interpretations and the legend. As map unit concepts were finalized, map units were added to and deleted from the legend to fit those concepts.

The landscape was first divided on the basis of landforms (Figures 12 and 13). Thus, for example, moraines were separated from glaciofluvial deposits, floodplains, alluvial fans, lacustrine deposits and colluvial deposits. The landforms were then subdivided on the basis of materials; calcareous versus non-calcareous and medium versus coarse textures. The resulting terrain units were then further subdivided into soilscape groups on the basis of soil development and soil climate as indicated by vegetation (Figures 14 and 15). These soilscape group concepts were identified on

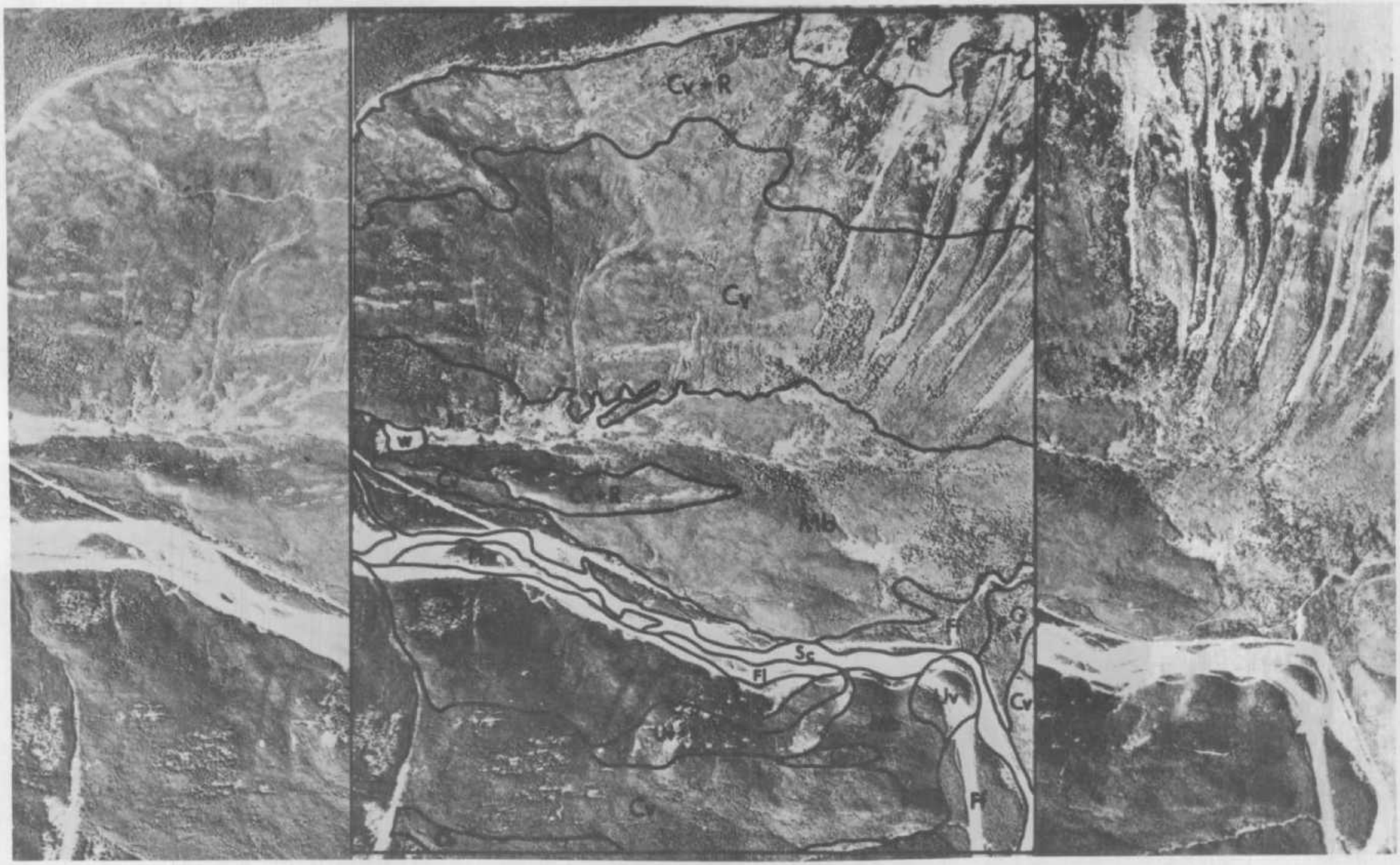


Figure 12. Stereo-triplet showing landforms

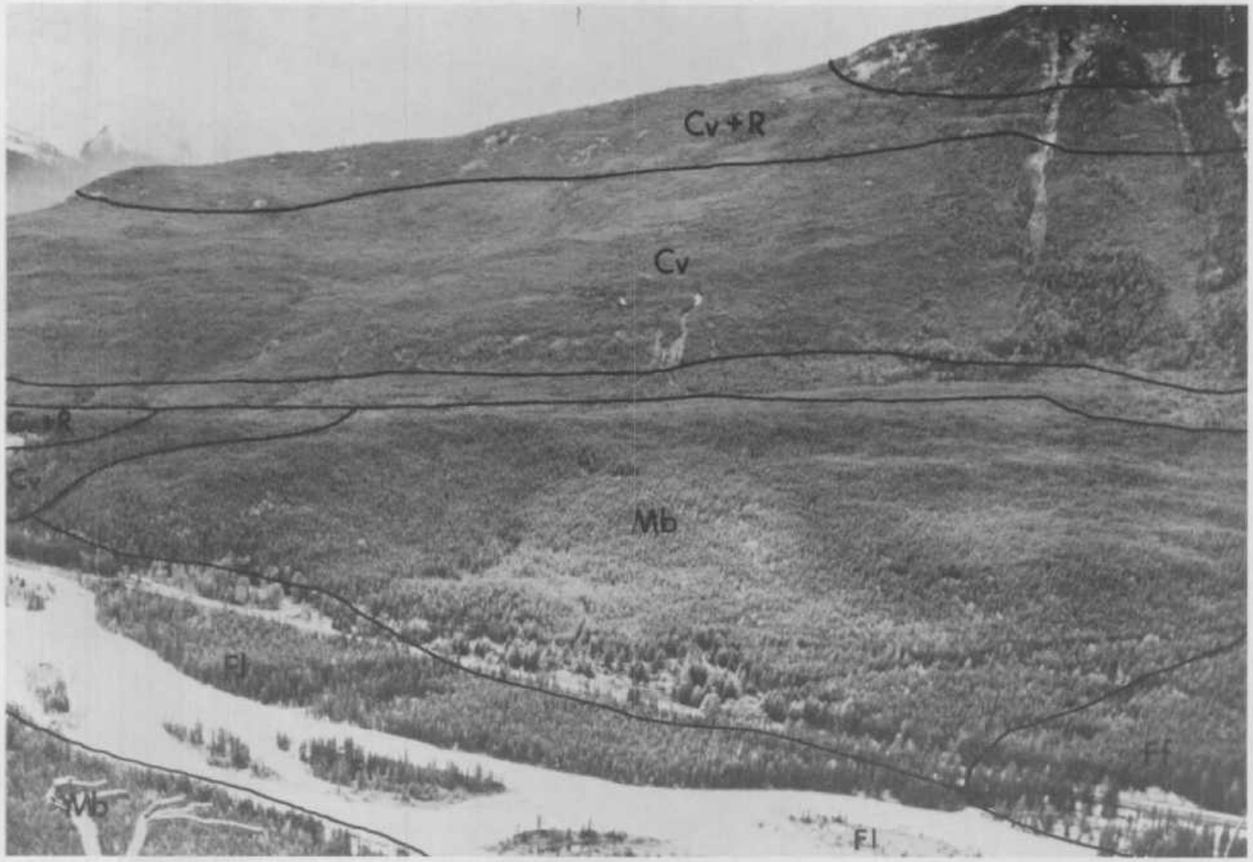


Figure 13. Oblique photo showing the landforms delineated in Figure 12.

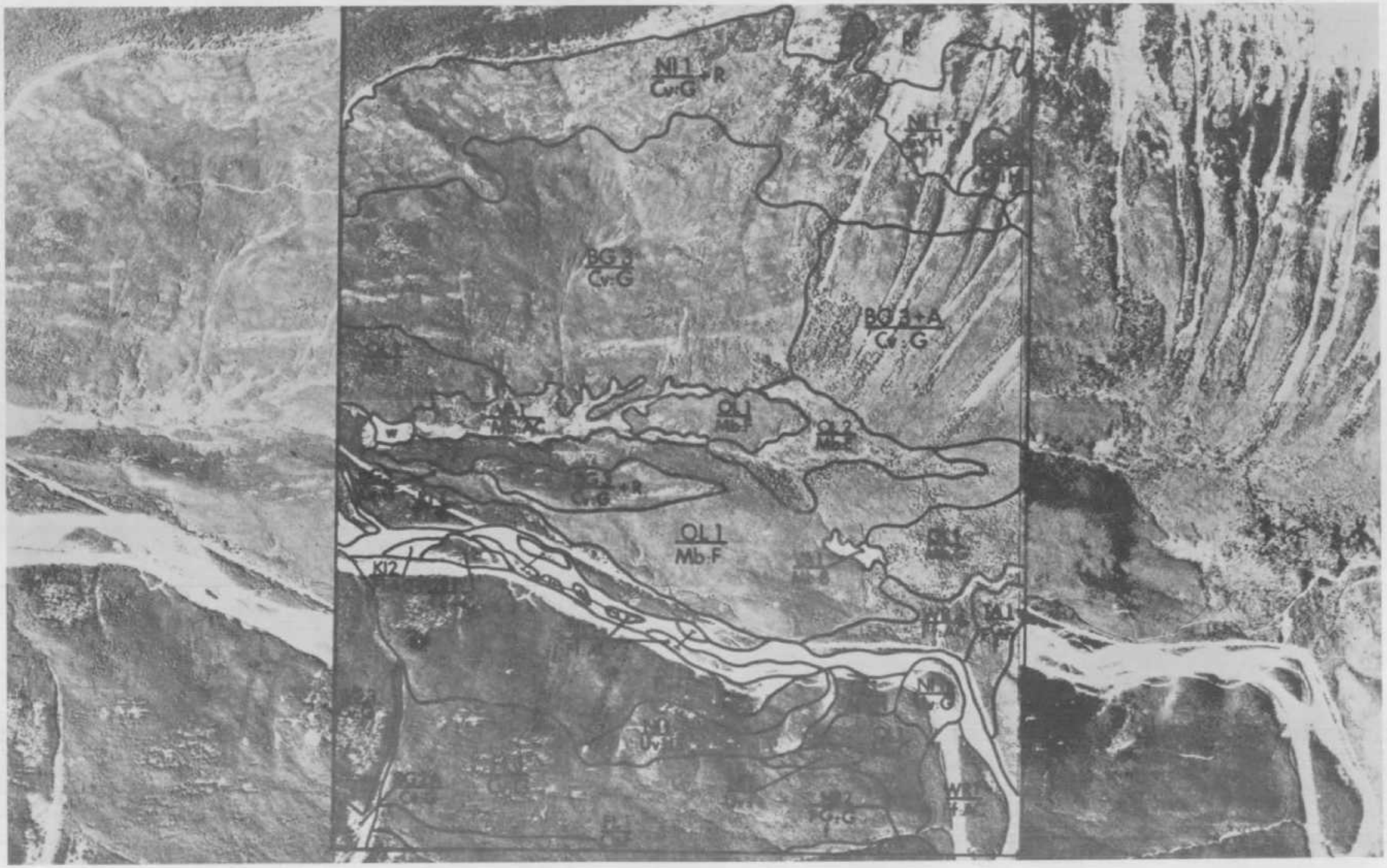


Figure 14. Stereo-triplet showing landforms subdivided into soilscape map units.

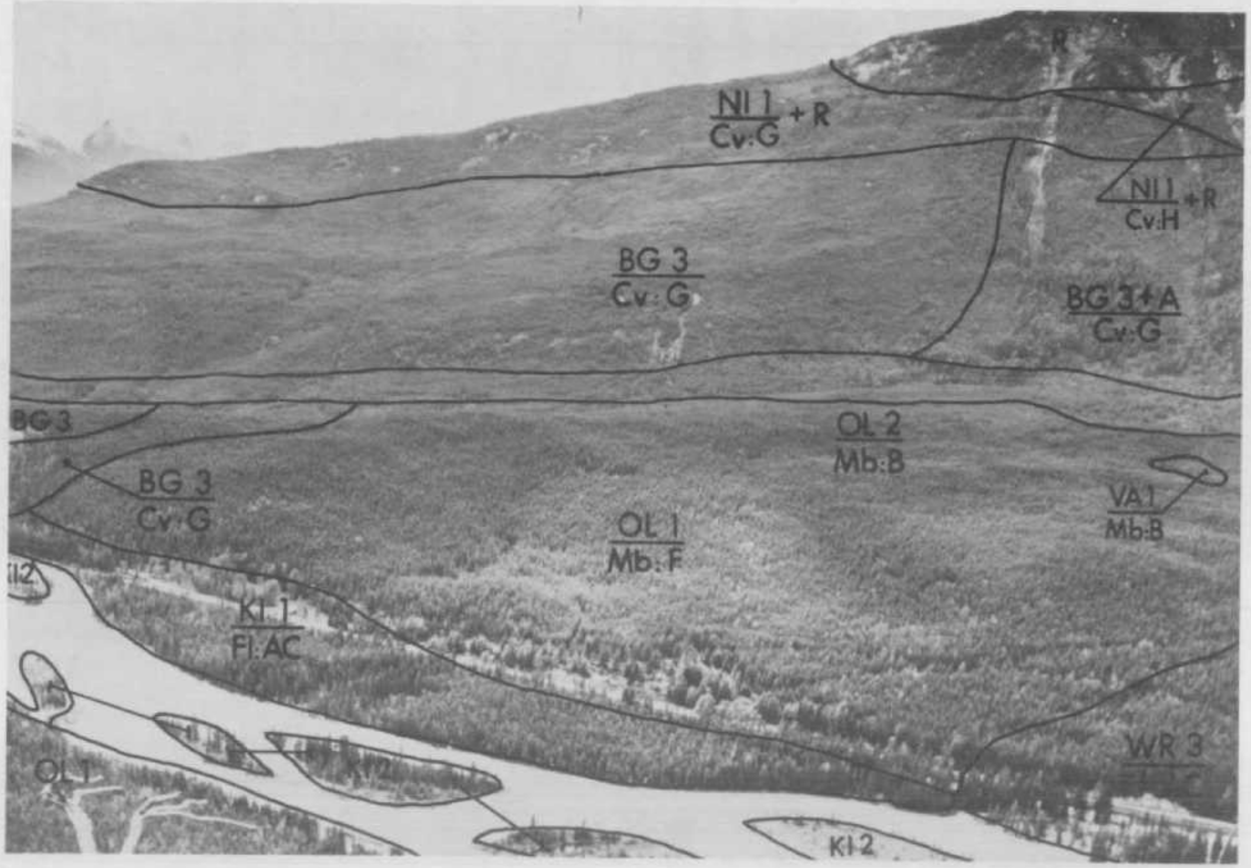


Figure 15. Oblique photo showing the soilscape map units delineated in Figure 14.

the maps by local geographic names such as Ogden (OG). Some of the soilscape groups were then further subdivided into map units on the basis of texture (of the fine earth fraction), coarse fragment contents and drainage. These subdivisions are denoted by a number after the name (e.g. OG1 and OG2). Some of the soilscape groups were not further subdivided resulting in only one map unit within that group concept. When, within a given soilscape group, changes in textural class, coarse fragments or drainage occurred in areas too small to separate cartographically, new map units were not established. Rather, the map unit description indicated the kind of variation occurring and a discussion of where the variants were located on the landscape. Also, new map units were not established when the areal extent of the proposed map unit was insignificant relative to the areas of the other map units, and the nature of the variation did not result in a highly contrasting concept from the most similar existing map unit. Again the variability and its relation to the landscape was described in the map unit description.

The map units as delineated on the aerial photographs were continuously updated as the map unit concepts changed, so that when the map unit concepts were finalized, the map unit boundaries as delineated on the aerial photographs were representative of those final map unit concepts. Representative pedons (soil profiles) were described and sampled to characterize the map units. Thus, each map unit concept is a composite of the information obtained from the aerial photographs, the field analyses and the chemical and physical analyses conducted in the laboratory. The location of each pedon chosen to represent the soilscape map units is shown on Figure 16.

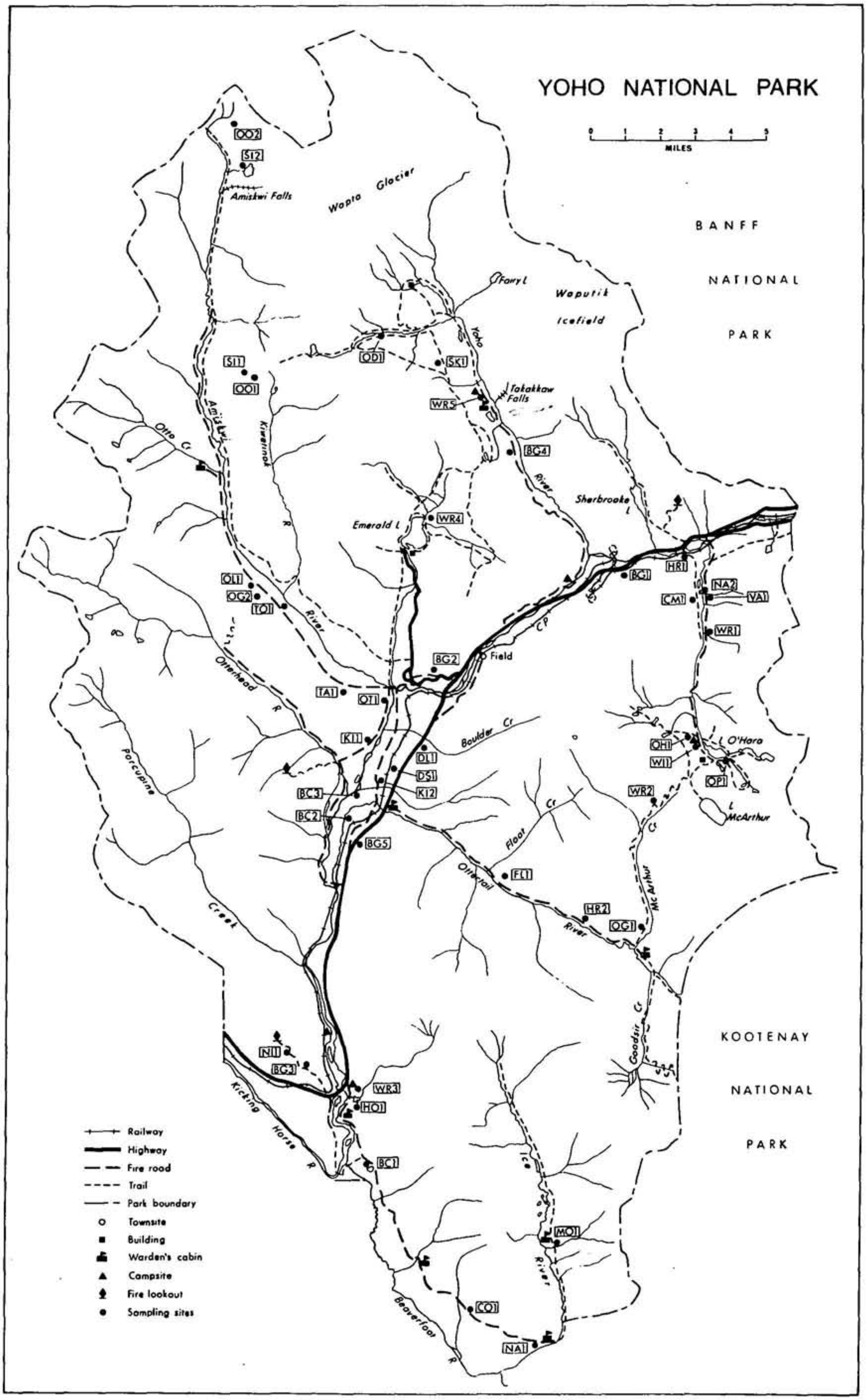


Figure 16. Sampling locations of type pedons chosen to represent soilscape map units.

LANDFORM

Major landforms generally have predictable kinds of materials, topography, drainage, and stability. Hence, these separations form a logical framework when preparing a soils legend and map. The landforms found in Yoho National Park were classified according to the outline presented in Table 3. This landorm classification is modified from Fulton et al.(1974) and has tentatively been adopted by the Canada Soil Survey Committee. Testing by soil survey groups throughtout Canada has resulted in more recent versions (CSSC 1976b). Accordingly, this landform classification may appear with some modifications in other soil survey reports.

A veneer surface form as used in this report (Table 3) and as shown on the soil maps, indicate a surficial deposit which masks little of the configuration of the underlying bedrock or deposit. It is generally assumed to be less than 2 m deep and unless otherwise indicated, occurs over bedrock.

A blanket surface form as used in this report and on the soil maps, indicates a surficial deposit which subdues, but doesn't entirely mask the configuration of the underlying bedrock or deposit. A blanket is generally estimated to be between 2 and 15 m thick. Unless otherwise indicated, a blanket deposit is underlain by bedrock.

Because the materials associated with specific landforms act as one of the soil-forming factors, when a significant landform change occurs there is a concomirant soil change. The combinations of landforms and soilscape groups are presented in Table 4.

TOPOGRAPHY

Topography plays a very important part in the soil formation process and is also one of the major considerations when planning for the use of an area. The Park is located entirely in the Rocky Mountains and as such has a land surface which is extremely variable, ranging from relatively level floodplains and gently sloping alluvial fans to steeply sloping colluvial slopes and high rugged mountain peaks.

Table 3. An outline of the local (mineral) landform classification used in this report and on the soil maps (exerpted from Fulton et al. 1974).

	COMPOSITION AND GENESIS				
SURFACE FORM	Poorly sorted sediments deposited directly from glacial ice (Morainal)	Well sorted sands, silts or clays deposited in still, fresh-water (Lacustrine)	Well sorted gravels to clays deposited by running water (Fluvial)	Well to poorly sorted boulders to clays deposited at the base of slopes through gravity flow (Colluvial)	Undifferentiated sediments where mode of deposition is complex or unknown (Undifferentiated)
Generally flat, even surface lacking irregularities. Slopes less than 3%.	Ml - level morainal	Ll - level lacustrine L^G_l - level glaciolacustrine	Fl - level fluvial F^G_l - level glaciofluvial		Ul - level undifferentiated
Generally a smooth, irregular surface with broad, shallow topographic lows and broad, low highs. Slopes usually from 2 to 5%.	Mu - undulating morainal	Lu - undulating lacustrine L^G_u - undulating glaciolacustrine	Fu - undulating fluvial F^G_u - undulating glaciofluvial		Uu - undulating undifferentiated
Generally a broken, irregular surface with distinct knobs or mounds and depressions. Slopes generally from 5 to 30% but may be lower.	Mh - hummocky morainal	L^G_h - hummocky glaciolacustrine	F^G_h - hummocky glaciofluvial	Ch - hummocky colluvial	Uh - hummocky undifferentiated
Generally a smooth, regular surface with broad topographic lows, long side slopes and broad topographic highs. Slopes from 5 to 30%.	Mm - rolling morainal	L^G_m - rolling glaciolacustrine	F^G_m - rolling glaciofluvial		Um - rolling undifferentiated
Generally linear, parallel or intersecting pattern of slopes, surfaces generally smooth. Slopes often from 5 to 30% but may be lower.	Mr - ridged morainal	L^G_r - ridged glaciolacustrine	F^G_r - ridged glaciofluvial	Cr - ridged colluvial	Ur - ridged undifferentiated
Generally flat surface with deep, well defined circular depressions. Slopes on flats generally less than 3% but 5 to 30% in depressions.	Mp - pitted morainal	L^G_p - pitted glaciolacustrine	F^G_p - pitted glaciofluvial		Up - pitted undifferentiated
Generally long unidirectional slopes lacking forms characteristic of other groups. Slopes greater than 3%.	Mi - inclined morainal			Ci - inclined colluvial	Ui - inclined undifferentiated
Generally relatively flat surfaces bounded by steep slopes on at least one side. Occur in valleys.		Lt - terraced lacustrine L^G_t - terraced glaciolacustrine	Ft - fluvial terrace F^G_t - glaciofluvial terrace		Ut - terraced undifferentiated
Generally long, relatively smooth slopes extending from an apex in an arc of up to 180°. Slopes may vary from 5 to 30%.			Ff - fluvial fan F^G_f - glaciofluvial fan	Cf - colluvial fan	Uf - undifferentiated fan
Generally long, relatively smooth slopes extending from a series of aprons with perimeters coalescing with adjoining fans.			Fa - fluvial apron	Ca - colluvial apron	Ua - undifferentiated apron
Slopes characterized by thin surface deposits which mask little of the configuration of underlying bedrock or deposit.	Mv - morainal veneer	Lv - lacustrine veneer L^G_v - glaciolacustrine veneer	Fv - fluvial veneer F^G_v - glaciofluvial veneer	Cv - colluvial veneer	Uv - undifferentiated veneer
Slopes characterized by relatively thin surface deposits which subdue but do not completely mask the configuration of the underlying bedrock or deposit.	Mb - morainal blanket	Lb - lacustrine blanket L^G_b - glaciolacustrine blanket	Fb - fluvial blanket F^G_b - glaciofluvial blanket	Cb - colluvial blanket	Ub - undifferentiated blanket

Table 4. List of combinations of soilscape units and landform units used on the soils maps.

Materials	Soilscape Map Units*	Corresponding Landform Units
Glaciofluvial materials	HR1, HR2, TA1	F_f^G, F_h^G, F_l^G, F_m^G, F_r^G, F_t^G, F_u^G, F_b^G, F_v^G
Fluvial materials	BC1, BC2, BC3, KI1, KI2, OT1	Fl, Ft, Fu, Fb, Fv
Fluvial fan materials	CO1, HO1, MO1, OP1, WI1, WR1, WR2, WR3, WR4, WR5	Fa, Ff
Lacustrine materials	DS1	L_b^G, L_v^G
Moraine material	CM1, OD1, OG1, OG2, OH1, SK1, TO1, VA1	Mh, Mi, Ml, Mm, Mr, Mu, Mb, Mv
Colluvial residual and undifferentiated materials	BG1, BG2, BG3, BG4, BG5, FL1	Cf, Cg, Ch, Ci, Cr, Cb, Cv
	NI1	Cv, Uv
	SI1, SI2	Cb, Cv
	OO1, OO2	Cb, Cv, Ub, Uv
Organic materials	NA1, NA2	Bl, Nh

* Any soilscape map units in the centre column may occur as the numerator of a map symbol in which any one of the landform units in the right hand column may occur in the denominator.

The topography of each mapping unit, with the exception of Ice, Rock, Talus, and Recent Moraine was classified according to the guidelines presented in The System of Soil Classification for Canada (CSSC 1974). The topographic classes as used in this report are presented in Table 5.

Table 5. Topographic classes used to designate the overall slope within the areas outlined on the soils maps.

Slope Categories		
Symbol		
Simple Slopes	Complex Slopes	Range %
AC	ac	0 to 5
D	d	5 to 9
E	e	9 to 15
F	f	15 to 30
G	g	30 to 60
H	h	>60

SOIL PROFILE MORPHOLOGY

Pedon descriptions and taxonomic classifications were made according to the criteria established by the System of Soil Classification for Canada (CSSC 1973). The soil descriptions included thickness and depth of horizons, soil colors (Munsell Color Notations), texture, structure, consistence, roots, pores, coarse fragments, horizon boundaries and lime content as well as any other pertinent details. Site characteristics such as slope, aspect, vegetation, and elevation were also noted.

CONVENTION FOR MAP UNIT SYMBOLS

Soilscape map unit concepts are identified on the soils maps (in the pocket at the back of the report) using symbols such as the one below. The symbol records a composite of all the information obtained during the course of the survey pertaining to the designated polygon.

$$\frac{DS1}{\left[\frac{L^{G}_{v}}{Mu}\right] : E}$$

DS1 ← soilscape map unit (always two upper case plus a numeral)

:E ← topography [upper or lower case (CSSC 1974)]

[$\frac{L^{G}_{v}}{Mu}$] ← landform (often only a numerator in the landform symbol). Both numerator and denominator can have superscript and subscript.

The first two letters of the numerator in the map symbol identify the soilscape group name and the number identifies the soilscape map unit name within the given soilscape group. The map unit descriptions (Part III) provide more detailed information characterizing the map units as identified in the numerator. The entire left element in the deonminator identifies the landform associated with the map delineation (Table 3). The horizontal line indicates that a landform with shallow materials overlays another landform and material without completely masking the buried landform. The right element of the denominator identifies the dominant slope within the map delineation. The map symbol above signifies that within the delineation a non-stony, medium textured Brunisolic soil is developed on a glacio-lacustrine veneer over an undulating morainal deposit on a 9 to 15% slope.

In general the complex symbols such as $\frac{OG1}{Mb:H} + \frac{BG1}{Cv:H}$ were not necessary because the units could be cartographically separated.

In some cases it may have been possible to have avoided establishing a new map unit concept by using a complex symbol. However when a complex symbol is used the response of the so designated map unit to any proposed use may be different than that of either of the component map concepts. Thus, the complex symbol must be treated as an independent map unit for the purposes of interpreting its response to use, and in this report most such cases have been treated as an independent map concept and given a unique symbol.

There are two notable exceptions to the foregoing. Areas with significant rock outcrops or snow avalanche tracks were designated with complex symbols as follows:

1) Where rock covers greater than about 20% of the landscape but less than about 50% R follows the soil identifying symbol,

$$\text{e.g.} \quad \frac{\text{OG 1}}{\text{Mv:H}} + \text{R}^{2-5}$$

2) Where rock covers greater than about 50% of the landscape but less than about 80% R preceeds the soil identifying symbol,

$$\text{e.g.} \quad \text{R}^{5-8} + \frac{\text{OG 1}}{\text{Mv:H}}$$

3) Where snow avalanche tracks are narrow, isolated and cover less than 25% of the landscape the symbol would be similar to;

$$\frac{\text{OG 1}}{\text{Mv:H}} + \text{A}^{<2}$$

4) Where snow avalanche tracks are in broad bands, merging and/or cover greater than 25% of the landscape the symbol would be similar to;

$$\frac{\text{OG 1A}^{>2}}{\text{Mv:H}}$$

CHEMICAL AND PHYSICAL ANALYSES

Chemical and Physical analyses were carried out according to the routine procedures used by the Alberta Institute of Pedology (Canada Soil Survey Committee 1976c). These involved a determination of:

Soil Reaction; pH was determined with a pH meter using a 2:1 0.01 M $CaCl_2$ solution to soil ratio (Peech 1965).

Total Nitrogen; determined by the macro Kjeldahl-Wilforth-Gunning method (A.O.A.C. 1955). A mixture of HgO, $CuSO_4$, and K_2SO_4 (Kelpak) was used as a catalyst.

Calcium Carbonate Equivalent: inorganic carbon manometric method of Boscombe (1961).

Organic Carbon; by difference between total carbon and inorganic carbon. Total carbon was determined by dry combustion using an induction furnace (Allison, et al. 1965) with a gasometric detection of evolved CO_2 (Leco model 577-100).

Cation Exchange Capacity; by displacement of ammonium with sodium chloride (Chapman 1965).

Exchangeable Cations; extraction by Neutral N NH_4OAC (A.O.A.C. 1955) with K, Mg, Na and Ca determined by atomic absorption spectrophotometry.

Sodium Pyrophosphate Extractable Iron and Aluminum by McKeague (1967) method. The determination of Fe and Al was done by Atomic absorption spectroscopy.

Particle Size Distribution; by the pipette method of Kilmer and Alexander (1949) as modified by Toogood and Peters (1953).

Liquid limit, Plastic limit, and Plasticity Index; by the method outlined by ASTM (1970).

One-third and fifteen Bar Moisture; by the pressure plate and pressure membrane methods (U.S. Salinity Laboratory Staff 1954).

FIELD TESTS

1. Bulk Density; by the soil core method. The samples were oven dried and weighed. Calculations were based on field moist, gravel-free volume. Values reported are the arithmetic mean of 5 determinations per horizon.

2. Percolation; by the method suggested by the Alberta Department of Manpower and Labour, Plumbing Inspection Branch (1972). This consists of digging a hole to the depth of interest and saturation for 24 hours before measuring the rate of drop of the water level in the hole.

3. Infiltration; by the double ring method with a constant head apparatus as suggested by Adams et al. (1957).

PART III

MAP UNIT DESCRIPTIONS

INTRODUCTION

The general relationships between the landforms and their associated soilscape groups are discussed in the following section. Information related to specific soilscape groups and soilscape map units is given in the section entitled Soilscape Group Descriptions (page 47). A summary of the soilscape group - landform combinations is given in Table 4. The descriptions are arranged alphabetically for ease of use.

LANDFORM-SOILSCAPE GROUP RELATIONSHIPS

Colluvial Landforms

Burgess (BG), Float (FL), Niles (NI), Silverslope (SI) and Otto (OO) are the soilscape groups which are associated with colluvial landforms (Figures 23, 75, 84). Generally, they occur on colluvial veneers and blankets over bedrock, but colluvial fans and aprons are also common. The materials are generally calcareous and medium textured, although coarse textured materials may also occur, depending upon the lithology of the colluvial source. Coarse fragment contents vary from nil to about 90%, and the coarse fragments vary from gravel sized to boulders. The soils characterizing the Burgess soilscape group are Regosolics while the Float, Niles, Silverslope and Otto soilscape groups are more stable and are characterized by Brunisolic and Podzolic soils.

Fluvial Floodplain Landforms

Kicking Horse (KH), Otterhead (OT) and Beaverfoot (BC) are the soilscape groups which are associated with fluvial floodplains (Figures 18, 50, 81). Generally they occur on level or gently undulating fluvial floodplain deposits but Otterhead soilscape groups may occur on fluvial terraces which have not flooded for hundreds of years. Fluvial floodplains are found in the valley bottoms of most of the major valleys, especially along the Kicking Horse and Beaverfoot Rivers. The materials are calcareous, stratified, medium and coarse textured alluvium. The soils characterizing the Beaverfoot soilscape group are Gleysolics which are subject to annual flooding. The Kicking Horse soilscape group is characterized by Regosolic soils which receive occasional flooding and the Otterhead soilscape group is characterized by Brunisolic soils which are above the present floodplain.

Fluvial Fan Landforms

Watchtower (WR), Clawson (CO), Hoodoo (HO), Opabin (OP), Mollison (MO) and Wiwaxy (WI) are the soilscape groups which are associated with fluvial fans and aprons (Figure 99). These landforms occur at the valley bottom, where marked reductions in stream gradient results in fan shaped deposits. The materials may be calcareous or non-calcareous and medium or coarse textured, depending mainly upon the type of bedrock within the drainage basin and especially where the downcutting is occurring. There may be a considerable variation in the texture and coarse fragment content of the materials on any given fan due to the nature of the deposition of fluvial fans. The fans usually have one or more stream channels which may shift during spring flooding, especially on the steeper fans. On fans with gentle slopes, there is often a small amount of overland flow adjacent to the channels during spring runoff. The shifting stream channels and temporary overland flow result in Regosolic soils on the majority of fluvial fans. However, Brunisolic and Podzolic soils do occur on the older and more stable fans and Gleysolic soils occur on several gently sloping fans.

Glaciofluvial Landforms

Haygarth (HR) and Takakkaw (TA) are the soilscape groups which are associated with glaciofluvial landforms (Figures 34, 39). Generally they occur on glaciofluvial terraces of limited areal extent, but small glaciofluvial fans, plains, blankets and veneers, as well as ridged glaciofluvial deposits are also present. Glaciofluvial deposits are found at low elevations along the sides of the major valleys, with maximum elevations being about 1750 metres in the Narao Lakes area. The materials are well sorted, calcareous sands and gravels generally overlain by a silty surficial deposit which is less than 50 cm thick. The soils range from Orthic Eutric Brunisols at the lower elevations to Orthic Humo-Ferric Podzols at the higher elevations.

Lacustrine Landforms

Dennis (DS) is the only soilscape group which is associated with lacustrine landforms (Figure 39). Generally it occurs on lacustrine veneers over morainal deposits, but lacustrine blankets may also occur. The materials are well sorted, calcareous silts, with few or no coarse fragments. The soils developed on lacustrine landforms are generally Brunisols. Most lacustrine landforms appear to be remnants of the immediate post glacial erosion when the lake in which the deposits formed was drained. Characteristically, these remnants are of small areal extent and difficult to delineate on aerial photographs, although areas of probable occurrence can be predicted.

Morainal Landforms

Ogden (OG), Ottertail (OL), Tocher (TO), Vanguard (VA), Odaray (OD), Shaffer (SK), Cathedral (CM) and O'Hara (OH) are the soilscape groups which are associated with morainal landforms (Figures 34, 39, 61). Generally they occur on morainal blankets and veneers over bedrock, but undulating, rolling, ridged and inclined moraines are also present at lower elevations in the major valleys. The Ogden, Ottertail, and Tocher soilscape groups occur on very calcareous, medium textured, stony till; the Cathedral soilscape group occurs on calcareous, coarse textured, stony till; the O'Hara soilscape group occurs on non-calcareous, coarse textured stony till; and Vanguard, Odaray, and Shaffer soilscape groups occur mainly on calcareous, medium textured till, with minor coarse textured till. In some areas, the till is overlain by a thin (less than 25 cm thick) silty surficial deposit. Soil development shows a vertical zonation grading from Eutric and Dystric Brunisols at lower (< 1600 m) elevations to Orthic Humo-Ferric Podzols at intermediate elevations (1600 - 2150 m) and Sombric Humo-Ferric Podzols at high (> 2150 m) elevations.

Organic Landforms

Narao (NA) is the only soilscape group which is associated with organic landforms (Figure 55). It occurs on flat bogs and horizontal fens. The materials consist of 40 to about 130 cm of mesic and fibric organic materials overlying calcareous alluvium. The soils are Terric Mesisols and Terric Fibrisols.

SOILSCAPE GROUP DESCRIPTIONS[1]

This section contains an identification key (Table 6) and generalized descriptions[1] of the soilscape map units used in this report. The key identifies the soilscape unit in relation to the soil maps and includes general information on the landforms, parent materials, soil classification, soil texture and coarse fragments, drainage and vegetation. The generalized descriptions of the soilscape map units include some landscape and vegetation information and indicate some of the dominant soil qualities of each unit. Some morphological and analytical information from a location chosen to characterize the map unit is presented in tabular form. More detailed analytical information is presented in Appendixes A and B.

The descriptions indicate that the soils of Yoho National Park have a wide range of soil characteristics that affect soil quality. Soil characteristics refer to physical and chemical features such as particle size distribution, soil structure, stoniness, amount of lime, acidity and amount of organic matter. Soil qualities refer to the inferred soil properties resulting from various combinations of physical and chemical characteristics and are designated by such terms as erodibility, permeability or drainage. Soil limitation means an evaluation of the degree and kind of risk or impediment that a certain soil (identified on the map as a soilscape map unit) has for a specific, selected Park use. For example: the kind of limitation for a campground may be wetness; the degree of limitation may be severe if the watertable is shallower than 50 cm during the season of use. An expanded discussion of soil limitations is found in Part IV.

[1] More complete information on profile morphology and other mapping unit parameters can be obtained from the authors, and will be published as Appendix E in a separate volume.

Table 6. Key to major characteristics of the soilscape map units.

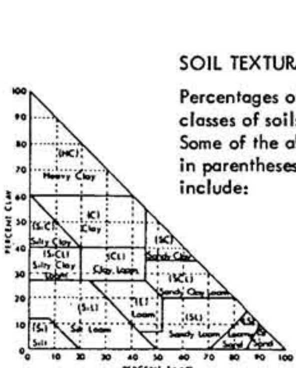
TERRAIN UNIT LANDFORM	TERRAIN UNIT MATERIALS	SOILSCAPE GROUP	SOILSCAPE MAP UNIT	SOIL SUBGROUP CLASSIFICATION	TEXTURE	COARSE FRAGMENTS	DRAINAGE	VEGETATION ZONE	COMMENTS
Glaciofluvial terrace	Calcareous stratified LS-SiL	Haygarth	HR1	Degraded Eutric Brunisols	LS	less than 10%	D1-D2	Subalpine	Outwash sand; intergrade to Humo-Ferric Podzols. Coarse fragments generally less than 5%; mainly gravels.
			HR2	Degraded Eutric Brunisols	SiL / SL	10 - 20%	D2	Subalpine & Montane	Ice contact stratified drift; valley train deposit.
	Calcareous stratified G & VGLS	Takakkaw	TA 1	Degraded Eutric Brunisols & Humo-Ferric Podzols	SiL / GSL	0 - 20% / more than 20%	D1-D2	Subalpine	Occasionally hummocky glaciofluvial included; less gravel near surface.
Floodplain	Calcareous stratified FSL-SiL over GSL	Kicking Horse	KI1	Orthic Regosols & Cumulic Regosols	FSL-SiL / GSL	0 - 20% / more than 20%	D3	Montane	Often droughty because of low water table if no rain; generally less than 75 cm to gravelly or very gravelly strata.
			KI2	Gleyed Orthic Regosols & Gleyed Cumulic Regosols	FSL-SiL / GSL	0 - 20% / more than 20%	D4	Montane	Generally less than 75 cm to gravelly or very gravelly strata.
		Otterhead	OT1	Degraded Eutric Brunisols	FSL-SiL / VGSL-VGLS	0 - 20% / more than 20%	D2	Montane	Generally less than 25 cm to gravels, some D3.
	Calcareous stratified SL & SiL alluvium	Beaverfoot	BC1	Rego Gleysols (peaty)	FSL-SiL	less than 5%	D6	Montane	Possibly some D5, frequently flooded.
			BC2	Orthic and Rego Gleysols	SiL	less than 5%	D6	Montane	Possibly some D5, frequently flooded.
			BC3	Rego Gleysols	SL-FSL / GSL	0 - 20% / more than 20%	D5-D6	Montane	Some areas artificially drained.
Fan*	Calcareous stratified coarse textured gravelly and very gravelly alluvium	Watchtower	WR1*	Orthic Regosols and Cumulic Regosols	GSL-GLS	20 - 50%	D2	Montane & Subalpine	Effervescent to the surface
			WR2*	Cumulic Regosols & Orthic Regosols	GL-GSL	more than 40%	D1-D2	Subalpine & Montane	Steeply sloping; cobbles and boulders common; dark colored, non-turfy Ah; often mechanical mixture of raw organic matter and mineral matter.
			WR3*	Orthic Regosols & Cumulic Regosols	SiL / GSL	less than 20% / 20 - 50%	D2	Montane	Often few coarse fragments near surface; gravelly below.
			WR4*	Gleyed Orthic Regosols & Gleyed Cumulic Regosols	SiL	less than 20%	D3	Montane	Deep medium textured; calcareous to surface; few coarse fragments.
			WR5*	Gleyed Orthic Regosols	GFSL-GSiL	20 - 50%	D4	Subalpine & Montane	Gleyed equivalent of WR3; generally less than 5% coarse fragments.
		Clawson	CO1*	Orthic Eutric Brunisols	GSiL / VGSL	20 - 50% / approx. 50%	D2	Montane	Represents the few stable fans in Yoho.
		Hoodoo	HO1*	Rego Gleysols & Orthic Gleysols	SiL-FSL	less than 10%	D5	Montane	Few coarse fragments, especially near surface.
	Non-calcareous stratified coarse textured gravelly and cobbly alluvium	Opabin	OP1*	Cumulic Regosols	VGSL-SiL	20 - 50%	D3	Subalpine	Coarse fragments are mainly quartzite (Gog formation); Lake O'Hara area.
		Mollison	MO1*	Orthic Humo-Ferric Podzols	GSL-GLS	20 - 50%	D2-D3	Montane	Coarse fragments are mainly granitic gravels and cobbles; Ice River Valley.
		Wiwaxy	WI1*	Orthic Humo-Ferric Podzols	L / VGLS	approx. 5% / more than 50%	D3	Upper Subalpine Meadow	Subalpine meadow below tree line; frost hollow.
Lacustrine veneer	Calcareous well sorted silts	Dennis	DS1	Degraded Eutric Brunisols	SiL-SiCL	less than 10%	D2	Montane & Subalpine	Small lacustrine pockets often approx. 75 cm thick over till.
Moraine	Calcareous non-stratified medium textured stony till	Ottertail	OL1	Degraded Eutric Brunisols	SiL	10 - 20%	D2	Montane	"Washed till", lime at 40 - 75 cm; warmer and drier climate than OG 1.
			OL2	Gleyed Melanic Brunisols & Gleyed Eutric Brunisols	SiL	less than 5% / 20 - 50%	D4	Montane & Subalpine	Some members of this map unit have gravels at or near the surface.
		Ogden	OG1	Orthic Humo-Ferric Podzols & Degraded Eutric Brunisols	SiL	less than 20%	D2	Subalpine	Mainly at higher elevations in the side valleys.
			OG2	Orthic Humo-Ferric Podzols	SiL	less than 5% / approx. 20%	D2	Subalpine	Silty surficial deposit over silt loam till.
		Tocher	TO1	Cumulic Regosols	L-SiL	less than 50%	D2	Subalpine & Montane	Eroding steep slopes; calcareous to the mineral surface.
	Calcareous non-stratified medium and coarse textured stony till	Vanguard	VA1	Rego Humic Gleysols (peaty)	SiL-SL	5 - 20%	D5-D6	Subalpine	Poorly drained associate of OG1, CM1, and OH1.
		Odaray	OD1	Orthic Humo-Ferric Podzols	SiL-SL	20 - 50%	D2	Upper Subalpine	Alpine larch, alpine fir, heather; thin "turfy" Ah; 2000 to 2150 m a.s.l.
		Schaffer	SK1	Sombric Humo-Ferric Podzols	SiL-GSL	less than 50%	D2-D3	Krummholz & Alpine	"Turfy" Ah; generally above 2150 m a.s.l.; complex and variable soil and vegetation patterns.
	Calcareous coarse textured stony till	Cathedral	CM1	Degraded Dystric Brunisols & Orthic Humo-Ferric Podzols	SL-GSL	10 - 25%	D2-D3	Subalpine	Mainly the Cataract Brook and the Porcupine Creek valleys; occasional seepage inclusions.
	Non-calcareous coarse textured till	O'Hara	OH1	Orthic Humo-Ferric Podzols & Degraded Dystric Brunisols	GLS-SL	15 - 30%	D2	Subalpine	Some imperfectly drained soils as inclusions; boulders common; surface 10 to 25 cm is FSL-SiL.
Colluvial slopes	Generally calcareous coarse and some medium textured cobbly bouldery and gravelly colluvium	Burgess	BG1	Boulder field plus some Orthic Regosols	SL-L	boulders 2 - 10 m diam.	D1-D2	Subalpine	Rock slide areas; soil covers 10-20% of the area; the rest is covered with large boulders.
			BG2	Cumulic Regosols and cobble land	V. Cobbly VGSiL	more than 50%	D1-D2	Subalpine & Montane	Steep vegetated slopes; often below cliffs.
			BG3	Orthic Regosols & some Orthic Eutric Brunisols	GSiL-GL	20 - 50%	D1-D2	Subalpine & Montane	Unstable colluvial slopes with fewer coarse fragments than BG2.
			BG4	Cumulic Regosols & Orthic Regosols	GSiL-GSL	more than 20%	D2-D3	Subalpine & Montane	Non-turfy, dark colored Ah; snow avalanched areas; coarse fragments variable.
			BG5	Orthic Regosols & Cumulic Regosols	SiL	less than 20%	D2	Subalpine	Derived from medium textured shales and schists.
		Float	FL1	Orthic Eutric Brunisols & Orthic Humo-Ferric Podzols	GSiL-GL	10 - 30%	D2	Subalpine	Sometimes developed on non-calcareous residual material near ridge tops.
		Niles	NI1	Lithic Orthic Eutric Brunisols & Lithic Orthic Regosols	SiL-L / R	less than 50%	D1-D2	Subalpine & Montane	Shallow slopewash and unconsolidated residual material (less than 50 cm to bedrock).
		Silverslope	SI1	Orthic Humo-Ferric Podzols & Orthic Ferro-Humic Podzols	SiL-SL	less than 50%	D2	Upper Subalpine	"Turfy" Ah, generally 2000 to 2150 m a.s.l., often modified residual parent material.
			SI2	Lithic Humo-Ferric Podzols & Lithic Eutric Brunisols	SiL-SL / R	less than 50%	D2	Upper Subalpine	Same as SI1 except shallow (less than 50 cm) to bedrock.
		Otto	OO1	Sombric Humo-Ferric Podzols	SiL-SL	less than 50%	D2	Krummholz & Alpine	"Turfy" Ah, generally more than 2150 m a.s.l., often modified residual parent material.
			OO2	Lithic Sombric Humo-Ferric Podzols	L-SL / R	less than 50%	D2	Krummholz & Alpine	Same as OO1 except shallow (less than 50 cm) on rock benches and ridge tops, and often on undifferentiated Parent materials.
		Narao	NA1	Terric Mesisols	sedge derived		D6	Montane	Organic soil area around Narao Lake.
			NA2	Terric Mesic Fibrisols	moss derived		D6	Subalpine	Organic soil areas in the Beaverfoot River area.

* These soilscape unit descriptions describe soils in approximately the mid-fan position. Almost every fan can vary from cobbly sand through thin sandy loam over gravel to fine sandy loam or silt loam and drainage classes from rapidly to poorly or very poorly drained.

SPECIAL LAND UNITS

A	Used as a suffix to indicate modification of soilscape by repeated snow slides or avalanches ($\frac{xxxA}{Y}$ if greater than 25% and $\frac{xxx}{Y}$ + A if less than 25% of the map area is affected).
Bp	Borrow Pit.
Er	Eroded areas where soil creep and erosion is so active as to prevent vegetation growth.
m	Recent moraine, unvegetated.
SC	Cobble land associated with stream channels.
T	Talus and coalescing talus cones.
R	Rock, bedrock and fractured bedrock stable enough so that talus cones are not evident.
W	Water body.

SOIL TEXTURAL CLASSES



Percentages of clay and sand in the main textural classes of soils; the remainder of each class is silt. Some of the abbreviations used in the table are given in parentheses in the triangle. Other abbreviations include:

- G - gravelly
- VC - very coarse sand
- C - coarse sand
- F - fine sand
- VF - very fine sand
- CF - coarse fragments (2 mm to 25 cm)

DRAINAGE CLASSES

- D1 - Rapidly drained
- D2 - Well drained
- D3 - Moderately well drained
- D4 - Imperfectly drained
- D5 - Poorly drained
- D6 - Very poorly drained

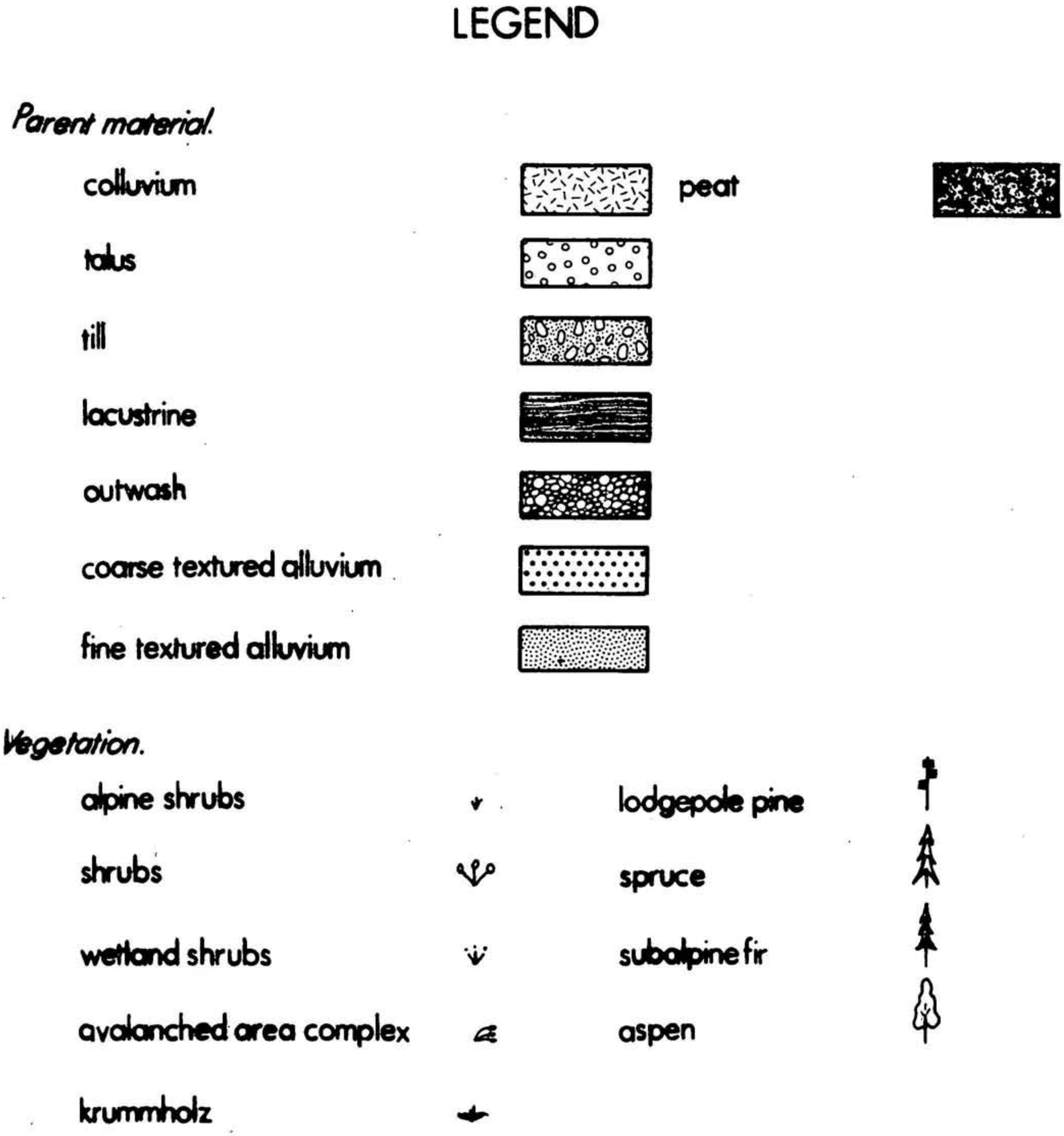


Figure 17. Symbols used in the sketches in Part III to identify the components of the physiographic settings of the map units.

BC - Beaverfoot Soilscape Group

Physiographic Setting

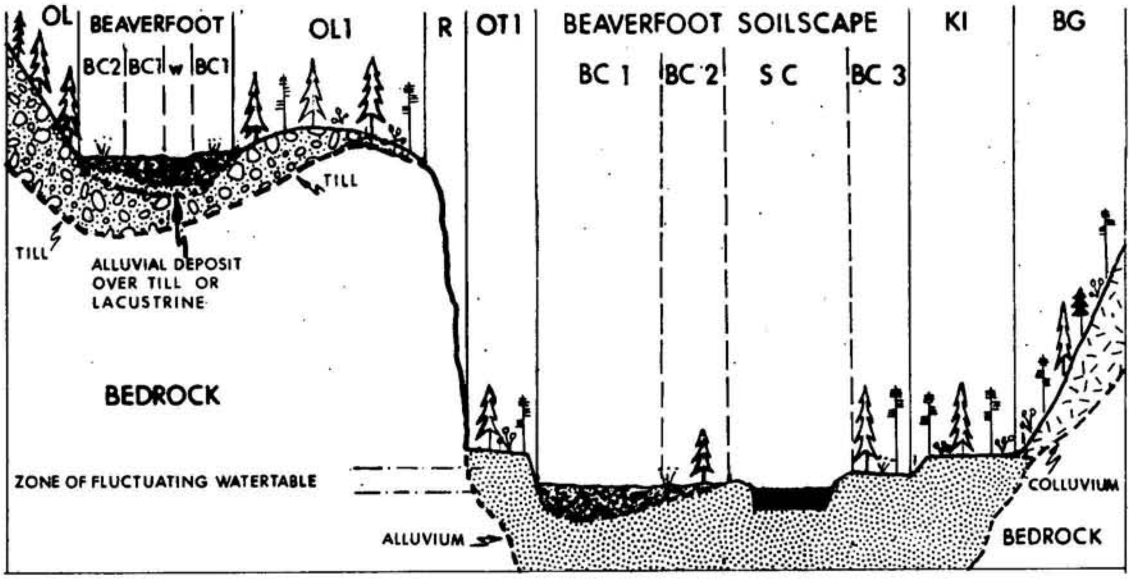


Figure 18. Sketch showing the landscape relationships between Beaverfoot and associated soilscape groups.

Landform and Parent Materials

The Beaverfoot Soilscape group occurs on nearly level to depressional fluvial plains. The materials are calcareous, stratified, medium and coarse textured recent alluvium.

Environment

The Beaverfoot soilscape group occurs on poorly drained valley bottom sites generally within the montane vegetative zone, but occasionally extending into the lower part of the subalpine zone at elevations up to about 1600 m a.s.l.

Table 7. Key criteria differentiating the Beaverfoot map units.

Soilscape Map Unit	Classification	Texture	Coarse Fragment Content (%)	Drainage Class
BC 1	Rego Gleysols (peaty)	FSL-SiL	< 5%	very poorly
BC 2	Orthic & Rego Gleysols	SiL	< 5%	very poorly
BC 3	Rego Gleysols	SL-FSL / GSL	0 - 20% / > 20%	poorly

BC1 Map Unit (Rego Gleysols)

This map unit is used to identify the very poorly drained, peaty soils in depressional areas of the floodplain. Soils of this map unit have a peaty surface layer 15 to 60 cm thick, consisting of the remains of mosses and sedges. All soils of this map unit are medium to fine textured with less than 5% coarse fragments and have very poor internal drainage. Mottles are present throughout the pedon.

Table 8. Brief description of the pedon chosen to characterize the BC1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
Om	18-1	very dark brown	nil	-	6.6	70
Oh	1-0	dark brown	nil	not sampled		
Ckg1	0-1	bluish gray	nil	silt loam	not sampled	
Ckg2	1-19	bluish gray	nil	silt loam	7.3	3.3
Ahgb	19-20	very dark brown	nil	not sampled		
Ckgb	20-32+	bluish gray	nil	silt loam	7.4	-

Rego Gleysol

The very poor drainage, high watertable, frequent flooding and organic surface horizons suggest that this map unit has very severe limitations for most recreational and engineering uses.

Figure 19. Site of the pedon chosen to characterize the BC 1 map unit.

Figure 20. Rego Gleysol soil which characterized the BC 1 map unit. Note the dark organic material in the top 18 cm and the water in the bottom of the pit when sampled in September.

BC 2 Map Unit (Orthic and Rego Gleysols)

This map unit is characterized by poorly drained, medium textured soils with thin organic surface horizons. These soils have developed on alluvium. The textures are generally silt to silt loam and coarse fragment contents are usually less than 5%. Mottles are present throughout the pedon. In oxbow areas, some submerged soils may be included within this map unit concept.

Table 9. Brief description of the pedon chosen to characterize the BC 2 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L	1-0	not sampled				
Ckg1	0-22	light brownish gray	nil	silt	7.2	1.6
Ckg2	22-40	gray to light gray	nil	silt	7.3	0.8
Ofb	40-42	black to very dark gray	nil	not sampled		
Ckgb	42-67	gray to light gray	nil	silt	7.2	4.6
IIOmb	67-80+	black to very dark gray	nil	-	6.7	61

Rego Gleysol

The very poor drainage, high watertable and frequent flooding suggest that this map unit has very severe limitations for most recreational and engineering uses.

BC 3 Map Unit (Rego Gleysols)

This map unit is used to identify the coarse textured, poorly to very poorly drained soils developed on fluvial floodplains. These soils generally occur adjacent to stream channels and may have a variable thickness of medium textured materials deposited by recent flooding overlying the coarse textured materials. Mottles are present to the soil surface.

Figure 21. Site of the pedon chosen to characterize the BC 3 map unit.

Figure 22. Rego Gleysol soil which characterized the BC 3 map unit. Note the finer materials near the surface with gravels at about 30 cm. Mottles are also evident in the upper 30 cm.

Table 10. Brief description of the pedon chosen to characterize the BC 3 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F	1-0	dark brown; partly decomposed material				
ACk	0-2	dark grayish brown	nil	silt	7.3	13
Ckg1	2-7	light brownish gray	nil	silt	7.2	1.2
Ckg2	7-20	grayish brown	nil	very fine sandy loam		trace
IICkg	20-37+	dark gray	60	very gravelly coarse sand		0.3

Rego Gleysol

The poor drainage, high watertable and frequent flooding suggest that this soil has very severe limitations for most recreational and engineering uses.

BG - Burgess Soilscape Group

Physiographic Setting

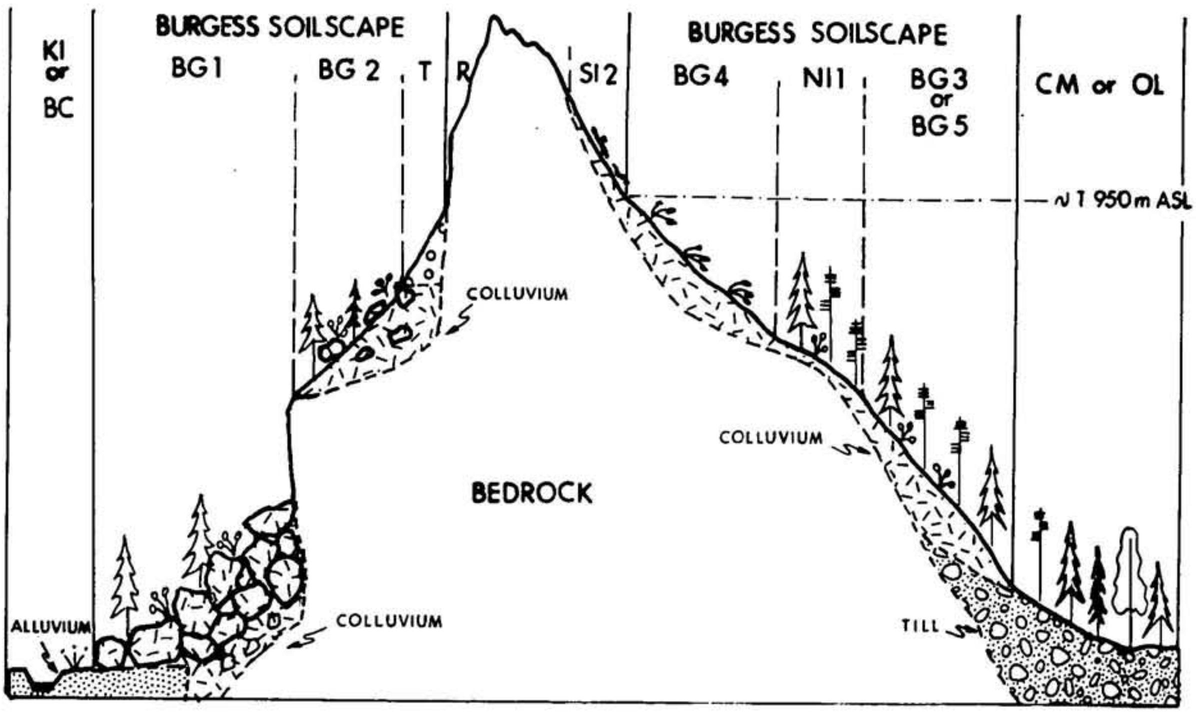


Figure 23. Sketch showing the landscape relationships between Burgess and associated soilscape groups.

Landform and Parent Materials

The Burgess soilscape group generally occurs on very steeply to extremely sloping (30 - 60+ %) colluvial slopes. The parent materials are usually calcareous and medium textured, but some coarse textured materials are included. The materials generally range from gravelly to bouldery.

Environment

The Burgess soilscape group is found at elevations ranging from valley bottom to that of the forest-alpine ecotone at about 2,000 m a.s.l., occurring in both the montane and subalpine vegetative zones.

Table 11. Key criteria differentiating the Burgess map units.

Soilscape Map Unit	Classification	Texture	Coarse Fragment Content (%)	Drainage Class
BG1	Boulder field plus Orthic Regosols and Orthic Eutric Brunisols	SiL-L	boulders 1-10 m in diameter	well to rapidly
BG2	Cumulic Regosols plus cobbleland	VGSiL-VGL	> 50%	well to rapidly
BG3	Orthic Regosols and some Orthic Eutric Brunisols	GSiL-GL	20-50%	well to rapidly
BG4	Cumulic Regosols and Orthic Regosols	GSiL-GL	> 20%	well to rapidly
BG5	Orthic Regosols and Cumulic Regosols	SiL	< 20%	well

BG1 Map Unit (Boulder Field plus Orthic Regosols and Orthic Eutric Brunisols)

This map unit is characterized by landslide deposits and the occasional soils which are developed on them. The materials consist of boulders up to 10 meters in diameter with pockets of fine earth material between them. The fine earth materials often consist of translocated till and may make up as much as 30% of the map unit, but in other areas the boulders are touching and there is little or no fine earth material.

Figure 24. This photo shows the huge boulders and vegetation associated with the BG 1 map unit.

Figure 25. A railway cut through a BG 1 area shows that some finer materials are to be found below the bouldery surface.

Soil development on the fine earth materials, where present, is regosolic or brunisolic.

The extreme stoniness causes very severe limitations for recreational and engineering uses.

BG 2 Map Unit (Cumulic Regosols plus Cobbleland)

This map unit is characterized by those soils, with little horizon development and greater than 50% coarse fragments, which occur on colluvium. Commonly this material is recognized below cliffs or rock outcroppings which provide the supply of colluvial material. The instability of the soils within this map unit is indicated by the open tree cover and the high number of stunted and curved trees which are present. Snow avalanching is sometimes associated with parts of this map unit and is designated as BG 2 + A where the avalanching occurs on less than about 25% of the map unit and is restricted to well defined chutes, or as BG 2 A where avalanching occurs on greater than 25% of the map unit. These soils do not usually have an Ah horizon.

Table 12. Brief description of the pedon chosen to characterize the BG 2 map unit

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-H	1-0	very dark brown			7.4	47
A & Ck	0-32	dark brown to brown	90	VGSiL	7.4	13
Ck	32-70+	dark yellowish brown	95	VGSiL	7.5	5.9

Cumulic Regosol

The extreme stoniness, high coarse fragment content and generally steep slopes present very severe limitations for recreational and engineering uses on this map unit.

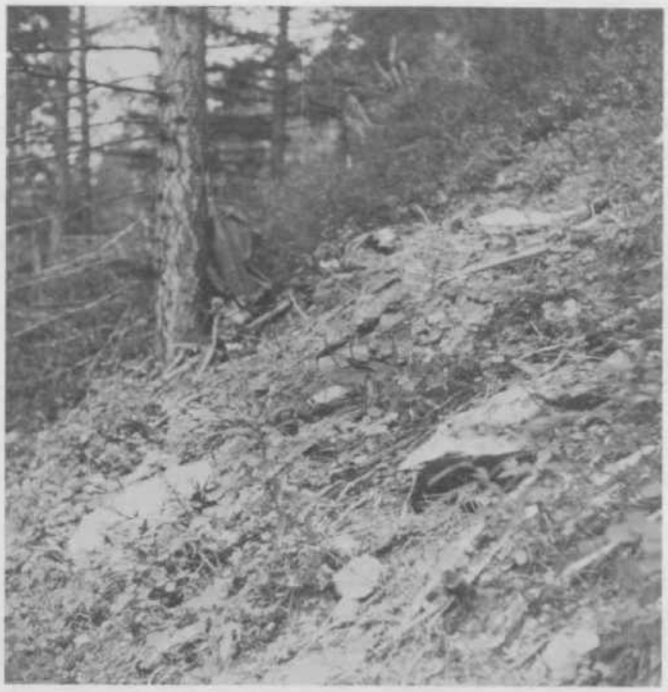


Figure 26. Site of the pedon chosen to characterize the BG 2 map unit. Note the abundant coarse fragments on a 60% slope, with widely spaced Douglas fir trees.

Figure 27. Cumulic Regosol soil chosen to characterize the BG 2 map unit. The loose dark colored appearance is typical of this map unit.

BG 3 Map Unit (Orthic Regosols)

This map unit is characterized by those soils, with little horizon development and containing 20 to 50% coarse fragments, which occur on colluvium. The depth to bedrock is generally greater than 50 cm, but is often less than 200 cm. Snow avalanching is sometimes associated with parts of the BG 3 map unit and is shown on the maps as BG 3 + A where the avalanching occurs on less than about 25% of the map unit and is restricted to well defined chutes, or as BG 3A where avalanching occurs on greater than 25% of the map unit. These soils do not usually have an Ah horizon

Table 13. Brief description of the pedon chosen to characterize the BG 3 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L	2-0	consists mostly of needles			-	-
ABk	0-12	light brown	25	gravelly silt loam	6.9	6.6
Ck	12-70	yellowish brown	85	very gravelly silt loam	7.2	-
R	70+					

Orthic Regosol

The very stony nature of these soils and the steep slope generally associated with this map unit result in severe to very severe limitations for most recreational and engineering uses.

BG 4 Map Unit (Cumulic and Orthic Regosols)

This map unit is characterized by those soils which have developed on snow avalanche chutes having vegetative communities characterized by alders and/or willows and forbs. The depth to bedrock of these soils is characteristically greater than 50 cm, but in many mapped areas it may be less than 200 cm. A well developed non-turfy, dark colored Ah horizon is found on these soils.

Figure 28. Site of the pedon chosen to characterize the BG 3 map unit.

Figure 29.

Orthic Regosol soil chosen to characterize the BG 3 map unit. The loose appearance is typical.

Table 14. Brief description of the pedon chosen to characterize the BG 4 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
Ah	0-20	black	50	very gravelly silt loam	7.0	26
ACk	20-35	very dark grayish brown	50	very gravelly silt loam	7.3	8.7
Ck1	35-85	light olive brown	45	gravelly silt loam	7.3	0.5
Ck2	85-100+	olive brown	55	very gravelly silt loam	7.3	2.2

Cumulic Regosol

The generally steep slopes and the snow avalanching associated with this map unit suggest severe to very severe limitations for recreational and engineering uses.

BG 5 Map Unit (Orthic and Cumulic Regosols)

This map unit is characterized by those soils with little horizon development and containing less than 20% coarse fragments which occur on colluvium. The colluvium is generally derived from fine textured slates and schists. On steeper slopes, this map unit may present serious stability problems such as those on the north corner of Mount Hurd where there is abundant evidence of ongoing soil creep as well as mudflow scars. Snow avalanching may be associated with parts of this map unit and is designated as BG 5 + A where the avalanching occurs on less than about 25% of the map unit and is restricted to well defined chutes, or as BG 5A where avalanching occurs on more than 25% of this map unit. These soils do not usually have an Ah horizon.

Figure 30. Site of the pedon chosen to characterize the BG 4 map unit showing the lush non-forest vegetation typical of the snow avalanched areas where this map unit is located.

Figure 31. Cumulic Regosol soil chosen to characterize the BG 4 map unit.

Figure 32. Site of the pedon chosen to characterize the BG 5 map unit. The curved trunks of the trees indicate that downslope creep is active.

Figure 33. Orthic Regosol soil chosen to characterize the BG 5 map unit. Fewer coarse fragments are evident than in the last four Burgess units.

Table 15. Brief description of the pedon chosen to characterize the BG5 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L	-	mainly charcoal				
Ck1	0-20	yellowish brown	20	gravelly silt loam	7.2	1.9
Ck2	20-110+	light olive brown	20	gravelly silt loam	7.5	0.7

Orthic Regosol

The relatively unstable steep slopes of this map unit suggest that it has severe to very severe limitations for most recreational and engineering uses.

CM - Cathedral Soilscape Group

Physiographic Setting

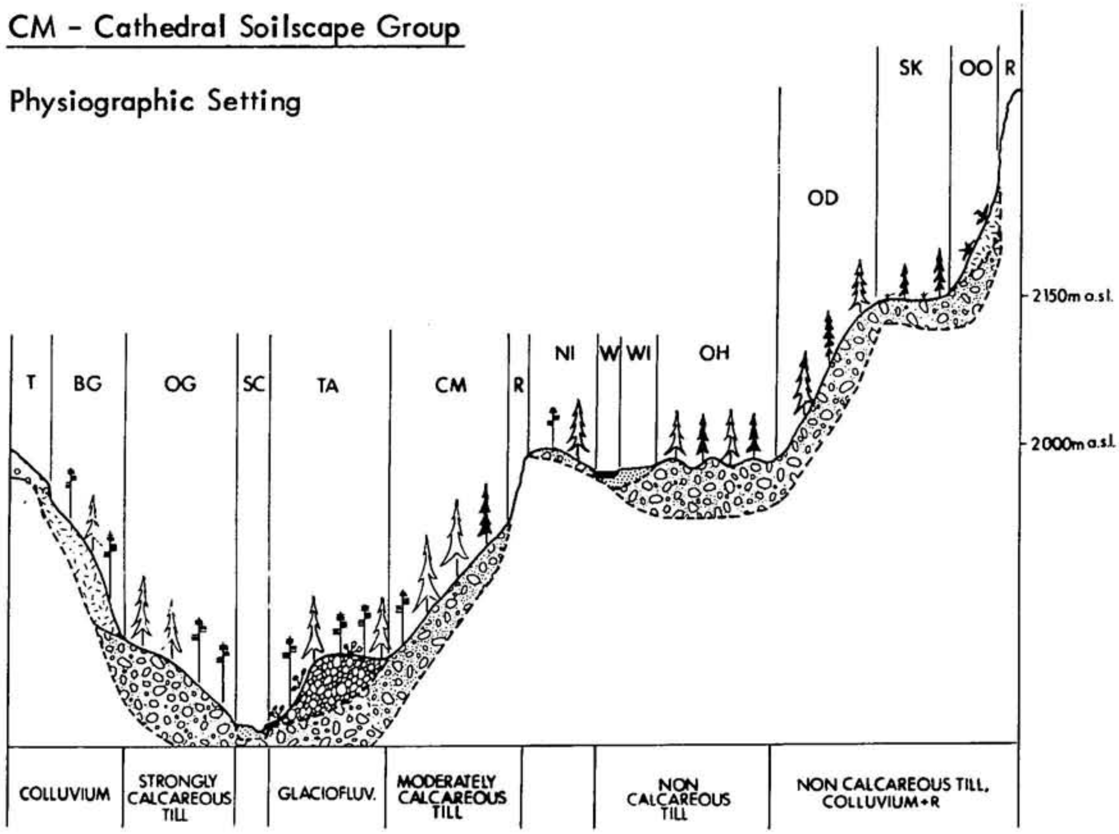


Figure 34. Sketch showing the landscape relationships between the Cathedral and associated soilscape group.

Landform and Parent Materials

The Cathedral soilscape group occurs on morainal veneers and blankets over bedrock, as well as deeper morainal deposits. The parent materials are calcareous, coarse textured stony till.

Environment

Cathedral map units are generally found in the subalpine vegetative zone, occurring between about 1550 and 2000 m a.s.l.

CM1 Map Unit (Orthic and Degraded Dystric Brunisols and Orthic Humo-Ferric Podzols)

This map unit is characterized by those soils with distinct reddish B horizons, which have developed on coarse textured, calcareous glacial till at elevations below the forest-alpine ecotone. These soils have sandy loam to loam textures, generally contain less than 30% coarse fragments, and are well drained. Ae horizons are usually present and the depth to free lime is often 1 to 2 meters. Moderately well to imperfectly drained inclusions occur along the west side of Cataract Brook.

Table 16. Brief description of the pedon chosen to characterize the CM1 map unit.

Horizon	Depth (cm)	Moist color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F	10-0	very dark grayish brown			3.5	78
Ae	0-10	pinkish gray	15	fine sandy loam	3.5	2.2
Bm1	10-25	reddish yellow	25	gravelly fine sandy loam	4.2	1.0
Bm2	25-50	reddish yellow	15	loam	4.3	0.9
BC1	50-95	yellowish brown	15	loam	4.9	0.2
BC2	95-150+	yellowish brown	20	gravelly loam	5.8	0.1

Degraded Dystric Brunisol

Figure 35. Site of the pedon chosen to characterize the CM1 map unit. Large Engelmann spruce, some subalpine fir and a dense ground cover of mosses characterize this site.

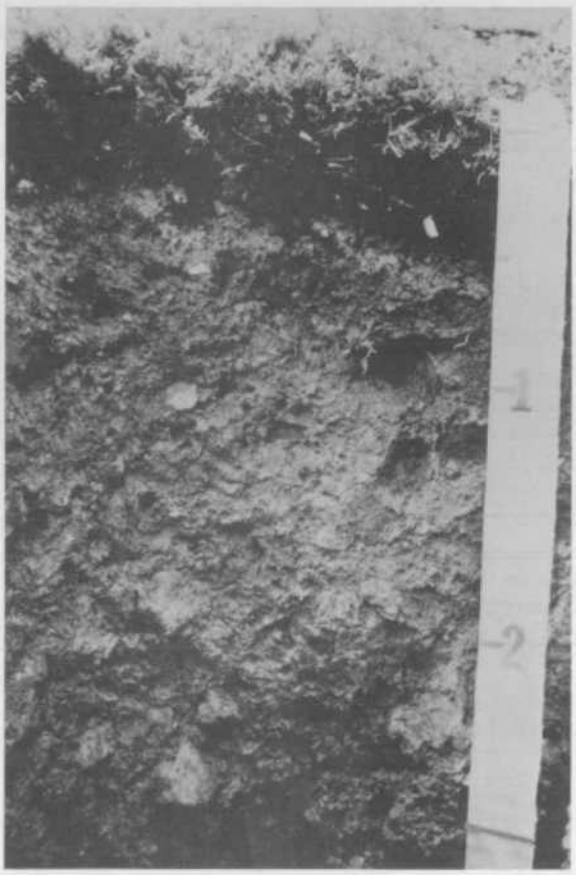


Figure 36. Degraded Dystric Brunisol soil chosen to characterize the CM1 map unit. Lime does not occur within 150 cm, and is probably about 200 cm from the surface.

The steep slopes which are generally associated with this map unit result in severe and very severe limitations for many recreational and engineering uses. Where slopes are not limiting, these soils are generally well suited for recreational uses, but have a moderate limitation for buildings and roads due to potential frost heaving.

CO - Clawson Soilscape Group

Physiographic Setting (Figure 99)

Members of the Clawson soilscape group occur on fans where the stream is deeply entrenched preventing flooding. These fans are typically larger than most fans in Yoho, and generally have less than 20% slopes. Positions of these fans near the apex or the stream may be subject to profile disruption and thus not part of the Clawson soilscape group concept.

Landform and Parent Materials.

The Clawson soilscape group occurs on fluvial fans and aprons. The materials are calcareous, stratified, medium and coarse textured alluvium which generally contain less than 50% coarse fragments.

Environment

The Clawson soilscape group is usually mapped on well drained sites at valley bottoms within the montane vegetative zone, and occasionally in the subalpine vegetative zone.

CO1 Map Unit (Orthic Eutric Brunisols)

This map unit is characterized by soils with brownish B horizon development on calcareous fan alluvium. The soils are medium to coarse textured, generally contain less than 50% coarse fragments, and are well drained.

Figure 37. Site of the pedon chosen to characterize the CO1 map unit. The lodgepole pine, Douglas fir and trembling aspen along with buffalo-berry are commonly found among the montane vegetation associated with this map unit.

Figure 38. Orthic Eutric Brunisol soil chosen to characterize the CO1 map unit. Coarser textures, with more gravels commonly occur with increasing depth.

Table 17. Brief description of the pedon chosen to characterize the CO1 map unit.

Horizon	Depth (cm)	Moist color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F	6-0	very dark brown			4.0	65
Ae	0-2	gray to light gray	20	silt loam	3.8	3.6
Bm1	2-9	strong brown	30	gravelly silt loam	4.9	3.8
Bm2	9-65	pale brown	60	very gravelly sandy loam	6.5	0.5
Ck	65-85+	pale brown	60	very gravelly sandy loam	-	-

Orthic Eutric Brunisol

The silty surface texture and moderate coarse fragment content suggest that this map unit has moderate limitations for recreational uses. The map unit is generally well suited for engineering uses.

DS - Dennis Soilscape Group

Physiographic Setting

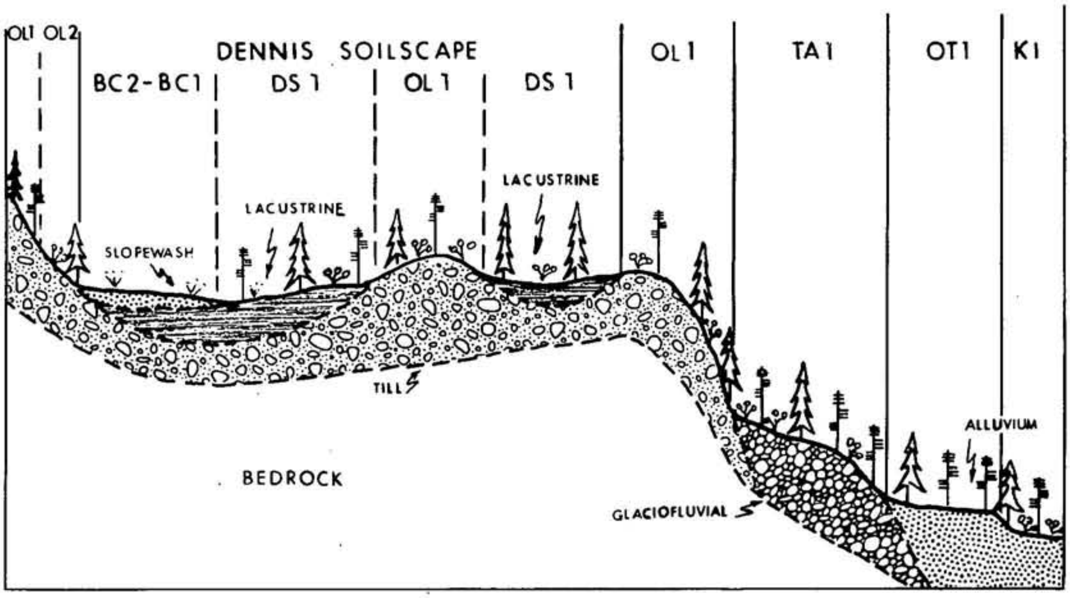


Figure 39. Sketch of the landscape relationship between Dennis and associated soilscape groups.

Landform and Parent Materials

The Dennis soilscape group occurs on lacustrine veneer or blankets over morainal deposits. The materials are calcareous, well sorted silts with few or no coarse fragments. Where the contact between lacustrine till occurs within a meter of the surface, coarse fragments are often evident within the lacustrine material.

Environment

The Dennis soilscape group occurs on well drained sites along the sides of the major valleys within the montane vegetative zone, and a few small areas in the larger side valleys within the subalpine vegetative zone.

DS 1 Map Unit (Degraded Eutric Brunisols)

This map unit is characterized by soils found on lacustrine parent materials. These soils are medium textured, have few or no coarse fragments and are generally well drained.

Table 18. Brief description of the pedon chosen to characterize the DS 1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F	1-0	black to dark brown; composed mainly of pine needles			6.0	-
Ae	0-2	light brown	nil	silt loam	not sampled	
Bm	2-18	reddish yellow and light yellowish brown	nil	silt loam	6.2	1.9
Ck1	18-50	pale yellow	nil	silty clay loam	7.7	-
Ck2	50-80+	pale yellow	nil	silty clay loam	7.8	-

Degraded Eutric Brunisol

Figure 40. Site of the pedon chosen to characterize the DS1 map unit. The montane vegetation is characterized by lodgepole pine-buffalo-berry communities.

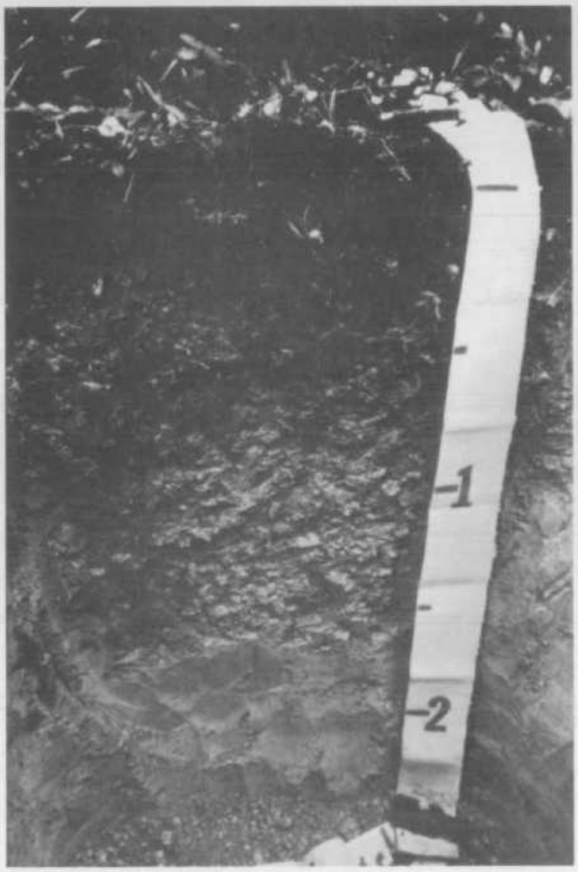


Figure 41. Degraded Eutric Brunisol soil chosen to characterize the DS1 map unit. Note the lack of gravels and cobbles. Lime occurs at about 18 cm.

The silty surface texture, slow permeability, and susceptibility to frost-heaving suggests that this map unit has moderate and severe limitations for most recreational and engineering uses.

FL - Float Soilscape Group

Physiographic Setting (Figure 84)

Members of the Float soilscape group occur on steeply sloping (30 to 60%) colluviated mountain sides, generally well above the valley floor.

Landform and Parent Materials

Members of the Float soilscape group occur on similar landform positions to the Burgess soilscape group (Figure 23), especially BG 3, except that for various reasons the soils of the Float soilscape group are stable enough to allow the development of distinct horizons. In general the increased stability appears to occur where no rock cliff is above the land unit to provide a continuous increment of gravity transported material each year. However, gravity transported materials provide the parent material for the soils so catastrophic events such as fires must have allowed unstable periods of colluvial transport.

Environment

Float soilscape groups occur on well drained sites in the subalpine and montane vegetative zones at elevations ranging from valley bottom to about 2000 m a.s.l.

FL1 Map Unit (Orthic Eutric Brunisols and Orthic Humo-Ferric Podzols)

This map unit is characterized by soils which occur on colluvium at elevations below the forest-alpine ecotone and which have brownish and reddish B horizon development. These soils are medium to coarse textured, generally contain 10 to 30% coarse fragments and are well drained. The relatively stable soils of this map unit probably result from the lack of cliffs which supply a constant source of new

Figure 42. Site of the pedon chosen to characterize the FL1 map unit. The open canopied lodgepole pine stand allows abundant ground cover of grasses and forbs.

Figure 43. Degraded Eutric Brunisol soil chosen to characterize the FL1 map unit. Note the abundance of flat coarse fragments.

material and/or shallowness (often less than 2 meters) to bedrock. Considerably higher than average coarse fragment contents and coarser textures may occur in the lower horizons of the shallow soils.

Table 19. Brief description of the pedon chosen to characterize the FL1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F	6-0	very dark grayish brown; slightly to well decomposed needles and deciduous leaves			5.5	-
Ae	0-4	very pale brown to pale brown		loam	not sampled	
Bm	4-45	brownish yellow	45	gravelly silt loam	6.1	3.1
Ck1	45-90	light yellowish brown	70	very gravelly coarse sandy loam	7.2	-
Ck2	90-110+	light yellowish brown	85	very gravelly coarse sandy loam	7.4	-

Degraded Eutric Brunisol

The steep slopes which are generally associated with this map unit result in severe and very severe limitations for recreational and engineering uses.

HO - Hoodoo Soilscape Group

Physiographic Setting (Figure 50 , page 85)

Members of this soilscape group occur on gently sloping fluvial fans generally where they adjoin the fluvial floodplains of the larger rivers.

Landform and Parent Materials

The Hoodoo soilscape group occurs on fluvial fans and aprons. The materials are calcareous, stratified, medium textured fan alluvium, containing few or no coarse fragments.

Environment

The Hoodoo soilscape group occurs on poorly drained valley bottom sites within the montane vegetative zone.

HO 1 Map Unit (Rego and Orthic Gleysols)

This map unit is characterized by poorly and very poorly drained soils found on alluvial fans. These soils are generally medium textured with less than 10% coarse fragments. Mottles are present throughout the pedon.

Table 20. Brief description of the pedon chosen to characterize the HO1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F	7-0	Partly decomposed organic litter			6.5	59
Ckg1	0-7	reddish brown	nil	silt loam	7.3	4.0
Ckg2	7-25	brown	nil	silt loam	7.3	0.7
Ckg3	25-47	light olive gray	nil	silt	7.4	trace
Ahb	47-48	-	nil	silt loam	-	-
Ckgb1	48-50	light olive gray	nil	silt loam	7.5	trace
Ckgb2	59-90+	light olive gray	nil	silt	7.2	0.7

Rego Gleysol

The poor drainage and high water table associated with this map unit suggests that it has severe limitations for recreational and engineering uses.

Figure 44. Site of the pedon chosen to characterize the HO1 map unit. White spruce with abundant mosses characterize the vegetation

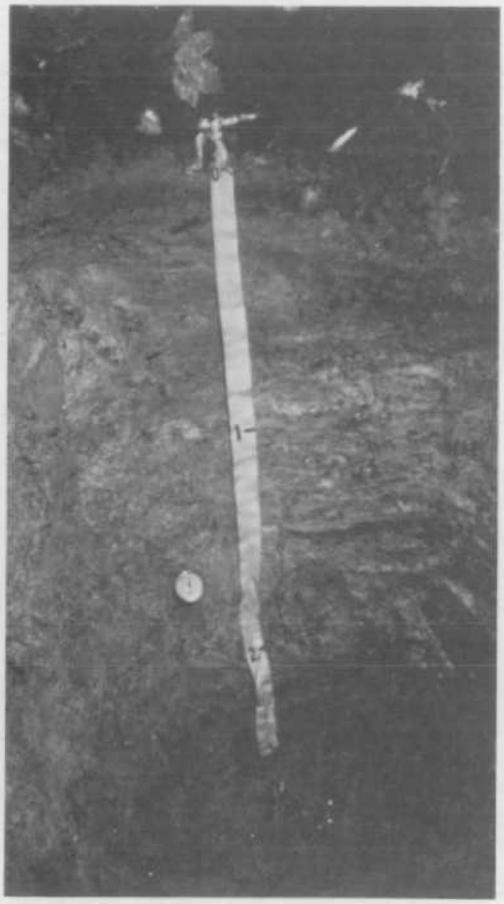


Figure 45. Rego Gleysol soil chosen to characterize the HO1 map unit. The dull, drab appearance and mottles are typical of these soils.

HR - Haygarth Soilscape Group

Physiographic Setting

Haygarth soilscape groups occur associated with ice contact stratified drift in several physiographic settings such as small plains on valley sides, and stable fans on the valley bottom.

Landform and Parent Materials

Haygarth soilscape groups occur on glaciofluvial terraces, veneers and blankets. The materials are calcareous stratified sands and calcareous stratified ice-contact drift. Coarse fragments are of mainly gravel and cobble sizes and generally make up less than 20% by volume of the materials.

Environment

The Haygarth soilscape group is located slightly above valley bottom at elevations up to approximately 1700 m a.s.l., occurring in the montane vegetative zone and extending into the lower part of the subalpine vegetative zone.

Table 21. Key criteria differentiating the Haygarth map units

Soilscape Map Unit	Classification	Texture	Coarse Fragment Content (%)	Drainage Class
HR1	Degraded Eutric Brunisols	loamy sand to sandy loam	< 10%	well to rapidly
HR2	Degraded Eutric Brunisols	silt over sandy loam	10-20%	well

HR1 Map Unit (Degraded Eutric Brunisols)

The soils of this map unit are predominantly coarse (loamy sand to sandy loam) textured with occasional bands of medium to moderately fine (silt loam to silty clay loam) textured materials present. Coarse fragment contents are commonly less than 2%. This map unit is found at the east end of Wapta Lake and along the Ottertail river below Mount Hurd.

Table 22. Brief description of the pedon chosen to characterize the HR1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L	2-0	black; charcoal with some recent fairly well decomposed organic matter			3.9	95
Ae	0-4	light gray	< 1	silt loam	4.3	1.4
Bm1	4-9	yellowish red	< 1	fine sandy loam	5.2	2.6
Bm2	9-33	yellowish red to brownish yellow	< 1	loamy sand	5.3	0.2
Bm3	33-45	yellowish brown and reddish brown	2	loamy sand	5.6	0.3
Ck	45-105	light olive brown	10	sand	7.4	-
IICk	105-130+	light yellowish brown	< 1	silt loam	7.1	-

Degraded Eutric Brunisol

This map unit is generally well suited for recreational uses, but has severe limitations for buildings and roads due to potential frost heaving.

HR2 Map Unit (Degraded Eutric Brunisols)

The soils of this map unit are coarse textured with varying amounts of pea-sized coarse fragments. Coarse fragment contents usually range from 10 to 20%

Figure 46. Site of the pedon chosen to characterize the HR1 map unit.

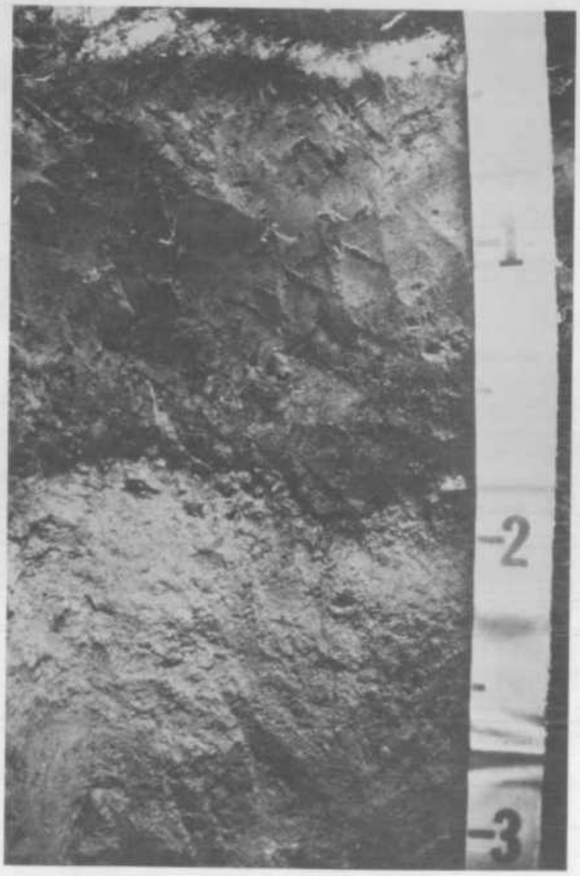


Figure 47
Degraded Eutric Brunisol soil chosen to characterize the HR1 map unit. This photo shows the occurrence of stratified coarse textured materials.

in the solum, but may exceed 50% in the C horizons. This map unit occurs on ice-contact stratified drift and glaciofluvial fans. Till exposures may be associated with the relatively thin ice contact deposits while small lacustrine pockets are sometimes found associated with the glaciofluvial fan deposits. This map unit occurs along the Ottertail and Beaverfoot Rivers.

Table 23. Brief description of the pedon chosen to characterize the HR2 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F		dark reddish brown; rotting wood fiber with needles and leaves			4.4	69
Ae	0-2	white to pinkish white	10	silt loam	4.4	2.6
Bm1	2-9	yellowish brown	30	gravelly silt loam	5.2	2.4
Bm2	9-20	yellowish brown to brownish yellow	15	silt loam	7.0	2.1
Ck1	20-40	light yellowish brown	45	gravelly silt loam	7.3	-
Ck2	40-95+	light olive brown to light yellowish brown	35	gravelly sandy loam	7.4	-

Degraded Eutric Brunisol

The silty surficial texture indicates that this map unit has moderate limitations for recreational uses. In addition, steep slopes may cause severe and very severe limitations in some areas.

Figure 48. Site of the pedon chosen to characterize the HR 2 map unit.

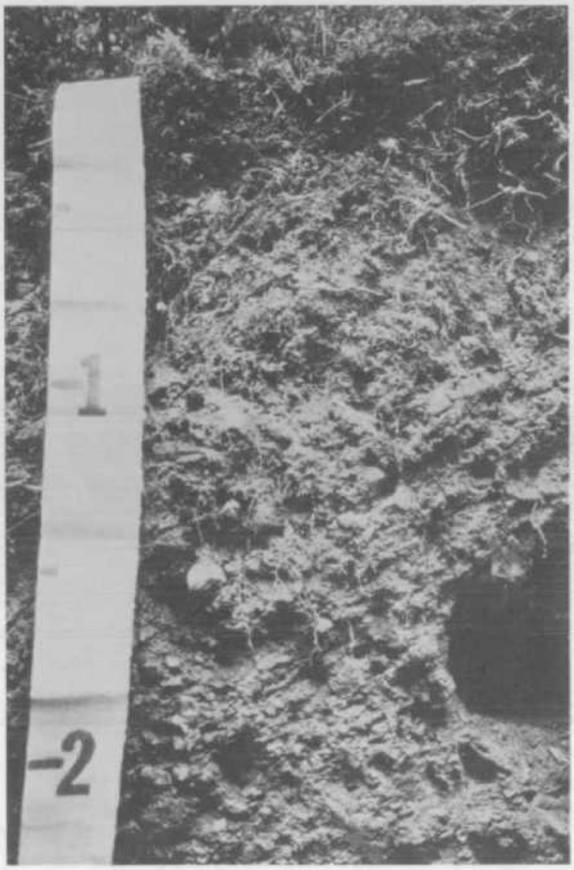


Figure 49.
Degraded Eutric Brunisol soil chosen to characterize the HR 2 map unit. The loose, soft appearance of the soils is typical of this map unit.

KI - Kicking Horse Soilscape Group

Physiography

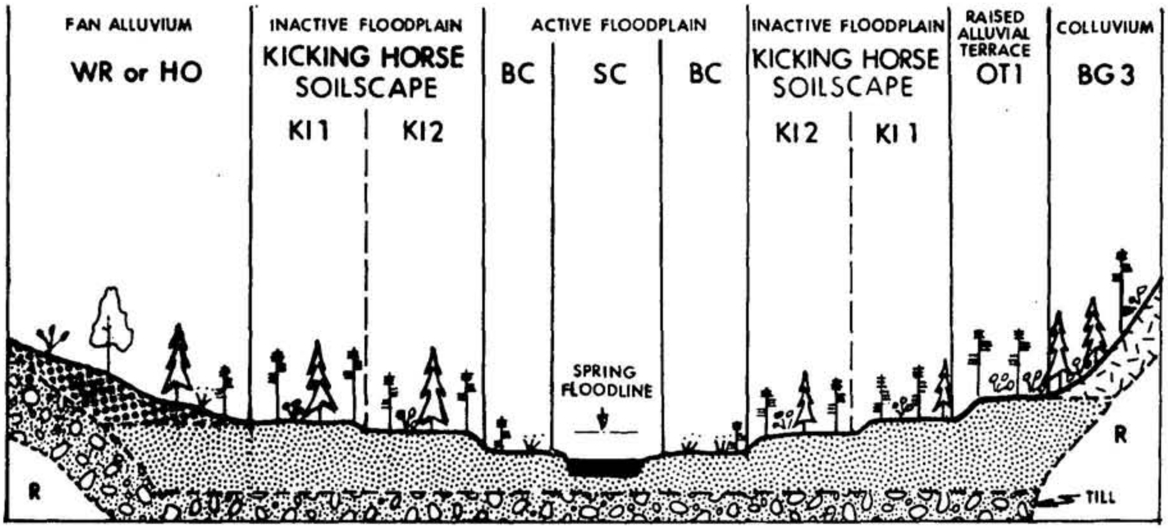


Figure 50. Sketch showing the landscape relationships between the Kicking Horse and associated soilscape groups.

Landform and Parent Materials

The Kicking Horse soilscape group occurs on level fluvial deposits on the older parts of the floodplains. The materials are calcareous and stratified and often consist of medium textured materials overlying coarse textured materials.

Environment

Kicking Horse map units occur most extensively at elevations below 1350 m a.s.l. and are seldom found above 1550 m a.s.l. Thus, they most commonly occur in the montane vegetative zone, but occasionally do occur in the lower part of the subalpine vegetative zone.

Table 24. Key criteria differentiating the Kicking Horse map units.

Soilscape Map Unit	Classification	Texture	Coarse Fragment Content (%)	Drainage Class
KI 1	Orthic Regosols and Cumulic Regosols	FSL-SiL / GSL-GLS	0 - 20% / >20%	moderately well
KI 2	Gleyed Orthic Regosols & Gleyed Cumulic Regosols	FSL-SiL / GSL-GLS	0 - 20% / > 20%	imperfectly

KI 1 Map Unit (Orthic and Cumulic Regosols)

The soils of this map unit have from 10 to 30 cm of medium textured material overlying coarse textured materials. There are usually less than 10% coarse fragments in the medium textured surficial deposit and 20 to 50% coarse fragments in the coarse textured materials below. Most of the coarse fragments are gravel sized but cobble sized coarse fragments are not uncommon. The water table is generally quite high in the spring, but drops to about 2 meters below the land surface in summer. Free calcium carbonate throughout the pedon and lack of A and B horizon development suggests that these soils receive additions of calcareous silt as a result of occasional flooding.

Table 25. Brief description of the pedon chosen to characterize the KI 1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse fragments (%)	Texture	pH ($CaCl_2$)	Organic matter (%)
L-F	2-0	very dark brown	-	-	-	-
ACk	0-5	dark yellowish brown	nil	silt loam	7.0	9.5
Ck1	5-12	pale brown	nil	silt loam	7.1	trace
IICk1	12-15	light yellowish brown	40	gravelly fine sandy loam	7.1	trace
IICk2	15-33	light yellowish brown to pale brown	60	very gravelly loamy coarse sand	7.2	0.5
IICk3	33-50+	light gray	60	loamy coarse sand	7.3	0.7

Cumulic Regosol

Silty surficial textures provide moderate limitations for most recreational uses. Potential flooding hazard also contributes to the limitations and results in a severe limitation for buildings.

KI2 Map Unit (Gleyed Orthic and Cumulic Regosols)

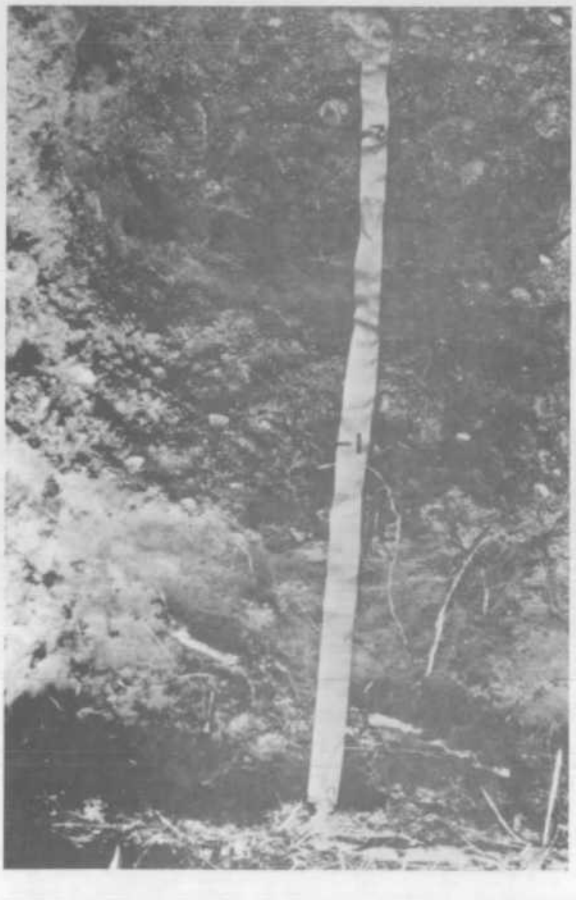
The soils of this map unit have from 10 to 30 cm of medium textured material overlying coarse textured materials. There are usually less than 10% coarse fragments in the medium textured overlay and 20 to 50% coarse fragments in the coarse textured materials. Most of the coarse fragments are gravel sized, but some cobbles may be present. The presence of mottles near the soil surface indicates that these soils have water contents above field capacity for moderately long periods in spring and early summer. By July however, these soils may become dry and droughty as the water level drops. Free calcium carbonate throughout the pedon and lack of A and B horizon development suggests that these soils receive additions of calcareous silt as a result of periodic flooding.

Table 26. Brief description of the pedon chosen to characterize the KI2 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F	1-0	not sampled				
ACk	0-4	dark brown	nil	silt loam	-	14
Ckg1	4-20	light yellowish brown	nil	silt loam	7.1	trace
Ckg2	20-29	pale olive	nil	silt loam	7.0	1.6
IICk1	29-40	brown	55	very gravelly loamy coarse sand	7.1	trace
IICk2	40-45	grayish brown	2	coarse sand	not sampled	
IICkg1	45-50	grayish brown to light olive brown	nil	sandy loam	not sampled	
IICkg2	50-63+	grayish brown to brown	55	very gravelly loamy coarse sand	7.1	trace

Gleyed Cumulic Regosol

Figure 51. Site of the pedon chosen to characterize the KI2 map unit. This site is quite wet for short periods in the spring but often dry in the summer and fall. Open canopied forest with junipers and shrubby cinquefoil are common.



reversed

Figure 52.
Gleyed Cumulic Regosol soil chosen to characterize the KI2 map unit. Lime occurs to the surface. The finer textures near the surface result from deposition of calcareous silty material from flood waters.

Wetness, texture, and potential flooding hazard result in moderate and severe limitations for most recreational uses as well as for buildings and roads.

MO - Mollison Soilscape Group

Physiographic Setting

Members of this soilscape group occur on fluvial fans which derive a major portion of their sediments from igneous (nepheline syenite) outcrops. In Yoho, igneous outcrops are restricted to the Ice River area (except for occasional small dykes). Because the major source of sediments for a given fan can be different on adjacent fans soils of the Mollison soilscape group alternate with those of the Watchtower soilscape group as the successive creeks enter the Ice River Valley.

Landform and Parent Materials

The Mollison soilscape group occurs on fluvial fans and aprons. The materials are non-calcareous, stratified, gravelly and cobbly, coarse textured fan alluvium derived mainly from igneous rocks.

Environment

The Mollison soilscape group occurs on well drained valley bottom sites within the montane vegetative zone in the Ice River valley.

MO1 Map Unit (Orthic Humo-Ferric Podzols)

This map unit is characterized by soils which developed on the alluvial (fluvial) fans in the Ice River Valley. These coarse textured soils generally contain more than 20% of dominantly igneous coarse fragments, are moderately stony and are usually well drained.

Figure 53. Site of the pedon chosen to characterize the MO1 map unit. Engelmann spruce, false huckleberry and mosses characterize the vegetation.

Figure 54.
Orthic Humo-Ferric Podzol soil chosen to characterize the MO1 map unit. The lack of an Ae horizon, the dark colored Bf horizon and the occurrence of large igneous boulders are important attributes of this soil.

Table 27. Brief description of the pedon chosen to characterize the MO 1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F	5-0	dark reddish brown; slightly decomposed needles and branches			3.7	80
Bf	0-20	dark brown to brown	45	gravelly fine sandy loam	4.8	3.6
Bm	20-50	brown to dark yellowish brown	50	gravelly fine sandy loam	5.4	1.9
BC	50-77	dark brown	15	loamy sand	5.7	-
C	77-100+	yellowish brown	35	gravelly very fine sandy loam	5.8	-

Orthic Humo-Ferric Podzol

The coarse fragment content and moderate stoniness suggest that this map unit has moderate limitations for many recreational and engineering uses.

NA - Narao Soilscape Group

Physiographic Setting

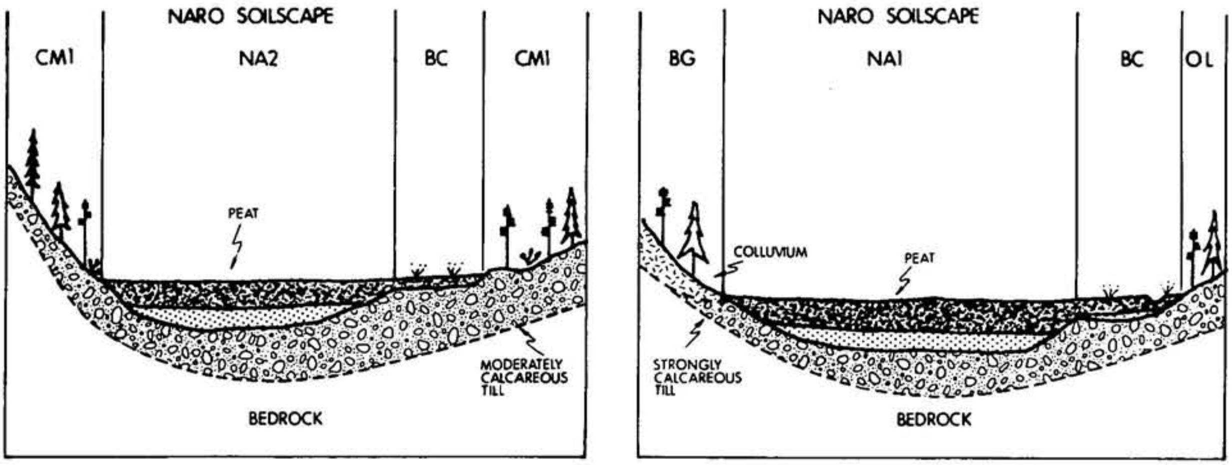


Figure 55. Sketch showing the landscape relationships between Narao and associated soilscape groups.

Landform and Parent Materials

The Narao soilscape group occurs on flat bog and horizontal fen landforms. The materials consist of mesic and fibric organic layers overlying calcareous alluvium.

Environment

The Narao soilscape group occurs on very poorly drained sites within the montane vegetative zone and the lower portion of the subalpine vegetative zone.

NA 1 Map Unit (Terric Mesisols)

This map unit is characterized by organic soils with neutral reaction and dominantly mesic organic layers. Calcareous mineral materials are usually encountered within 130 cm of the surface. This map unit is generally located at about 1200 m a.s.l.

Table 28. Brief description of the pedon chosen to characterize the NA 1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
Om1	0-16	dark brown	-	-	6.4	76
Om2	16-31	dark reddish brown	-	-	6.2	71
Om3	31-50	dark reddish brown	-	-	6.2	74
Ckg	50-65+	white	nil	silt loam	7.2	-

Terric Mesisol

The permanent wetness and organic materials suggest that soils of this map unit have very severe limitations for most uses.

NA 2 Map Unit (Terric Mesic Fibrisols)

This map unit is characterized by organic soils with medium acid reaction and fibric organic layers near the surface. Calcareous mineral materials are usually encountered within 130 cm of the surface. This map unit is generally located at about 1500 m a.s.l.

Figure 56. Site of the pedon chosen to characterize the NA 1 map unit. Sedges dominate the vegetation. The water table was 10 cm from the surface; no photo of the profile is available. Fifty cm of organic material occurs over the gray calcareous silt loam material shown in the spoil pile.

Figure 57. Site of the pedon chosen to characterize the NA 2 map unit. Mosses and sedges dominate the vegetation. Some sphagnum mosses are present. Dwarf birch and some spruce also are indicative of the wet site.

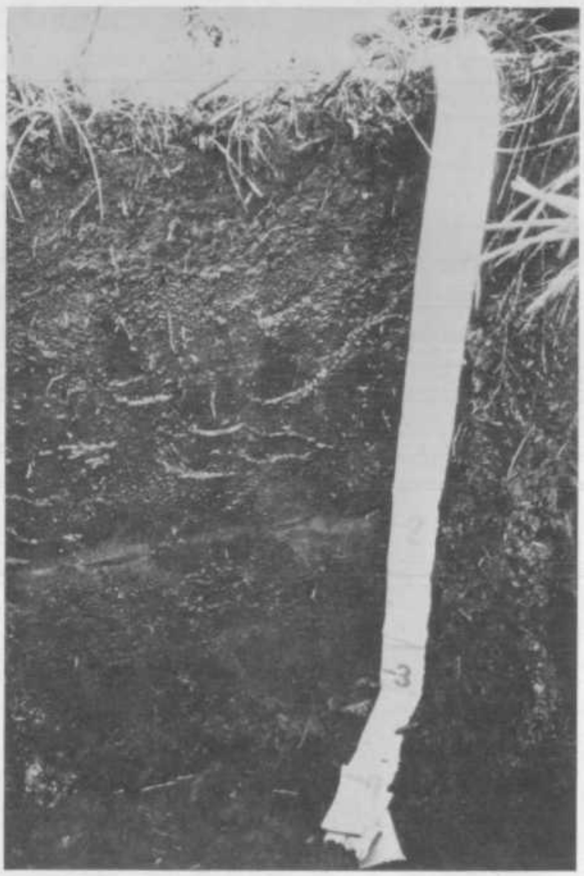


Figure 58.
Terric Mesic Fibrisol chosen to characterize the NA 2 map unit.

Table 29. Brief description of the pedon chosen to characterize the NA 2 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
Oh 1	0-10	black to very dark gray	-	-	5.8	66
Of 1	10-33	dark yellowish brown	-	-	5.7	67
Of 2	33-60	dark yellowish brown	-	-	5.5	66
Of 3	60-85	dark brown	-	-	5.2	66
Om	85-95	very dark grayish brown	-	-	6.0	26
Oh 2	95-115	very dark brown	-	-	6.1	30
Ckg	115-125+	gray	30-40	fine sandy loam	7.1	-

Terric Mesic Fibrisol

The permanent wetness and organic materials suggest that the soils of this map unit have very severe limitations for most uses.

NI - Niles Soilscape Group

Physiographic Setting (Figure 34, page 67)

Members of this soilscape group generally occur on steeply sloping landforms where the dip of the underlying sedimentary bedrock is parallel to the ground surface. The Niles soilscape group is characterized by shallow (less than 50 cm) unconsolidated materials which provide a uniform mantle over the rock.

Landform and Parent Materials

The Nile soilscape group occurs on undifferentiated, colluvial and occasionally morainal veneers over bedrock. The materials are usually medium textured and contain variable amounts of coarse fragments.

Environment

The Niles soilscape group occurs in the montane and subalpine vegetative zones, occurring at elevations ranging from valley bottom to about 1950 m a.s.l.

Figure 59. Site of the pedon chosen to characterize the NI1 map unit.

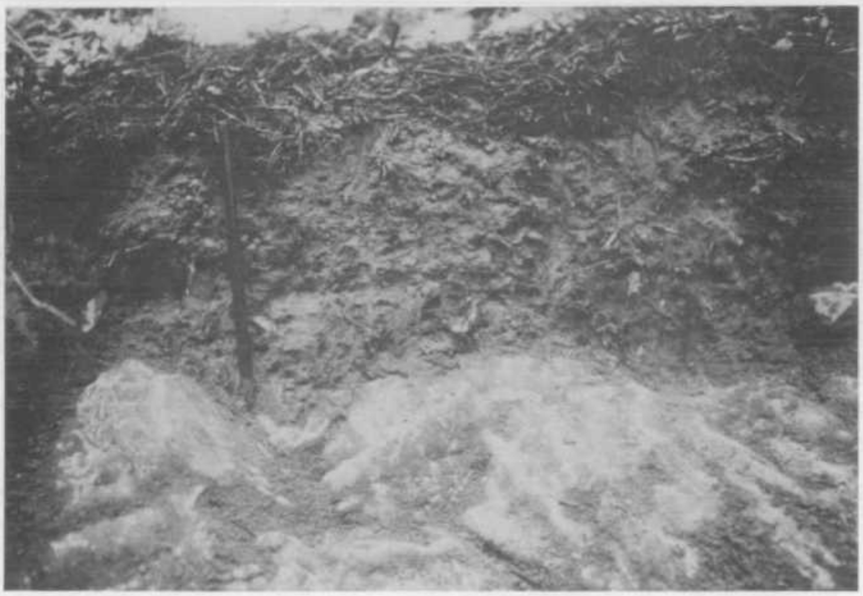


Figure 60. Lithic Orthic Eutric Brunisol soil chosen to characterize the NI1 map unit. The shallow soil profile over bedrock and removal of carbonate in the solum are typical of this map unit.

NI1 Map Unit (Lithic Orthic Eutric Brunisols)

This map unit is characterized by lithic soils which are found at elevations below the forest-alpine ecotone. These soils are usually medium textured, contain less than 50% coarse fragments and are well drained. Soil development is generally Brunisolic, but Regosols are also included in this map unit. These soils have depths to bedrock of less than 50 cm.

Table 30. Brief description of the pedon chosen to characterize the NI1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L	2-0	mainly needles			-	-
Bm	0-8	reddish brown	5	silt loam	6.3	3.1
Ck	8-15	yellowish brown (dry)	10	silt loam	7.0	-
R	15+	limestone				

Lithic Orthic Eutric Brunisol

The shallowness to bedrock in this map unit results in a severe to very severe limitation for many recreational and engineering uses.

OD - Odaray Soilscape Group

Physiographic Setting

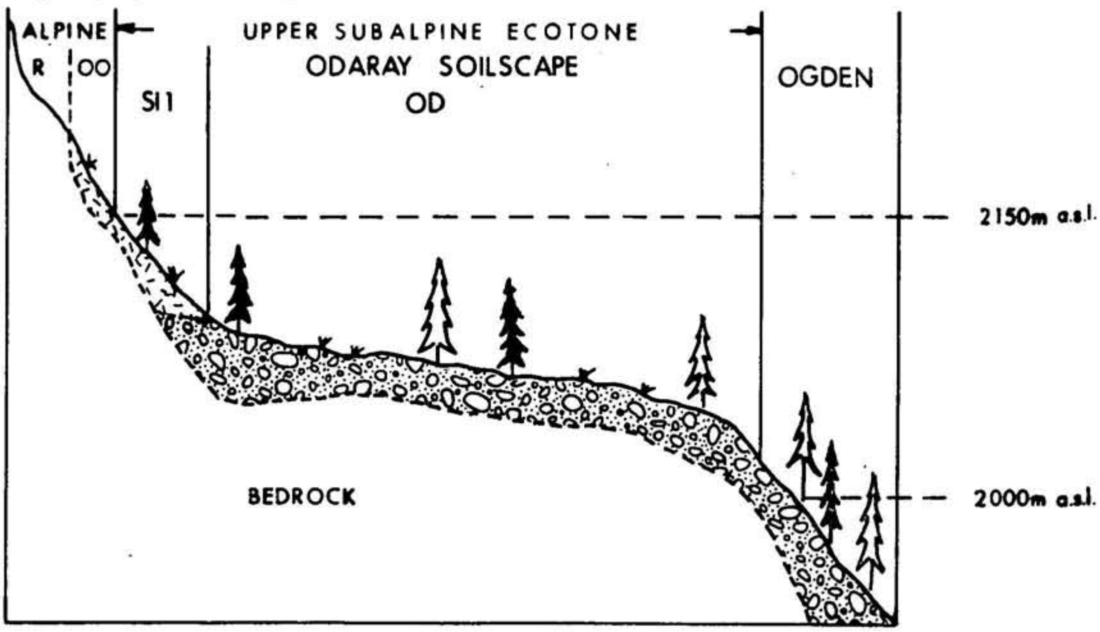


Figure 61. Sketch showing the landscape relationships between Odaray and associated soilscape groups.

Landform and Parent Materials

The Odaray soilscape group generally occurs on morainal veneers or blankets overlying bedrock. The materials are generally calcareous, coarse to medium textured till, but some non-calcareous parent materials are present in the upper Cataract Brook - Lake McArthur area. In general, the Odaray map units in the upper Cataract Brook - McArthur Lake area are strewn with large stones and boulders unlike those Odaray map units located in other parts of Yoho Park.

Environment

The Odaray soilscape group occurs in the upper part of the subalpine vegetation zone at elevations of about 2000 to 2150 m a.s.l. This zone is referred to as the upper subalpine ecotone, and has a relatively open (< 30%) forest cover.

OD 1 Map Unit (Orthic Humo-Ferric Podzols)

This map unit occurs on morainal landforms in the upper subalpine ecotone. The soils which characterize OD 1 are medium to coarse textured, generally contain less than 50% coarse fragments and usually are well drained. A thin, turfy Ah or H horizon is usually present. In the McArthur Pass area, there is an abundance of stones greater than 1 m in diameter, and roughly 5 to 25 m apart. Occasional poorly drained late snowmelt areas occur as inclusions in this map unit

Table 31. Brief description of the pedon chosen to characterize the OD 1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
H	5-0	dark reddish brown; well decomposed material with Ah-like appearance			4.8	61
Ae	0-2	light reddish brown	< 5	silt loam	4.5	6.4
Bhf	2-15	dark reddish brown	< 5	silt	5.8	17
Bm	15-35	yellowish brown	15	fine sandy loam	6.2	13
Ck	35-62 +	light yellowish brown	35	gravelly loam	7.3	-

Figure 62. Site of the pedon chosen to characterize the OD 1 map unit.

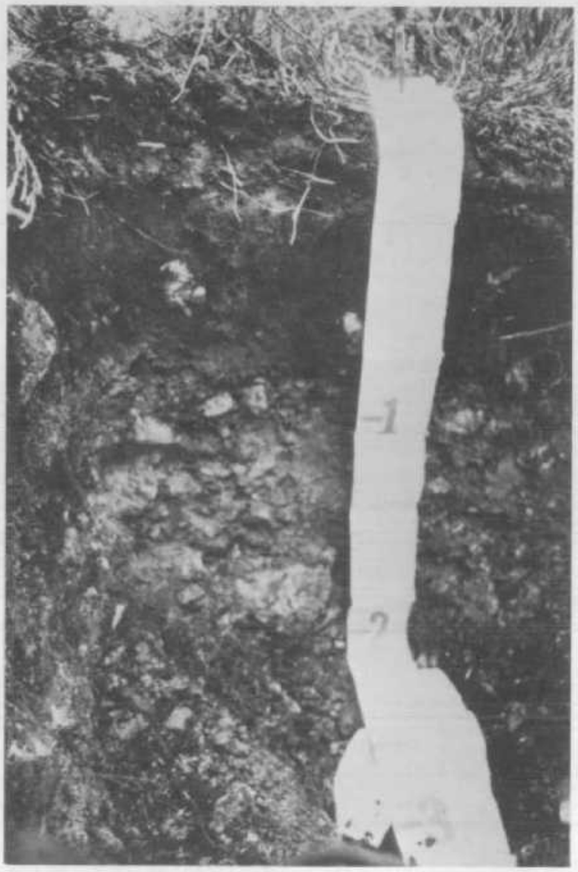


Figure 63.
Orthic Ferro-Humic Podzol soil chosen to characterize the OD 1 map unit. The thin Ae and dark colored Bhf is typical of this map unit.

The steep slopes which are generally associated with this map unit result in severe limitations and very severe limitations for recreational and engineering uses. Where slopes aren't limiting, moderate limitations are present resulting from surficial texture, stoniness, and potential frost heaving. The severe climate associated with this map unit also indicates that this terrain has high susceptibility to environmental damage.

OG - Ogden Soilscape Group

Physiographic Setting

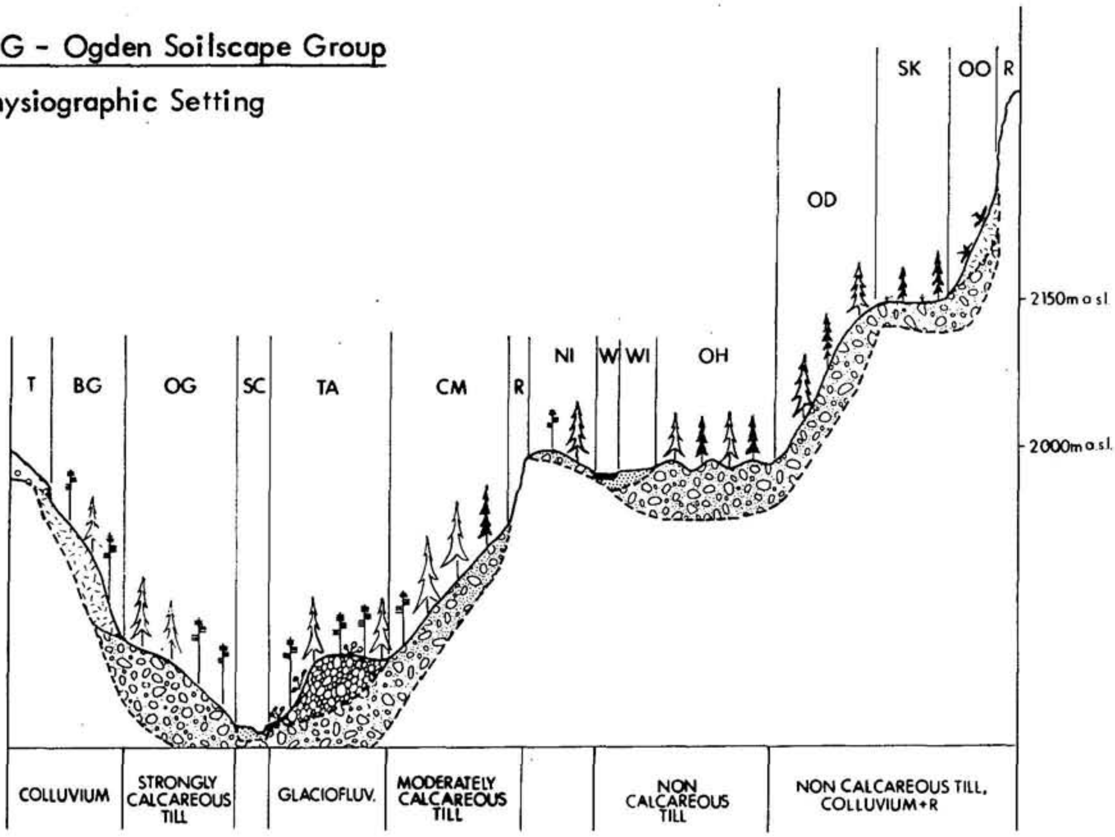


Figure 64. Sketch showing the landscape relationships between Ogden and associated soilscape groups.

Landform and Parent Material

The Ogden soilscape group occurs most often on morainal veneers or blankets over bedrock but not uncommonly on deeper morainal deposits. The parent materials are compact, strongly calcareous, non-stratified, medium textured, stony till.

Environment

The Ogden soilscape group occurs in the subalpine vegetative zone at elevations between about 1550 and 2000 m a.s.l. The upper limit is that elevation where the open forest cover of the upper subalpine begins.

Table 32. Key criteria for differentiating the Ogden map units.

Soilscape Map Unit	Classification	Texture	Coarse Fragment Content (%)	Drainage
OG 1	Orthic Humo-Ferric Podzols and Degraded Eutric Brunisols	silt loam	< 20	well
OG 2	Orthic Humo-Ferric Podzols	silt loam	$\frac{5}{< 20}$	well

OG 1 Map Unit (Orthic Humo-Ferric Podzols and Degraded Eutric Brunisols)

The soils of this map unit are medium textured. The coarse fragment content is generally less than 20% in the solum, but may range up to approximately 35% in the parent material. Generally, the OG 1 map units found in the Yoho valley are coarser textured and have higher amounts of coarse fragments in the parent materials than those found in the Ottertail, Otterhead and Beaverfoot valleys. Orthic Humo-Ferric Podzols are the most common soils on this map unit but Degraded Eutric Brunisols also occur, especially at the lower elevations. Those OG 1 map units with slopes steeper than 50% may be susceptible to soil creep and significant soil erosion resulting in map inclusions of Regosolic soils.

Figure 65. Site of the pedon chosen to characterize the OG 1 map unit.

Figure 66.
Orthic Humo-Ferric Podzol soil chosen to characterize the OG 1 map unit. The thin, reddish Bf, and the occurrence of coarse fragments is typical of the soils of this map unit.

Table 33. Brief description of the pedon chosen to characterize the OG 1 map unit

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
F-H	5-0	very dark brown			3.9	-
Ae	0-3	light gray	3	silt loam	4.3	1.6
Bfh	3-12	reddish brown	10	silt loam	4.7	6.9
Bm	12-23	brownish yellow	40	gravelly silt loam	6.5	1.0
Ck1	23-50	light olive brown	25	gravelly silt loam	7.3	-
Ck2	50-105+	light yellowish brown	20	silt loam	7.5	-

Orthic Humo-Ferric Podzol

Steep slopes result in severe and very severe limitations for most recreational uses on this map unit. Where slopes aren't limiting, silty surficial textures result in moderate limitations for recreational uses and potential frost heaving results in moderate to severe limitations for building foundations and roads.

OG 2 Map Unit (Orthic Humo-Ferric Podzols)

This map unit is characterized by soils that have a silty surficial deposit overlying a compact medium textured horizon. Otherwise they are similar to those of map unit OG1. This surficial deposit has a lower bulk density, less coarse fragments, a finer structure, and is more friable than the underlying till, which makes these soils quite susceptible to erosion if the vegetation is removed or the soil is disturbed. This map unit occurs mainly in the Amiskwi valley.

Figure 67. Site of the pedon chosen to characterize the OG 2 map unit.

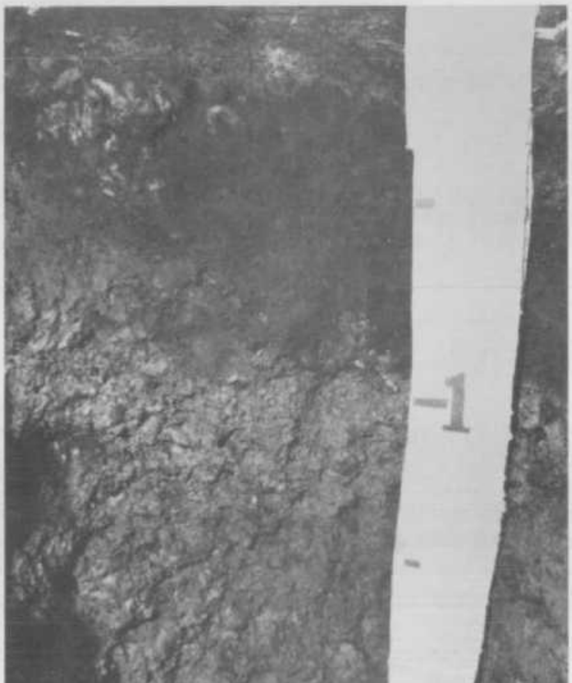


Figure 68.
Orthic Humo-Ferric Podzol chosen to characterize the OG 2 map unit. A thick dark organic-rich Bhf horizon is typical of the soils of this map unit.

Table 34. Brief description of the pedon chosen to characterize the OG 2 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F	8-0	very dark brown; fairly well decomposed organic material			3.9	-
Ae	0-3	light brownish gray	< 5	silt loam	4.7	4.0
Bhf	3-6	very dusky red	< 5	silt loam	4.3	22
Bf	6-25	yellowish red	15	silt loam	4.8	8.5
IIBC	25-45	yellowish brown	25	silt loam	6.5	-
IICk	45-75+	yellowish brown	40	gravelly loam	7.2	-

Orthic Humo-Ferric Podzol

Steep slopes result in severe and very severe limitations for recreational use on this map unit. Where slope is not limiting, the silty surficial texture results in moderate limitations for recreational use and potential frost heaving results in moderate to severe limitations for roads and buildings.

OH - O'Hara Soilscape Group

Physiographic Setting

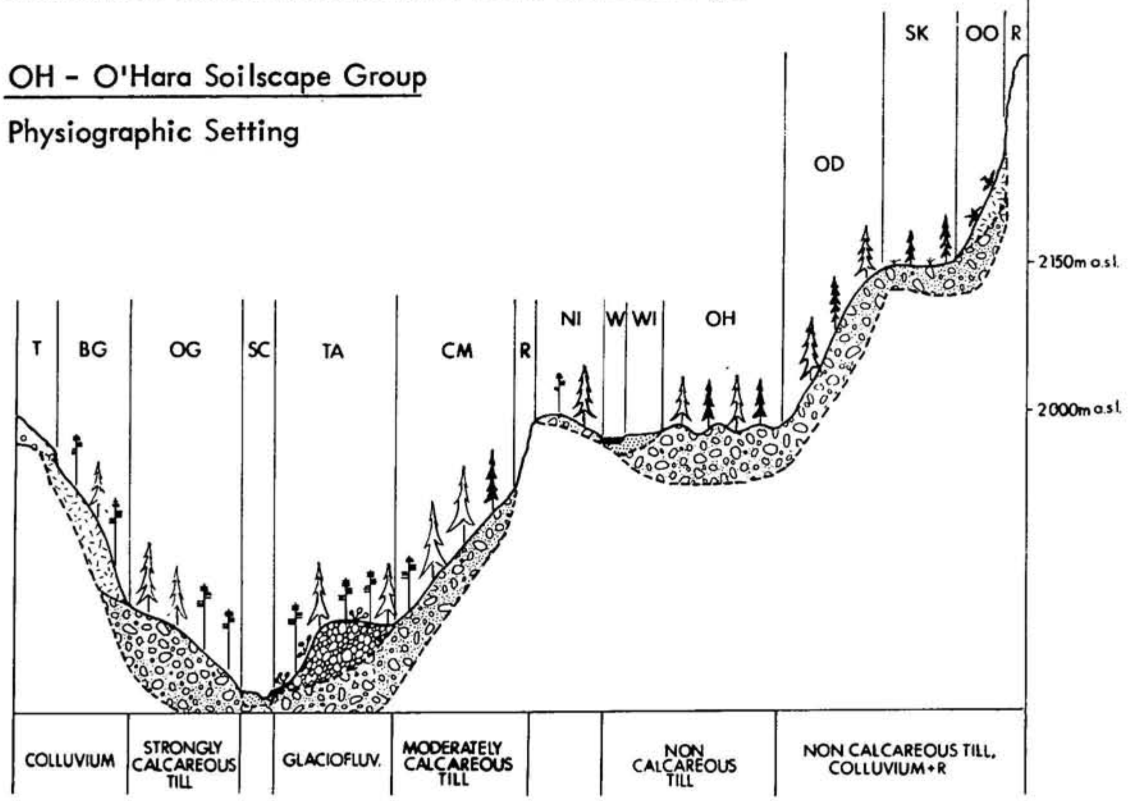


Figure 69. Sketch showing the landscape relationships between O'Hara and associated soilscape groups.

Landform and Parent Materials

The O'Hara soilscape group generally occurs on morainal veneers and blankets over bedrock. The parent materials are non-calcareous, coarse textured stony tills.

Environment

The O'Hara soilscape group is found in the subalpine vegetation zone.

OH 1 Map Unit (Orthic Humo-Ferric Podzols and Degraded Dystric Brunisols)

This map unit characterizes those soils developed on non-calcareous, coarse textured glacial till at elevations below the upper subalpine ecotone. These soils have textures of grevelly loamy sand to sandy loam, coarse fragment contents of 15 to 30%, and are well drained. These soils are exceedingly stony and occur only in the Upper Cataract Brook - Lake O'Hara area.

Table 35. Brief description of the pedon chosen to characterize the OH 1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse fragments (%)	Texture	pH ($CaCl_2$)	Organic matter (%)
L-F	7-0	moss and needle litter			3.4	-
Ae	0-5	pinking gray	10	silt loam	3.3	5.0
Bhf	5-9	weak red to reddish brown	5	silt loam	4.2	19
Bm	9-38	reddish brown	45	gravelly loamy sand	4.5	1.4
BC1	38-54	strong brown	45	gravelly loamy sand	4.6	-
BC2	54-66+	very pale brown	40	gravelly sand	5.2	-

Degraded Dystric Brunisol

The stoniness and generally steep slopes associated with this map unit result in severe and very severe limitations for most recreational and engineering uses.

Figure 70. Site of the pedon chosen to characterize the OH1 map unit.

Figure 71. Degraded Dystric Brunisol soil chosen to characterize the OH 1 map unit. The thin (4 cm) Bhf horizon in this pedon results in the Brunisolic rather than Podzolic classification.

OL - Ottertail Soilscape Group

Physiographic Setting (Figure 55, page 91)

This soilscape group occurs on morainal landforms below 1550 m a.s.l., in the main valley bottoms, often as remnants and small pockets of what was probably more extensive moraine.

Landform and Parent Materials

The Ottertail soilscape group commonly occurs on morainal blankets over bedrock, but morainal veneers and deep morainal deposits are not uncommon. The parent materials are compact, calcareous, medium textured till which may have been locally reworked by water. Small lacustrine pockets are often found as inclusions in this till along the Kicking Horse Valley.

Environment

The Ottertail soilscape group occurs in the montane vegetative zone ranging in elevation from about 1050 m a.s.l. at the western Park gate to about 1550 m a.s.l.

Table 36. Key criteria differentiating the Ottertail map units.

Soilscape Map Unit	Classification	Texture	Coarse Fragment Content (%)	Drainage Class
OL1	Degraded Eutric Brunisols	silt loam	10-20%	well
OL2	Gleyed Melanic and Gleyed Eutric Brunisols	silt loam	$\frac{< 5\%}{20\text{-}50\%}$	imperfectly

OL1 Map Unit (Orthic Eutric Brunisols)

This map unit is characterized by soils which are developed on calcareous medium textured till, and which are dominantly Brunisolic with brownish B horizons. The textures are generally silt loam to loam and coarse fragment contents are usually, but not always, below 20%.

Figure 72. Site of the pedon chosen to characterize the OL1 map unit.

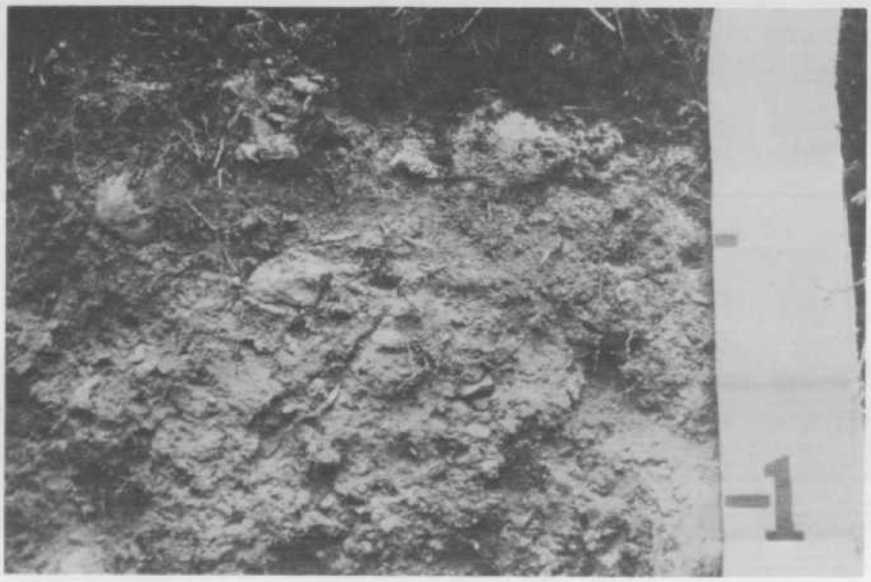


Figure 73. Degraded Eutric Brunisol soil chosen to characterize the OL1 map unit.

Table 37. Brief description of the pedon chosen to characterize the OL1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F-H	4-0	very dark grayish brown			4.5	-
Ae	0-3	light gray	5	silt loam	4.9	2.4
Bm1	3-10	yellowish red	10	silt loam	6.0	2.6
Bm2	10-42	brownish yellow	45	gravelly sandy loam	6.7	0.3
IICk	42-90	light yellowish brown	10	loam	7.6	-

Degraded Eutric Brunisol

The steep slopes which are generally associated with this map unit result in severe and very severe limitations for most recreational and engineering uses. Where slopes are not limiting, the silty surficial texture provides moderate limitations for recreational uses and potential frost heaving results in moderate to severe limitations for building foundations and roads.

OL2 Map Unit (Gleyed Melanic and Gleyed Eutric Brunisols)

This map unis is characterized by soils which have developed on imperfectly drained, calcareous, medium textured till. A silty surficial deposit is often present over the compact till. Textures are generally silt loam and coarse fragment contents are variable, increasing at depth. These soils are commonly found at the bottoms of long slopes where they are subject to seepage and hence the imperfectly drained conditions. Mottles are generally present in the B horizon. Due to the moist conditions, a thick L-F-H horizon and an Ah horizon are usually present.

Figure 74. Site of the pedon chosen to characterize OL2 map unit. Note the abundant understory vegetation.

Table 38. Brief description of the pedon chosen to characterize the OL2 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F-H	13-0	black to very dark gray; partially to well decomposed			6.0	67
Ah	0-20	black to dark reddish brown	nil	silt	6.7	38
Bmg	20-43	yellowish brown and yellowish red	30	silt loam	7.8	1.0
Ckg	43-90+	yellowish brown	50	very gravelly silt loam	7.4	-

Gleyed Melanic Brunisol

Wetness and the silty surficial texture result in severe limitations for most recreational uses on this map unit.

OO - Otto Soilscape Group

Physiographic Setting

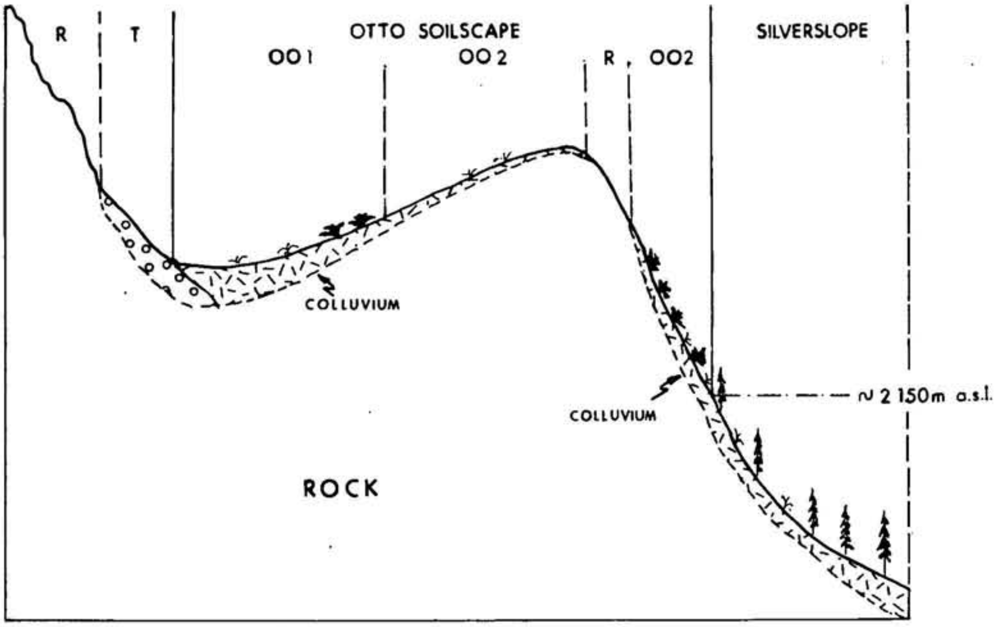


Figure 75. Sketch showing the landscape relationships between Otto and associated soilscape groups.

Landform and Parent Materials

The Otto soilscape group occurs on residual and colluviated slopes. The parent materials are usually calcareous and range from medium to coarse textured. Shallow materials of undifferentiated origin are also included within this soilscape group concept.

Environment

The Otto soilscape group occurs in the Krummholz portion of the subalpine vegetative zone and in the alpine vegetative zone. Tree cover is less than 10% and elevations are generally above about 2150 m a.s.l.

Table 39. Key criteria differentiating the Otto map units.

Soilscape Map Unit	Classification	Texture	Coarse Fragment Content (%)	Drainage Class
OO1	Sombric Humo-Ferric Podzols	loam to sandy loam	< 50%	well
OO2	Lithic Sombric Humo-Ferric Podzols	loam to sandy loam over bedrock	< 50%	well

Figure 76. Site of the pedon chosen to characterize the OO 1 map unit. Slope is 40 to 50%. Vegetation is dominated by heathers and western anemone.

Figure 77. Sombric Humo-Ferric Podzol soil chosen to characterize the OO1 map unit. The grayish surface horizon with redder material below is typical of the profile development in these areas.

OO1 Map Unit (Sombric Humo-Ferric Podzols)

This map unit is characterized by non-lithic soils which occur on colluvium at elevations above the continuous forest line. Medium textures and coarse fragment contents of about 20% are typical of this map unit, as are turfy Ah horizons up to 25 cm thick. Evidence of solifluction is often seen on this map unit.

Table 40. Brief description of the pedon chosen to characterize the OO1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
Ah1	0-8	dark brown	10	silt loam	4.5	17
Ah2	8-19	dark brown	15	loam	4.5	11
Bf	19-40	yellowish red	20	gravelly loam	4.6	3.1
C	40-60	brownish yellow	25	gravelly silt loam	4.5	-
R	60-70+	Paralithic brown unaltered meta siltstone				

Sombric Humo-Ferric Podzol

The steep slopes and severe climate which are generally associated with this map unit present severe and very severe limitations for most recreational and engineering uses.

OO2 Map Unit (Lithic Sombric Humo-Ferric Podzols)

This map unit is similar to OO1 except that depth to bedrock is generally less than 50 cm. It is characterized by lithic soils which are found at elevations above the continuous forest line. Medium textures and coarse fragment contents of 20% or less are typical. The depth of fine earth materials over bedrock is characteristically less than 50 cm and a turfy Ah horizon is generally present.

Figure 78. Site of the pedon chosen to characterize the OO2 map unit. The frequent outcropped of bedrock on the bench in the foreground typifies this map unit.

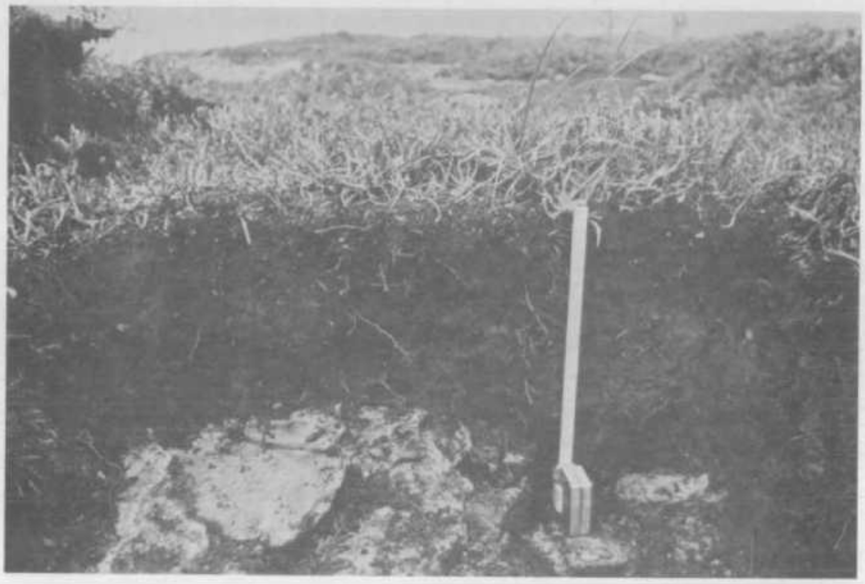


Figure 79. LithicSombric Humo-Ferric Podzol soil chosen to characterize the OO2 map unit. The dark colored Ah is typical of soils associated with this map unit.

Table 41. Brief description of the pedon chosen to characterize the OO2 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
Ah1	0-4	very dark brown	< 1	silt loam	5.2	24
Ah2	4-11	dark brown	3	silt loam	5.2	12
Bf	11-16	strong brown and yellowish brown	5	silt loam	5.7	5.0
R	16+					

Lithic Sombric Humo-Ferric Podzol

The severe climate and shallowness to bedrock suggests that this map unit has severe and very severe limitations for recreational and engineering uses.

OP - Opabin Soilscape Group

Physiographic Setting

This soilscape group occurs on active fluvial fans derived from non-calcareous sedimentary materials. Associated soilscape groups are O'Hara (moraines) and Burgess (colluvium).

Landform and Parent Materials

The Opabin soilscape group occurs on fluvial fans. The materials are non-calcareous, stratified, gravelly and very gravelly, medium and coarse textured fan alluvium, derived mainly from the quartzites of the Gog Group.

Environment

The Opabin soilscape group occurs on moderately well drained sites within the subalpine vegetative zone.

OP 1 Map Unit (Cumilic Regosols)

This map unit is characterized by soils with little horizon development on non-calcareous fan alluvium. These soils are medium to coarse textured with coarse fragment contents of 20% or more. The coarse fragments are mainly Gog Group quartzites. The Regosolic nature of these soils suggests that they are subject to occasional stream channel shifting and/or overland flow during the spring runoff.

Table 42. Brief description of the pedon chosen to characterize the OP 1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse fragments (%)	Texture	pH ($CaCl_2$)	Organic matter (%)
L-F	10-0	dark brown			5.8	-
C	0-27	pale brown	65	very gravelly sandy loam	6.2	3.1
Ahb	27-43	dark grayish brown and pale brown	55	very gravelly clay loam	5.8	11
Bmb	43-61	dark brown to brown	55	very gravelly clay loam	not	sampled
Cb	61-75+	dark brown to brown	60	very gravelly sandy clay loam	6.2	3.5

Cumulic Regosol

The high coarse fragment content suggests that this map unit has severe limitations for recreational uses. Slope is the major limitation for engineering uses on this map unit.

Figure 80. Site of the pedon chosen to characterize the OP1 map unit. The profile consists of drab grayish stratified materials.

OT - Otterhead Soilscape Group

Physiographic Setting (Figure 18, page 52)

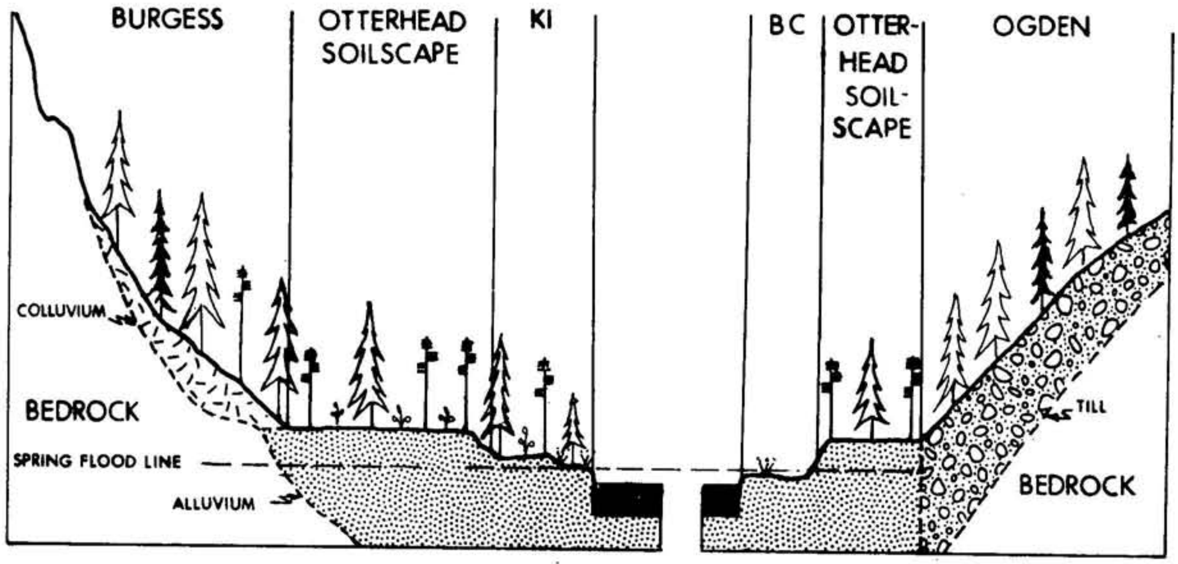


Figure 81. Sketch showing the landscape relationships between Otterhead and associated soilscape groups.

Landform and Parent Materials

The Otterhead soilscape group generally occurs on alluvial terraces above the present floodplain. The parent materials are generally calcareous, and usually have a variable thickness of medium textured materials overlying coarse textured material.

Environment

The Otterhead soilscape group occurs on well drained sites in the montane vegetative zone, but occasionally is mapped in the lower part of the subalpine vegetative zone. It is seldom found above 1550 m a.s.l.

OT 1 Map Unit (Degraded Eutric Brunisols)

This map unit is used to identify those soils with brownish B horizon development which occur on fluvial floodplains. Coarse fragment contents are usually 5 to 10% in the medium textured surficial deposit and greater than 20% in the coarse textured C horizons. Gravel sized coarse fragments are most common, but cobbles are also present. Most Otterhead 1 map units are well drained, but moderately well to imperfectly drained inclusions do occur along the Ottertail River and near Emerald Lake.

Table 43. Brief description of the pedon chosen to characterize the OT1 map unit

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L	8-0	dark reddish brown			3.5	78
Ae	0-3	pinkish gray	10	silt loam	4.7	4.5
Bm	3-15	strong brown	45	gravelly silt loam	5.6	3.6
Ck	15-85+	yellowish brown	80	very gravelly loamy sand	7.4	-

Degraded Eutric Brunisol

A silty surficial texture and a moderate stoniness class results in moderate limitations for most recreational uses.

Figure 82. Site of the pedon chosen to characterize the OT1 map unit.

Figure 83.
Degraded Eutric Brunisol soil chosen to characterize the OT1 map unit. The increase in gravels and cobbles below a silty surficial deposit is typical of the soils representing this map unit.

Sl - Silverslope Soilscape Group

Physiographic Setting

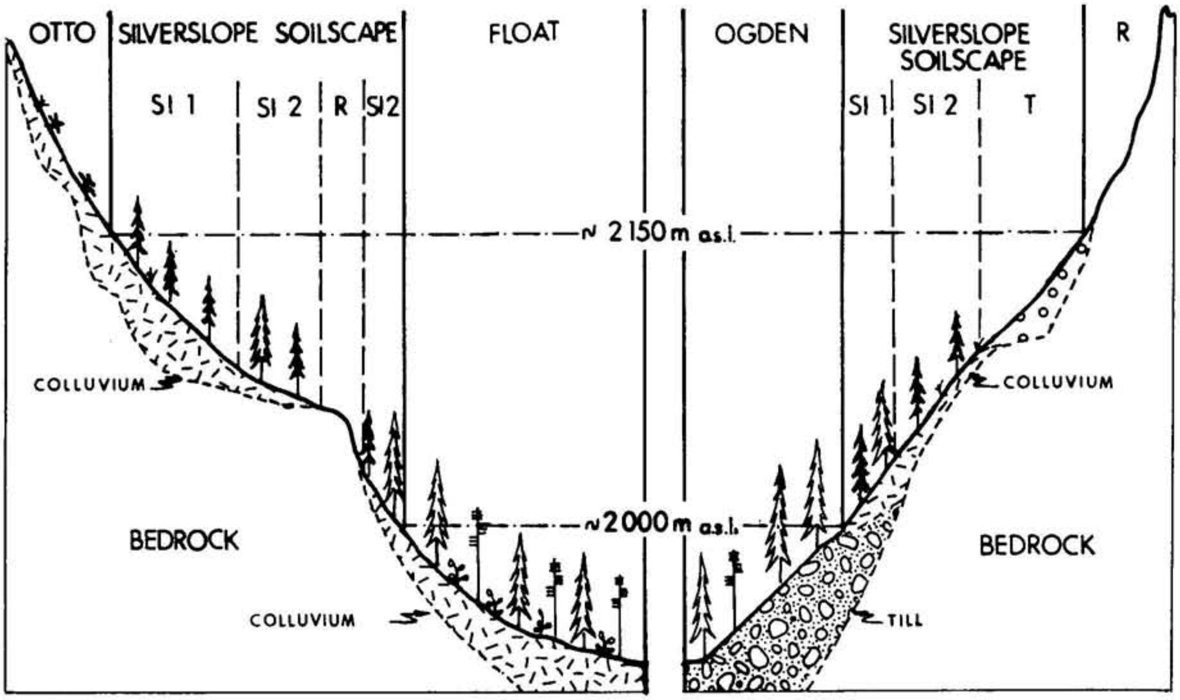


Figure 84. Sketch showing the landscape relationships between Silverslope and associated soilscape groups.

Landform and Parent Materials

The Silverslope soilscape group occurs on residual and colluvial slopes. The parent materials are usually calcareous and range from medium to coarse textured. Shallow materials (lithic) of undifferentiated (till, colluvium,residual) origin are also included within this map concept.

Environment

The Silverslope soilscape group occurs in the upper part of the subalpine vegetative zone at elevations of about 2000 to 2150 m a.s.l. This zone is referred to as the upper subalpine ecotone and has a relatively open (< 30%) forest cover.

Table 44. Key criteria differentiating the Silverslope map units.

Soilscape Map Unit	Classification	Texture	Coarse Fragment Content (%)	Drainage Class
SI1	Orthic Humo-Ferric and Ferro-Humic Podzols	silt loam to sandy loam	< 50%	well
SI2	Lithic Orthic Humo-Ferric Podzols	silt loam to sandy loam over bedrock	< 50%	well

SI1 Map Unit (Orthic Humo-Ferric and Ferro-Humic Podzols)

This map unit is characterized by non-lithic soils which are developed on colluvium within the upper subalpine ecotone. A turfy Ah horizon is often, but not always present. Snowchute areas which occur within the upper subalpine ecotone are generally mapped as SI1A.

Table 45. Brief description of the pedon chosen to characterize the SI1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
Ah	0-6	very dark brown	45	gravelly silt loam	4.5	22
Ae	trace	light gray to gray	-	fine sandy loam	-	-
Bhf	6-21	strong brown and dark yellowish brown	10	silt loam	5.0	8.8
Bm	21-38	yellowish brown	50	very gravelly sandy loam	5.0	1.6
Ck1	38-85	pale olive	90	very gravelly coarse sandy loam	5.2	-
Ck2	85-95+	pale olive	40-50	gravelly loam	6.0	-

Orthic Ferro-Humic Podzol

The steep slopes and severe climate which are associated with this map unit suggest that it has severe and very severe limitations for most recreational and engineering uses.

Figure 85. Site of the pedon chosen to characterize the SI1 map unit. Slope 60%, open canopy of subalpine fir.

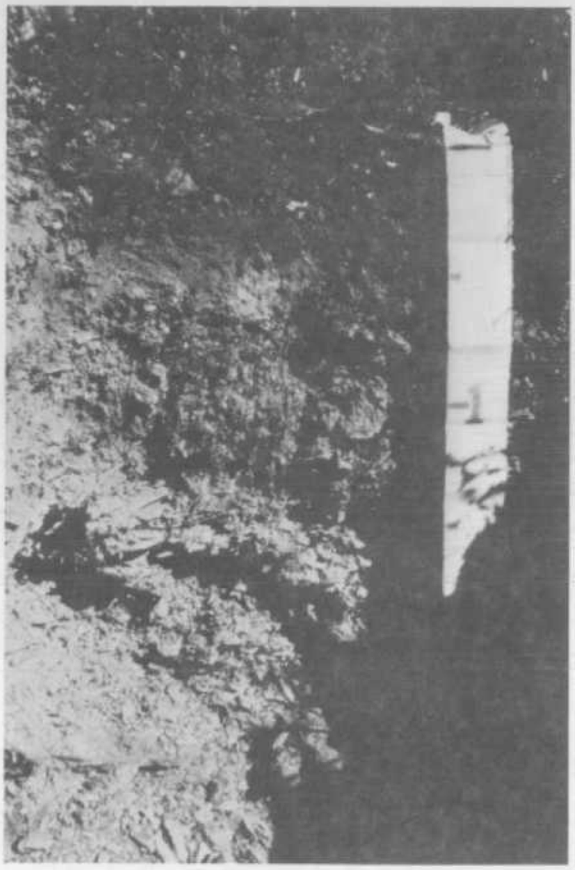


Figure 86.
Orthic Ferro-Humic Podzol soil chosen to characterize the SI1 map unit.

SI2 Map Unit (Lithic Humo - Ferric Podzols)

This map unit is characterized by lithic soils which occur in the upper subalpine ecotone. Medium textures and coarse fragment contents of about 20% are most typical of this map unit. A turfy Ah horizon is often, but not always present. The depth to bedrock is generally less than 50 cm on this map unit.

Table 46. Brief description of the pedon chosen to characterize the SI2 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
charcoal	1-0		not sampled			
Ae	0-3	pinkish gray	< 1	silt loam	4.0	4.5
Bf1	3-8	yellowish red	< 1	silt loam	4.7	4.8
Bf2	8-15	reddish yellow	5	silt loam	4.6	2.8
BC	15-19	dark brown and dusky red	< 1	silt loam	5.7	-
R	19+		not sampled			

Lithic Humo-Ferric Podzol.

The severe climate and shallowness to bedrock suggests that this map unit has severe to very severe limitations for most recreational and engineering uses.

SK - Schaffer Soilscape Group

Physiographic Setting (Figure 34, page 67)

Members of this soilscape group occur in the alpine and Krummholz portion of the subalpine zone on moderately sloping morainic landforms often near cirques and cols and associated with the Otto soilscape group which occurs on the colluvial landforms.

Figure 87. Site of the pedon chosen to characterize the SI2 map unit. This site was burned in 1971; the photo was taken in September 1974.

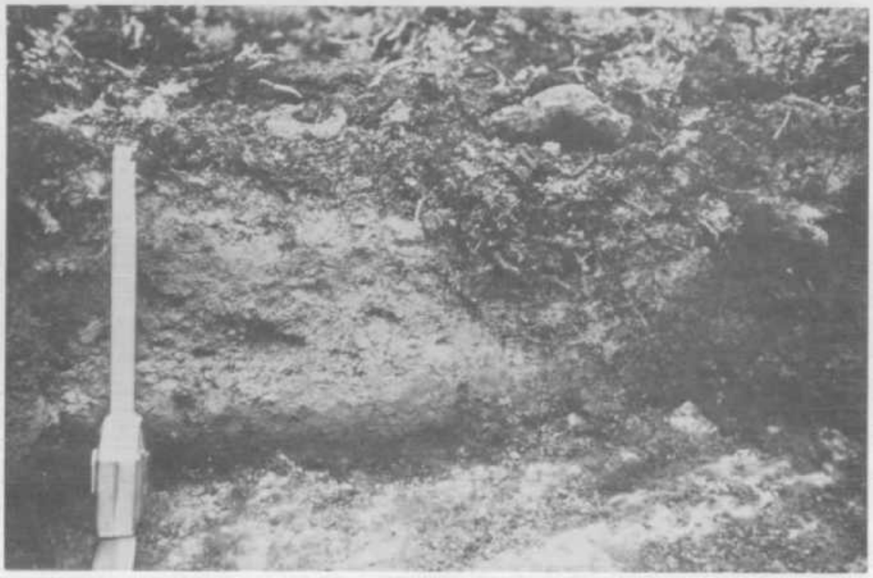


Figure 88. Lithic Humo-Ferric Podzol soil chosen to characterize the SI2 map unit.

Landform and Parent Materials

The Schaffer soilscape group generally occurs on morainal veneers and blankets overlying bedrock. The materials are generally calcareous, medium textured till but a few coarse textured non-calcareous tills are included with this soilscape group. The coarse textured tills occur mainly in Eagles Eyrie and the upper Cataract Brook - McArthur area.

Environment

The Schaffer soilscape group occurs in the Krummholz portion of the subalpine vegetative zone and in the alpine vegetative zone. Tree cover is less than 10% and elevations are above about 2150 m a.s.l.

SK 1 Map Unit (Sombric Humo-Ferric Podzols)

This map unit is characterized by those soils which have developed on glacial till at elevations above the continuous forest line. The soils of this map unit are generally medium textured, (with the exception of those in the Eagles Eyrie and the upper Cataract Brook - Lake McArthur areas which may be coarse textured), contain less than 50% coarse fragments, and are usually well to moderately well drained. A turfy Ah horizon is characteristic of this map unit. Small earth hummocks may form in the imperfectly to poorly drained depressions which occur as inclusions within this map unit.

Figure 89. Site of the pedon chosen to characterize the SK 1 map unit. Heathers, western anemone and pussy-toes were the common vegetative species.

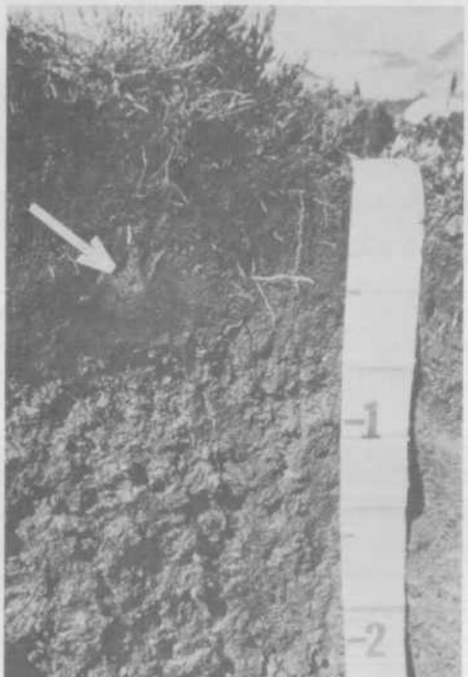


Figure 90.
Sombric Humo-Ferric Podzol soil chosen to characterize the SK 1 map unit. The arrow points to some Ae horizon material mixed into the Bhf horizon material, indicating "churning" through frost action.

Table 47. Brief description of the pedon chosen to characterize the SK1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
Ah	0-15	dark brown	< 1	silt loam	4.5	14
Ae	15-22	grayish brown to light brownish gray	< 5	silt loam	4.7	6.4
Bhf	22-27	dark yellowish brown to brown	< 5	silt loam	4.8	9.3
Bf	27-45	strong brown to reddish yellow	5	loam	4.7	1.9
Bm	45-75	brown	25	gravelly clay loam	5.0	0.7
Ck	75-100+	pale brown	25	loam	7.2	-

Sombric Humo-Ferric Podzol

When steep slopes are associated with this map unit they result in severe and very severe limitations for recreational and engineering uses. Where slopes are not limiting, moderate limitations are present due to the silty surficial texture and the potential frost heaving. The severe climate associated with this map unit also results in a high susceptibility to environmental damage.

TA - Takakkaw Soilscape Group

Physiographic Setting (Figures 34, 39, pages 67, 72)

Members of this soilscape group are found throughout the lower subalpine and montane regions of the Park, generally at the confluence of two or more major valleys where kame terraces and other stratified drift materials are located. Areas are not extensive or frequent.

Landform and Parent Materials

Takakkaw map units are generally found on kame terraces, but glaciofluvial fans, and eskers are also included in this map unit. The materials are generally well sorted, stratified and calcareous. Coarse fragments of gravel and frequently cobble sizes comprise up to 50% of the soil volume, and are generally overlain by a silty surficial deposit.

Environment

The Takakkaw soilscape group is generally found slightly above valley bottoms at elevations up to 1750 m a.s.l., occurring in the montane vegetative zone and extending into the lower part of the subalpine vegetative zone.

TA 1 Map Unit (Degraded Eutric Brunisols and Orthic Humo-Ferric Podzols)

This map unit characterizes the soils developed on glaciofluvial deposits with more than 20% coarse fragments, a significant percentage of which may be cobble and stone sized, especially in the McArthur Creek - Ottertail River area. A medium textured surficial deposit which seldom exceeds 20 cm is usually present. The soils of TA 1 map units are well to rapidly drained. Those TA 1 map units which occur on steep terrace margins tend to be less stable than is typical of TA 1 map units and as such may have Regosolic soil development.

Figure 91. Site of the pedon chosen to characterize the TA 1 map unit.

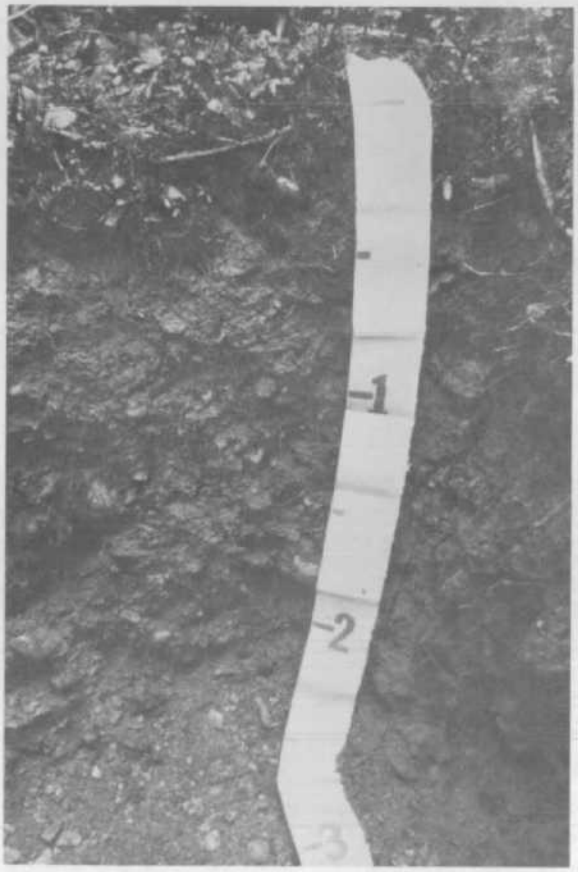


Figure 92.
Degraded Eutric Brunisol soil chosen to characterize the TA 1 map unit.

Table 48. Brief description of the pedon chosen to characterize the TA1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F	5-0	black			4.2	78
Ae	0-1	light gray to gray		not sampled		
Bm	1-20	yellowish red	25	gravelly silt loam	5.4	2.1
BCk	20-47	yellowish red	85	very gravelly loam	6.7	-
IICk	47-90+	light olive brown	90	very gravelly coarse sandy loam	6.9	-

Degraded Eutric Brunisol

The high coarse fragment content and silty surficial texture associated with this map unit result in moderate limitations for many recreational uses. Steep slopes may cause additional limitations in many areas of this map unit.

TO - Tocher Soilscape Group

Physiographic Setting

Members of this soilscape group occur along the unstable river banks where these cutbanks are mainly comprised of till, and occasionally on steep, unstable till slopes along valley walls.

Landform and Parent Materials

The Tocher soilscape group occurs on morainal blankets over bedrock as well as deeper morainal deposits. On the deeper morainal deposits, Tocher map units generally occur on the extremely sloping river cutbanks. The parent materials are calcareous, non-stratified, medium textured till.

Environment

The Tocher soilscape group occurs in the montane and subalpine vegetative zones.

TO1 Map Unit (Cumulic Regosols)

This map unit is characterized by Regosolic soils which are found on calcareous, medium textured till. The soils have loam to silt loam textures and are well drained, except for those in the Mount Hurd area which are moderately well drained. This map unit occurs on the extremely sloping (greater than 60%) cutbanks of the Amiskwi, Emerald and Otterhead Rivers where soil instability results from steep slopes and undercuttings at the bases of the slopes by the rivers, and in the Mount Hurd area where the soil instability results from excess soil moisture from snowmelt in spring and early summer. Soil slump and soil flow scars, as well as curved trees indicative of soil creep, are common on this map unit.

Table 49. Brief description of the pedon chosen to characterize the TO1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F	18-0	dark reddish brown; partly decomposed organic litter plus charcoal			5.1	82
Ck	0-1	light yellowish brown	nil	loam	not sampled	
Bmb	1-5	yellowish red	35	gravelly loam	6.7	9.0
Ckb1	5-43	light yellowish brown	50	very gravelly loam	7.3	-
Ckb2	43-80+	light yellowish brown	50	gravelly sandy loam	7.4	-

Cumulic Regosol

Figure 93.
Site of the pedon chosen to characterize the TO1 map unit. Dense understory on about 60% slope characterizes this site.

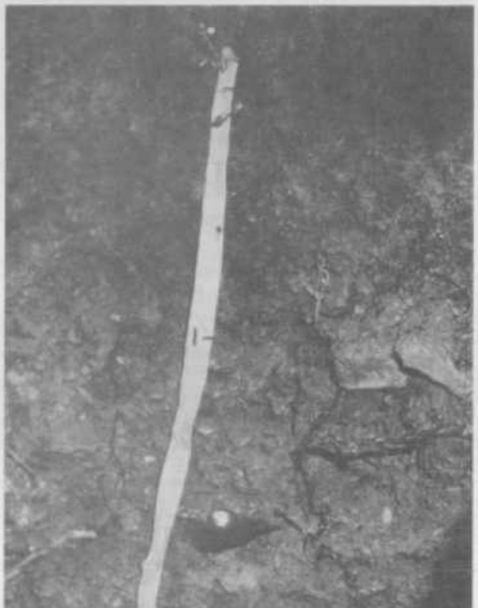


Figure 94.
Cumulic Regosol soil chosen to characterize the TO 1 map unit.

The steep slopes and the relatively unstable soils associated with the majority of the TO1 map units result in very severe limitations for recreational and engineering uses. Wetness, texture and slope cause moderate to severe limitations for most uses on the remaining TO1 map units.

VA - Vanguard Soilscape Group

Physiographic Setting

Wherever seepage or water accumulations at the surface occur in moraines over an extensive enough area (greater than about 5 acres), that it can be shown on the map, these areas are designated as belonging to the Vanguard soilscape group. Areas large enough to be shown on the map are not frequent in Yoho National Park.

Landform and Parent Materials

. The Vanguard soilscape group generally occurs on morainal blankets and thicker morainal deposits. The parent materials are calcareous, medium and coarse textured glacial till.

Environment

Vanguard map units occur at or near the bases of slopes and are usually found below elevations of 1750 m a.s.l., occurring in the montane and the lower portion of the subalpine vegetative zones.

VA 1 Map Unit (Rego Humic Gleysols)

This map unit is characterized by poorly drained soils on glacial till. These soils are medium to coarse textured, generally contain less than 20% coarse fragments, and are poorly to very poorly drained. They occur in seepage and groundwater discharge areas, and often there are numerous small creeks flowing over the land surface. A thin organic layer at the soil surface is typical of these soils.

Figure 95. Site of the pedon chosen to characterize the VA 1 map unit. Dwarf birch, willows and sedges are evident in this site.

Figure 96.
Orthic Humic Gleysol soil chosen to characterize the VA 1 map unit.

Table 50. Brief description of the pedon chosen to characterize the VA1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
Oh	17-0	dark reddish brown			7.2	-
Ahg	0-14	grayish brown and black	< 5	silty clay loam	7.0	31
Bg	14-32	yellowish red	-	silt loam	7.2	4.7
Ckg	32+	pale olive	-	loam	7.5	-

Humic Gleysol

The wetness and organic surface associated with this map unit results in very severe limitations for most recreational uses.

WI - Wiwaxy Soilscape Group

Physiographic Setting (Figure 64, page 100)

Members of this soilscape group occur on fluvial fans in the upper subalpine zone. In general these map units are of limited areal extent, and are not frequent within Yoho National Park, but the contrasting nature of soils and vegetation necessitates their cartographic separation even though small.

Landform and Parent Materials

The Wiwaxy soilscape group occurs on fluvial fans and level fluvial plains. The materials are coarse textured and may have a medium textured surficial deposit overlying the coarse materials.

Environment

The Wiwaxy soilscape group occurs on well and moderately well drained meadows in the upper part of the subalpine vegetative zone, generally 100 to 200 m below the tree line. The meadows appear to be related to cold air drainage or "frost pockets".

WI1 Map Unit (Orthic Humo-Ferric Podzols)

This map unit is characterized by soils of upper subalpine and alpine alluvial fans. A medium textured silty surficial deposit is usually observed overlying coarse textured gravelly alluvium

Table 51. Brief description of the pedon chosen to characterize the WI1 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
Ah	0-2	dark brown	< 2	silt loam	5.8	21
Ae	2-6	grayish brown to light brownish gray	< 2	silt loam	5.1	11
A & B	6-9	dark brown and dark yellowish brown	< 5	silt loam	4.8	16
Bhf	9-12	dusky red	15	silt loam	4.7	21
IIBm	12-60	dark yellowish brown	80	very gravelly loamy coarse sand	4.8	1.2
IIBC	60-90+	dark yellowish brown	80	very gravelly loamy coarse sand	5.3	-

Orthic Humo-Ferric Podzol

The rather severe climate and silty surficial texture results in moderate limitations for several uses.

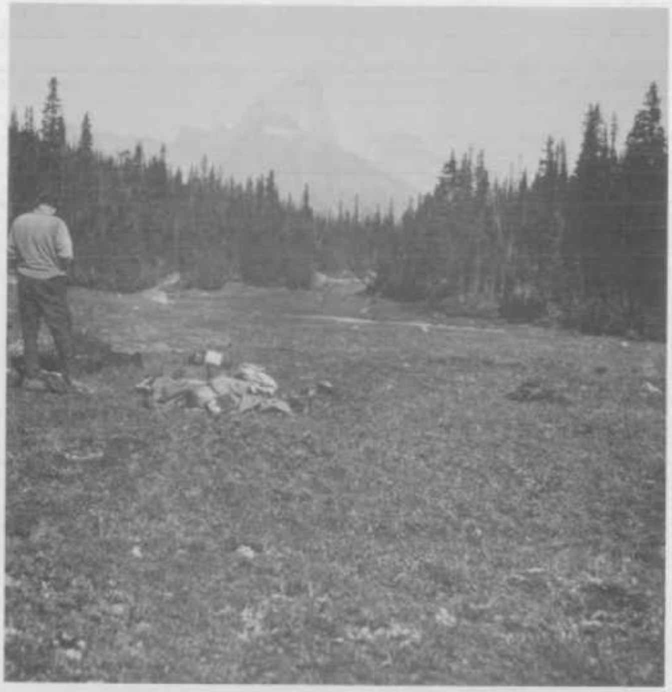


Figure 97.
Site of the pedon chosen to characterize the WI1 map unit. Sedges provide most of the ground cover.

Figure 98.
Orthic Humo-Ferric Podzol soil chosen to characterize the WI1 map unit. The finer textured silty surficial deposit is evident, and is typical of this map unit. Volcanic ash is often found in these surficial deposits.

WR - Watchtower Soilscape Group

Physiographic Setting

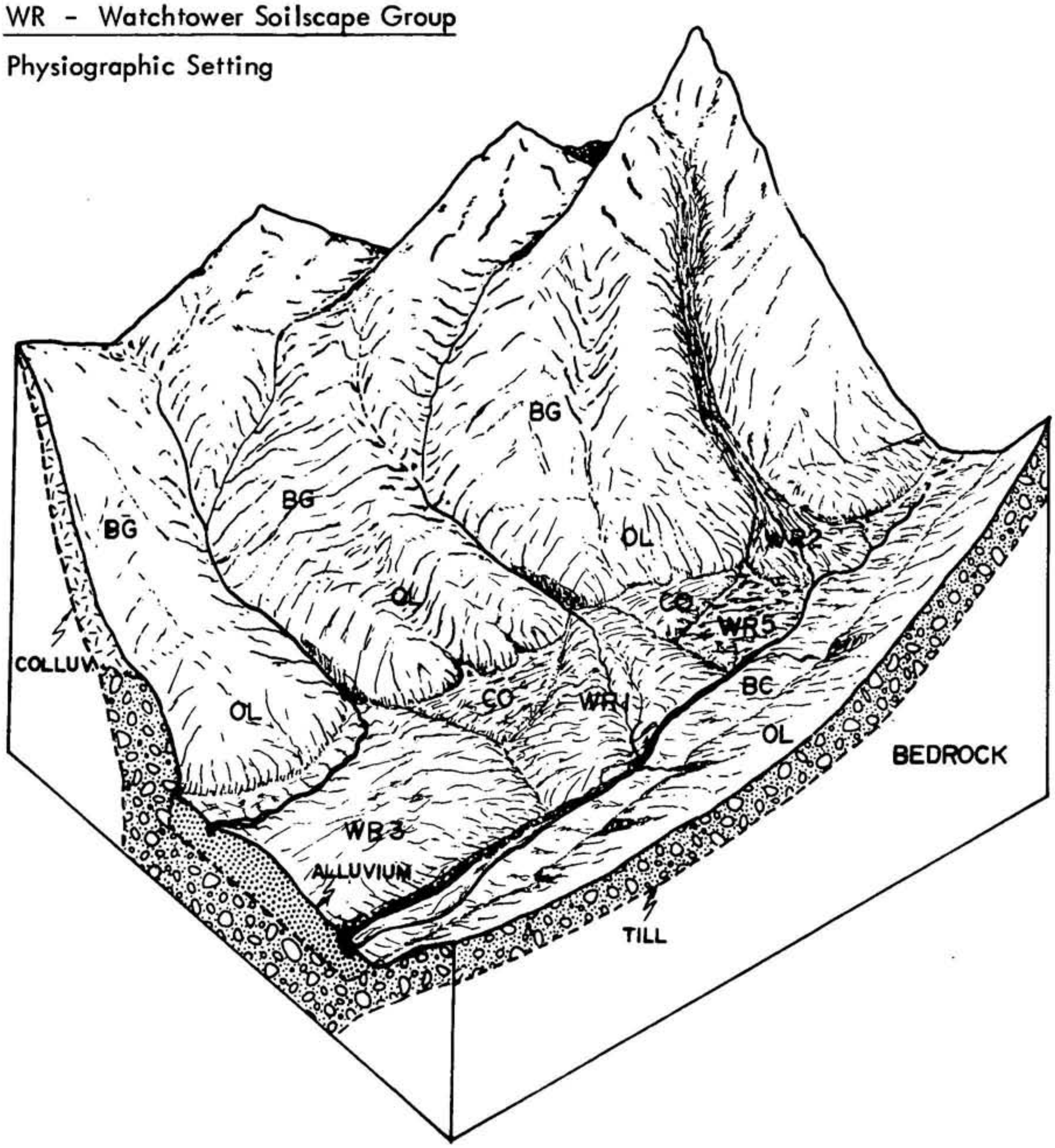


Figure 99. Sketch showing the landscape relationships among members of the Watchtower soilscape group and between Watchtower and associated soilscape groups.

Landform and Parent Materials

The Watchtower soilscape group occurs on fluvial fans and aprons. The materials are calcareous, stratified, medium and coarse textured alluvium. Coarse fragment contents range from 0 to 90% in these materials.

Environment

The Watchtower soilscape group generally occurs on well drained valley bottom sites within the montane vegetative zone. A small number of Watchtower map units are however, scattered throughout the subalpine vegetative zone.

Table 52. Key criteria differentiating the Watchtower map units.

Soilscape Map Unit	Classification	Texture	Coarse Fragment Content (%)	Drainage Class
WR 1	Orthic & Cumulic Regosols	gravelly sandy loam to gravelly loamy sand	20-50%	well to rapidly
WR 2	Cumulic & Orthic Regosols	gravelly loam to gravelly sandy loam	> 40%	well to rapidly
WR 3	Orthic & Cumulic Regosols	silt loam / gravelly sandy loam	< 20% / 20-50%	well
WR 4	Gleyed Orthic and Gleyed Cumulic Regosols	silt loam	< 20%	imperfectly
WR 5	Gleyed Orthic Regosols	gravelly fine sandy loam to gravelly silt loam	20-50%	imperfectly

WR 1 Map Unit (Orthic and Cumulic Regosols)

This map unit is characterized by gravelly and very gravelly soils with little horizon development, formed on coarse textured, calcareous fan alluvium. An Ah horizon is not present in these soils. Coarse fragments are gravel and cobble sized and may exceed 50% on some fans or portions of some fans. These soils are usually exceedingly stony.

Figure 100. Site of the pedon chosen to characterize the WR1 map unit. The very stony surface is evident in the photo and typical of the map unit.

Figure 101. Orthic Regosol soil chosen to characterize the WR1 map unit.

Table 53. Brief description of the pedon chosen to characterize the WR 1 map unit

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L	1-0	very dark brown	not sampled			
Ck1	0-15	gray	45	gravelly sandy loam	7.5	5.4
Ck2	15-30+	dark gray	60	very gravelly loamy coarse sand	7.6	4.7

Orthic Regosol

The stoniness which is associated with this map unit results in severe limitations for most recreational and engineering uses. In addition, shifting stream channels may cause limitations for some uses.

WR 2 Map Unit (Cumulic and Orthic Regosols)

This map unit is characterized by soils which frequently have an Ah horizon and are developed on calcareous, gravelly and very gravelly fan alluvium. Textures of very gravelly fine sandy loam and very gravelly loam are common. The coarse fragments are often flaggy and oriented parallel to the soil surface. Steep slopes and periodic snow avalanching are common on this map unit. These soils are usually exceedingly to excessively stony.

Table 54. Brief description of the pedon chosen to characterize the WR 2 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
Ahk	0-12	very dark brown	65	very gravelly fine sandy loam	6.8	26*
Ck1	12-40	dark brown	60	very gravelly fine sandy loam	7.0	1.2
Ck2	40-100+	dark brown to brown	60	very gravelly fine sandy loam	7.2	0.2

* much of this organic matter is quite raw and may be fine live roots.

Orthic Regosol

Figure 102.
Site of the pedon chosen to characterize the WR 2 map unit. The slope is 45 to 55%, and evidence of snow avalanching is evident in the photo.

Figure 103.
Orthic Regosol soil chosen to characterize the WR 2 map unit. The loose nature of the profile and the abundance of flat coarse fragments is typical of this map unit.

The stoniness and periodic snow avalanching which are generally associated with this map unit result in a very severe limitation for most recreational and engineering uses.

WR 3 Map Unit (Orthic and Cumulic Regosols)

This map unit is characterized by those soils which have developed on calcareous, stratified, gravelly to very gravelly fan alluvium overlain by medium textured deposits. Silt loam and fine sandy loam textures with about 5% coarse fragments are common in the medium textured surficial deposit while gravelly sandy loam and gravelly loamy sand textures are common in the lower horizons. These soils have weak horizon development although a thin (less than 5 cm thick) Bm horizon is sometimes present.

Table 55. Brief description of the pedon chosen to characterize the WR 3 map unit.

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F	3-0	very dark brown; partially decomposed needles and leaves			6.0	47
Ae	0-1	gray		not sampled		
ACk	1-4	brown	< 5	sandy loam	7.2	14
Ck1	4-40	light gray	< 1	silt loam	7.3	trace
Ck2	40-90	gray	60	very gravelly loamy coarse sand	7.2	trace
Ck3	90-110+	pale olive	10	silt loam	-	trace

Orthic Regosol

The generally silty surficial texture results in moderate limitations for most recreational uses. In addition, the Regosolic nature of these soils suggests that they are subject to occasional stream channel shifting and/or overland flow during spring runoff.

Figure 104. Site of the pedon chosen to characterize the WR 3 map unit.

Figure 105.
Orthic Regosol soil chosen to characterize the WR 3 map unit. Slight evidence of Ae and Bm horizons can be seem immediately below the leaf litter.

WR4 Map Unit (Gleyed Orthic and Gleyed Cumulic Regosols)

This map unit is characterized by imperfectly drained soils developed on calcareous, medium textured, fan alluvium. Textures of silt loam with less than 20% coarse fragments are typical of this map unit. Mottles are usually present in the soil profile.

Table 56. Brief description of the pedon chosen to characterize the WR4 map unit

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
Ck1	0-50	gray	10	silt loam	7.1	6.2
Ck2	50-86+	dark grayish brown	5	silt loam	7.3	3.5

Orthic Regosol

The imperfect drainage and silty surficial texture result in moderate limitations for many recreational uses. Severe limitations for engineering uses are implied by the susceptibility to frost heaving and the imperfect drainage.

WR5 Map Unit (Gleyed Orthic Regosols)

This map unit is characterized by moderately well to imperfectly drained soils found on calcareous, stratified, gravelly fan alluvium. Textures are generally gravelly silt loam to gravelly fine sandy loam with coarse fragment contents greater than 20%. A perched water table is sometimes present.

Table 57. Brief description of the pedon chosen to characterize the WR5 map unit

Horizon	Depth (cm)	Moist Color	Est. Coarse Fragments (%)	Texture	pH ($CaCl_2$)	Organic Matter (%)
L-F	2-0	very dark brown; well decomposed organic litter			not	sampled
Ck	0-17	light brownish gray	< 2	silt loam	7.2	2.4
Ahkb	17-20	very dark grayish brown	< 2	silt loam	7.2	6.1
Ckgb 1	20-33	light brownish gray	< 2	silt loam	7.3	3.3
Ckgb 2	33-40	pale brown	90	very gravelly fine sandy loam	7.4	2.8
Ckgb 3	40-55	very pale brown	5	silt loam	7.4	1.9
Ckgb 4	55-80+	light brownish gray	15	fine sandy loam	7.5	4.0

Gleyed Cumulic Regosol

The silty surficial texture and the impeded drainage result in moderate limitations for many recreational uses. Severe limitations for engineering uses are caused by the susceptibility to frost heaving.

Figure 106. Site of the pedon chosen to characterize the WR5 map unit. The vegetation at this site shows the impact of human use (Takakkaw campground).

PART IV

INTERPRETATIONS OF SOILS FOR SELECTED PARKS USES

INTRODUCTION

Soils are one of the basic resources which have to be considered when planning land use activities. The proper use and management of soil resources is required to accommodate user facilities and activities at minimal cost, both in terms of construction and maintenance, and in terms of the amount of environmental impact. Soils vary in the nature and the degree of limitations for recreational uses. Some soils may be well suited for a number of uses, while other soils may have moderate or severe limitations for one or more uses. A knowledge of soil characteristics is basic to good planning and management.

Part IV of this report provides predictions of soil performance based on field observations and laboratory data, as well as past experience and published information. These predictions are intended only to serve as guides for planners and managers. They are not intended as recommendations for land use.

The cirteria used to evaluate the kind and degree of limitations were largely adapted for unpublished guides used by the United States Department of Agriculture, Soil Conservation Service. Similar guides may be found in Montgomery and Edminster (1966), Soil Conservation Guide (1967), Knapik and Coen (1974), Coen and Holland (1976), Greenlee (1976) and Epp (1977).

IMPLICATIONS OF SOIL PROPERTIES FOR RECREATIONAL LAND USE PLANNING

The following are some of the basic soil properties that singly or in combination with others commonly affect recreational land use. The limitations imposed by these soil properties are summarized in Tables 58 through 64.

Wetness.

Wetness affects the bearing strength, compactibility and erodibility of soils. Wetness may result from a high water table, groundwater seepage, or proximity to late snowmelt areas or streams. High water tables also affect buildings (especially those with basements) and the proper functioning of septic tank absorption fields. Soil properties (such as mottles) and vegetation reflect the high moisture conditions even at a time in the year when the soil is dry. Soils that are wet for all or part of the season of use will have limitations for all recreational uses. Overcoming limitations due to wetness may involve costly construction such as extensive drainage or special maintenance such as sump pumps.

Flooding.

Soils that are subject to flooding during the season of use have obvious limitations for all recreational uses. Flooding may make a site unsuitable for campgrounds or as a building site, and will restrict the season of use for other activities such as hiking. Flooding hazard may be predicted from soil properties and landscape position.

Permeability.

Soil permeability is an important item to consider when planning playgrounds or camping areas, especially in areas of late snowmelt or frequent summer showers because it affects soils bearing strength and erodibility. Soil permeability also influences percolation rates which are important when planning septic tank absorption fields. Infiltration and percolation tests (Appendix C) have shown that in Yoho there is little limitation due to slow permeability, but that in some soils there is a potential for pollution of adjacent waters by septic tank absorption fields due to the very rapid percolation rates of these soils.

Texture.

Soil texture may limit the amount and type of use an area is suited to. Properties such as permeability, bearing strength, erodibility, susceptibility to frost heaving, dustiness, mudiness, available water capacity and nutrient availability for plant growth are all related to soil texture. For uses such as playgrounds, camp areas, picnic areas, and path and trails, it is the surface soil texture which is an important consideration. For engineering purposes however, it is the texture of the subsurface materials which is important. The latter is evaluated by the Unified (United States Army Corps of Engineers 1957) and AASHO (American Association of State Highway Officials 1961) classifications. Adverse soil textures may sometimes be overcome with the addition of topsoil or fill material respectively, but this procedure is costly and in many cases would be unfeasible.

Coarse Fragments.

The content of coarse fragments in a soil or on the soil surface will influence the difficulty of construction of recreational facilities. Coarse fragments on the soil surface must be removed when constructing playing fields and will present obstacles in trails, picnic areas, and campgrounds if they are not removed. Stoniness presents similar limitations for most uses and in addition makes excavations more difficult.

Slope.

Slope is one of the major limitations of many soils in Yoho. Steeply sloping areas have obvious limitations for such uses as playgrounds or camp areas, especially where bedrock is close to the surface. Slope increases construction costs and design requirements, and is also one of the major factors influencing erosion hazards.

Rockniess.

Rockiness and depth to bedrock are also important soil characteristics for almost all uses. Rock outcrops and shallow depths of soil over bedrock are especially limiting for use as septic tank absorption fields, or as sites for permanent buildings and road construction.

SOIL LIMITATIONS - AS GOVERNED BY SOIL PROPERTIES

Definitions of Soil Limitation Classes.

Soil lmitation ratings were used to evaluate the soils, and hence the mapping units for selected uses. These ratings express relative degrees of hazards, risks or limitations for potential uses of natural or essentially undistrubed soils. The long term effectsofthe potential uses on the behaviour of the soil are considered in the rating.

The soils have been rated according to their limitations for playgrounds, camping areas, picnic areas, paths and trails, septic tank absorption fields, buildings with and without basements, and local roads and streets (Table 67).

None to Slight Limitations.

All of the soil properties are essentially suited for the proposed use. Limitations are minor and can easily be overcome. Minimal construction costs, low maintenance and minimal environmental damage can be expected with proper management.

Moderate Soil Limitations.

These soils have one or more properties which are only moderately suitable for the proposed use. These limitations can be overcome or modified with special construction, design, planning or maintenance. During some seasons of the year, the performance of the structure or other planned use, may be somewhat less than desirable for soils with slight limitations. Some soils with a moderate rating may require treatment such as drainage, runoff control to reduce erosion, additions to topsoil, or some modification of certain soil features through soil manipulation. Construction plans may also need to be modified from those normally used for soils with slight limitations. These may include special foundations, extra reinforcement of structures, sump pumps, or other auxiliary equipment or procedures.

Severe Soil Limitations.

These soils have one or more properties which present a severe limitation for the proposed use. Some soils which are rated as severe can be improved by reducing or removing the soil feature that limits its use, but in most situations, it is difficult and costly to alter the soil or design the facility to compensate for severe limitations.

Very Severe Soil Limitations.

These soils have one or more properties which are so unfavourable for the proposed use that the soil cannot physically be used for that use or it is thought to be economically impractical to do so.

Guides for Assessing Soil Limitations

Guides for assessing soil limitations for seven possible parks uses are given in Tables 58 through 64. These tables provide, as specifically as possible, definitions of the soil properties which result in the specific degrees of limitation. The guides are included in the report so that the user can evaluate the criteria used to make the interpreations in Table 67.

Guides for assessing soil susceptibility to water erosion are also included in Table 65. One of the main soils parameters to consider in planning ski areas is susceptibility to erosion. Because so many non-soil parameters affect the choice of ski slopes, no attempt was made to evaluate directly the soils as to their limitations for ski areas.

Table 58. Guides for assessing soil limitations for playgrounds.

This guide applies to soils to be used intensively for playgrounds for baseball, football, badminton, and for other similar organized games. These areas are subject to intensive foot traffic. A nearly level surface, good drainage, and a soil texture and consistence that gives a firm surface generally are required. The most desirable soils are free of rock outcrops and coarse fragments.

Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of site.

Items Affecting Use	Degree of Soil Limitation			
	None to Slight	Moderate	Severe	Very Severe
Wetness (Wet)[1]	Rapidly, well, and moderately well drained soils with no ponding or seepage. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding of short duration and imperfectly drained soils. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding and poorly and very poorly drained soils. Water table above 50 cm during season of use.	Permanently wet soils.
Flooding (Flood)	None during season of use.	Occasional flooding. May flood once every 2 - 3 years during season of use.	Floods every year.	Prolonged flooding during season of use.
Permeability[2] (Perm)	Very rapid to moderate.	Moderately slow and slow.	Very slow.	
Slope (Slope)	0 to 2% (AB)	2 to 5% (C)	5 to 9% (D)	Greater than 9% (EH)
Depth to Bedrock (Rock - D)	over 100 cm	50 to 100 cm[3]	less than 50 cm[3]	
Coarse fragments On Surface[4] (C.F.)	Relatively free of coarse fragments.	Up to 20% coarse fragments.	Greater than 20% coarse fragments.	
Stoniness[4] (Stony)	Stones > 10 m apart. (Class 0 to 1)	Stones 2 to 10 m apart. (Class 2)	Stones 0.1-2 m apart. (Class 3, 4)	Stones < 0.1 m apart. (Class 5)
Rockiness[4] (Rock)	Rock exposures greater than 100 m apart and cover less than 2% of the surface. (Class 0)	Rock exposures 30 to 100 m apart and cover about 2 to 10% of the surface. (Class 1)	Rock exposures less than 30 m apart and cover greater than 10% of the surface.	Rock outcrops too frequent to permit playground location.
Surface Soil Texture[5] (Text)	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS	SC, SiC, C, S, Si	S and LS subject to blowing, organic soils.
Depth to Sand or Gravel[6] (Sand)	Greater than 100 cm	50 to 100 cm	Less than 50 cm	

1. The abbreviations in brackets are used in Table 67 to indicate the nature of the limitation.
2. In most, if not all of the soils found in Yoho, there is little if any limitation in permeability with regard to playgrounds (Appendix C).
3. Downgrade to a very severe limitation if the slope is greater than 5%.
4. See also definitions in the System of Soil Classification for Canada (Canada Soil Survey Committee 1974) pp 217-219. Coarse fragments for the purpose of this table include gravels and cobbles. Stones are evaluated by stoniness.
5. Surface soil texture influences soil ratings as it affects foot trafficability, surface wetness, dust, and maintenance. Adverse soil textures may be partially or completely overcome with the addition of topsoil.
6. Depth to sand or gravel is considered a limitation in that levelling operations may expose sand or gravel, thereby bringing about adverse surface textures and undesirable amounts of coarse fragments. The addition of topsoil after the levelling process would overcome this limitation.

Table 59. Guides for assessing soil limitations for camp areas.

This guide applies to soils to be used intensively for tents and camp trailers and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and levelling for campsites and parking areas. The soil should be suitable for heavy foot traffic by humans and limited vehicular traffic.[1] Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of site.

Back country campsites differ in design, setting and management but require similar soil attributes. These guides should apply to evaluations for back country campsites but depending on the nature of the facility the interpreter may wish to adjust the criteria defining a given degree of limitation to reflect the changed requirement. For example, small tentsites may allow Rock exposures greater than 10 m apart to be considered a slight limitation.

Items Affecting Use	Degree of Limitation			
	None to Slight	Moderate	Severe	Very Severe
Wetness (Wet)[2]	Very rapidly, rapidly, well and moderately well drained soils with no seepage or ponding. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils with no seepage or ponding. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding and poorly and very poorly drained soils. Water table above 50 cm during season of use.	Permanently wet soils.
Flooding (Flood)	None	Very occasional flooding during season of use. Once in 5 - 10 years.	Occasional flooding during season of use. Once in 2 - 4 years.	Flooding during every season of use.
Permeability[3] (Perm)	Very rapid to moderate inclusive	Moderately slow and slow	Very slow.	
Slope (Slope)	0 to 9% (AD)	9 to 15% (E)	15 to 30% (F)	Greater than 30% (GH)
Surface Soil Texture[4] (Text)	SL, FSL, VFSL, L	SiL, SCL, SiCL, LS, and sand other than loose sand	SC, SiC, C, Si	Organic and sand subject to severe blowing.
Coarse Fragments on Surface[5] (C.F.)	0 to 20%	20 to 50%[6]	> 50%	
Stoniness[7] (Stony)	Stones > 10 m apart. (Class 0 to 1)	Stones 2 to 10 m apart. (Class 2)	Stones 0.1-2 m apart. (Class 3 to 4)	Stones < 0.1 m apart. (Class 5)
Rockiness[7] (Rock)	No rock exposures.	Rock exposures > 10 m apart and cover < 25% of the area. (Class 1 to 2)	Rock exposures < 10 m apart and cover > 25% of the area. (Class 3 and 4)	Rock exposures too frequent to permit campground location. (Class 5)

1. For information specific to roads and parking lots, see Table 64.

2. The abbreviations in brackets are used in Table 67 to indicate the nature of the limitation.

3. Infiltration tests show that in most, if not all, of the soils found in Yoho there is little if any limitation in permeability with regard to camp areas (Appendix C).

4. Surface soil texture influences soil ratings as it affects foot trafficability, dust, and soil permeability.

5. Coarse fragments for the purpose of this table include gravels and cobbles. Stones are evaluated by stoniness.

6. Some gravelly soils may be rated as having slight limitations if the content of gravel exceeds 20% by only a small margin, providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size. See the definition for gravels in the System of Soil Classification for Canada (Canada Soil Survey Committee, 1974) pp. 219.

7. Very shallow soils are rated as having a limitation for rockiness and/or stoniness. See also definitions of rockiness and stoniness in the System of Soil Classification for Canada (Canada Soil Survey Committee, 1974) pp. 217-219.

Table 60. Guides for assessing soil limitations for picnic areas.

This guide applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to the access roads[1]. Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of site.

Items Affecting Use	Degree of Limitation			
	None to Slight	Moderate	Severe	Very Severe
Wetness (Wet)[2]	Very rapidly, rapidly, well, and moderately well drained soils not subject to seepage or ponding. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils not subject to ponding or seepage. Water table above 50 cm for short periods during season of use.	Imperfectly drained soils subject to seepage or ponding. Poorly and very poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use	Permanently wet soils
Flooding (Flood)	None during season of use.	May flood 1 or 2 times per year for short periods during season of use	Floods more than 2 times during season of use	Prolonged flooding during season of use.
Slope (Slope)	0 to 9% (AD)	9 to 15% (E)	15 to 30% (F)	> 30% (GH)
Surface Soil Texture[3] (Text)	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS, and sand other than loose sand.	SC, SiC, C, Si	Loose sand subject to severe blowing & organic soils
Coarse fragments on Surface[4] (C.F.)	0 to 20%	20 to 50% [5]	> 50%	
Stoniness[4] (Stony)	Stones > 2 m apart. (Class 0 to 2)	Stones 1 to 2 m apart. (Class 3)	Stones 0.1 - 1 m apart. (Class 4)	Stones < 0.1 m apart. (Class 5)
Rockiness[4,6] (Rock)	Rock exposures roughly 30 to 100 or more m apart and cover < 10% of the surface. (Class 0 to 1)	Rock exposures roughly 10 to 30 m apart and cover 10 to 25% of the surface.[7] (Class 2)	Rock exposures less than than 10 m apart and cover more than 25% of the surface.[7] (Class 3,4)	Rock exposures too frequent to permit location of picnic areas. (Class 5)

1. For information specific to roads or parking lots, see Table 64.
2. The abbreviations in brackets are used in Table 67 to indicate the nature of the limitation.
3. Surface soil texture influences soil ratings as it affects foot trafficability, dust and soil permeability.
4. See also definitions for coarse fragments, rockiness, and stoniness in the System of Soil Classification for Canada (Canada Soil Survey Committee 1974), pp. 217-219. Coarse fragments for the purpose of this table, include gravels and cobbles. Stones are evaluated by stoniness.
5. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.
6. Very shallow soils are rated as having severe or very severe limitations for stoniness or rockiness.
7. The nature and topography of the bedrock exposures may significantly alter these ratings. As such, on-site investigations will be necessary in map units containing bedrock when these are considered as possible sites.

Table 61. Guides for assessing soil limitations for trails.

This guide applies to soils to be used for paths and trails. It is assumed that the trails will be built at least 45 cm (18 inches) wide and that obstructions such as cobbles and stones will be removed during construction. It is also assumed that a dry, stable tread is desirable and that muddy, dusty, worn or eroded trail treads are undesirable. The guidelines are based on observations of trails that have less than 10,000 hikes per season. In situations where numbers greatly exceed 10,000, it may be necessary to change the "degree of limitation" a given "item affecting use" causes. Hiking and riding trails are not treated separately, but as the design requirements for riding trails are more stringent, a given limitation will be more difficult to overcome. Severe or Very Severe limitation does not indicate that a trail can not or should not be built. It does, however, suggest higher design requirements and maintenance to overcome the limitations.

Items[1] Affecting Use	Degree of Limitation			
	None to Slight	Moderate	Severe	Very Severe
Textural Class[2] (Text)[3]	SL, FSL, VFSL, L	SiL, CL, SiCL, LS, SCL	SC, SiC, C, Sand Si	Loose sand subject to severe blowing and organic soils.
Coarse fragment Content[4] (C.F.)	0 to 20%	20 to 50%[5]	> 50%	
Stoniness[6] (Stony)	Stones > 2 m apart. (Class 0 to 2)	Stones 1 to 2 m apart. (Class 3)	Stones 0.1 to 1 m apart. (Class 4)	Stones < 0.1 m apart. (Class 5)
Wetness[6] (Wet)	Very rapidly, rapidly well, and moderately well drained soils. Water table below 50 cm during season of use.	Moderately well drained soils subject to occaisonal seepage and ponding and imperfectly drained soils. Water table may be above 50 cm for short periods during season of use.	Poorly and very poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Permanently wet soils.
Rockiness[6] (Rock)	Rock exposures > 30 m apart and cover < 10% of the surface. (Class 0 to 1)	Rock exposures 10 to 30 m apart and cover 10 to 25% of the surface. (Class 2)[7]	Rock exposures < 10 m apart and cover > 25% of the surface (Class 3 to 4)[7]	Rock exposures too frequent to permit location of paths & trails. (Class 5)[7]
Slope[8] (Slope)	0 to 15% (AE)	15 to 30% (F)	30 to 60% (G)	> 60% (H)
Flooding (Flood)	Not subject to flooding during season of use	Floods 1 or 2 times during season of use.	Floods more than 2 times during season of use	Subject to prolonged flooding during season of use.

1. The items affecting use listed in this table are those which have been shown to cause significant differences in trail response. Elevation, aspect, position on slope, and snow avalanching may have slight affects or influence trail management and should be considered in the final site evaluation. Items such as vegetation, fauna, and scenic value are not considered in the guidelines (Epp 1977).

2. Texture refers to the soil texture which will form the tread texture. This is the surface texture on level areas but may be a subsurface texture on slopes. Textural classes are based on the less than 2 mm soil fraction (CSSC 1974). Texture influences soil ratings as it influences foot trafficability, dust, design or maintenance of trails, and erosion hazards.

3. The abbreviations in brackets are used in Table 67 to indicate the nature of the limitation.

4. Coarse fragments for the purpose of this table, include gravels and cobbles (CSSC 1974 p. 219). Gravels tend to cause unstable footing when present in high amounts, and are also associated with increased erosion. Cobbles (and stones) must be removed from the trail tread, increasing construction and maintenance difficulties. Stones are evaluated by stoniness.

5. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix or (b) the fragments are less than 2 cm in size.

6. See also definitions for rockiness, stoniness and soil drainage classes in the System of Soil Classification for Canada (CSSC 1974, pp. 217-221).

7. The type of rock outcrop (flat lying vs. cliffs), and the orientation of the structure (linear cliffs vs. massive blocks) can greatly alter the degree of the limitation. Each site with a Rockiness limitation based on the percent rock outcrop above should be evaluated on its own merits and the degree of limitation should then be modified appropriately if necessary.

8. Slope in this context refers to the slope of the ground surface, not the slope of the tread.

Table 62. Guides for assessing soil limitations for septic tank absorption fields.

This guide applies to soils to be used as an absorption and filtering medium for effluent from septic tank systems. A subsurface tile system laid in such a way that effluent from the septic tank is distributed reasonably uniformly into the natural soil is assumed when applying this guide. A rating of severe need not mean that a septic system should not be installed in the given soil, but rather, may suggest the difficulty, in terms of installation and maintenance, which can be expected.

Items Affecting Use	Degree of Soil Limitation			
	None to Slight	Moderate	Severe	Very Severe
Permeability Class[1] (Perm)[2]	Moderately rapid	Moderate	Slow	Very slow
Percolation rate (Auger hole method)[4] (Perm)	About 8 to 18 min/cm[3]	18 to 24 min/cm	slower than 24 min/cm	
Depth to Seasonal Water table[5] (W.T.)	> 180 cm[6]	120 to 180 cm	60 to 120 cm	< 60 cm
Flooding hazard (Flood)	Not subject to flooding.	Not subject to flooding.	Subject to occasional flooding. (once in 5 yrs.)	Floods every year.
Slope	0 to 9% (AD)	9 to 15% (E)	15 to 30% (F)	> 30% (GH)
Depth to hard rock, bedrock or other impervious materials (Rock-D)	> 180 cm	120 to 180 cm[7]	60 to 120 cm	< 60 cm

1. The limitation ratings should be related to the permeability of soil layers at and below depth of the tile line.
2. The abbreviations in brackets are used in Table 67 to indicate the nature of the limitation.
3. Soils having a percolation rate less than about 8 min/cm are likely to present a pollution hazard to adjacent waters. This hazard must be noted, but the degree of hazard must, in each case, be assessed by examining the proximity of the proposed installation to water bodies, water table, and related features.
4. Refer to Alberta Dept. of Manpower and Labour (1972) or U.S. Dept. of Health, Education and Welfare (1969) for details of this procedure.
5. Seasonal means for more than one month. It may, with caution, be possible to make some adjustment for the severity of a water table limitation in those cases where seasonal use of the facility does not coincide with the period of high water table.
6. A seasonal water table should be at least 4 feet below the bottom of the trench at all times for soils having a slight limitation (U.S. Dept. of Health, Education and Welfare 1969). The depths used to water table are based on an assumed tile depth of 2 feet. Where relief permits, the effective depth above a water table or rock can be increased by adding appropriate amounts of fill.
7. Where the slope is greater than 9%, a depth to bedrock of 120 to 180 cm is considered a severe limitation.

Table 63. Guides for assessing soil limitations for permanent buildings[1].

This guide provides ratings for undisturbed soils evaluated for single-family dwellings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundations; but soil slope, susceptibility to flooding and other hydrologic conditions, such as wetness, that have effects beyond those related exclusively to foundations are considered too. Also considered are soil properties, particularly depth to bedrock, which influence excavation and construction costs for the building itself and for the installation of utility lines. Excluded are limitations for soil corosivity (which is of little consequence in Yoho), landscaping and septic tank absorption fields. On-site investigations are needed for specific placement of buildings and utility lines, and for detailed design or foundations. All ratings are for undisturbed soils based on information gained from observations to a depth of 1 to 2 meters.

Items Affecting Use	Degree of Soil Limitation[2]			
	None to Slight	Moderate	Severe	Very Severe
Soil Drainage Class[3] (Wet)[4]	With Basements: Very rapidly, rapidly and well drained. Without basements: Very rapidly, rapidly, well, and moderately well drained.	With Basements: Moderately well drained. Without basements: Imperfectly drained.	With Basements: Imperfectly, poorly, and very poorly drained. Without basements: Poorly and very poorly drained.	With Basements: Permanently wet soils. Without basements: Permanently wet soils.
Depth to Seasonal Water Table (W.T.)	With basements: Below 150 cm Without Basements: Below 75 cm	With Basements: 75 - 150 cm Without Basements: 50 - 75 cm	With Basements: 25 - 75 cm Without Basements: 25 - 50 cm	With Basements: Above 25 cm Without Basements: Above 25 cm
Flooding (Flood)	None	None	Occasional Flooding. (Once in 5 years)	Frequent Flooding. (Every year)
Slope[5] (Slope)	0 to 9% (AD)	9 to 15 % (E)	15 to 30% (F)	> 30% (GH)
Unified Soil Group[6] (Str.)	GW, GP, SW, SP, GM, GC, SM, SC	ML, CL	CH, MH, OL, OH,	Pt
Potential Frost Action[7] (Frost)	Low (F1, F2[7])	Moderate (F3[7])	High (F4[7])	
Stoniness[8] (Stony)	Stones > 10 m apart. (Class 0 to 1)	Stones 2 to 10 m apart. (Class 2)	Stones 0.1 - 2 m apart. (Class 3 to 4)	Stones < 0.1 m apart. (Class 5)
Rockiness[8, 9] (Rock)	Rock exposures > 100 m apart and cover < 2% of the surface. (Class 0)	Rock exposures 30 to 100 m apart and cover 2 to 10% of the surface. (Class 1)	Rock exposures < 30 m apart and cover > 10% of the surface. (Class 2 to 4)	Rock exposures too frequent to allow location of permanent buildings. (Class 5)
Depth to Bedrock[9] (Rock - D)	With Basements: > 150 cm Without Basements: > 100 cm	With Basements: 100 to 150 cm Without Basements: 50 to 100 cm	With Basements: 50 to 100 cm Without Basements: < 50 cm	With Basements: < 50 cm

1. By halving the slope limits, this table can be used for evaluating soil limitations for buildings with large floor areas, but with foundation requirements not exceeding those of ordinary three-storey dwellings.

2. Some soils rated as having moderate or severe limitations may be good sites from an aesthetic or use standpoint, but they will require more site preparation and/or maintenance.

3. For an explanation of soil drainage classes, see the System of Soil Classification for Canada (Canada Soil Survey Committee, 1974) pp. 220-221.

4. The abbreviations in brackets are used in Table 67 to indicate the nature of the limitation.

5. Reduce the slope limits by one half for those soils subject to hillside slippage.

6. This item estimates the strength of the soil, that is, its ability to withstand applied loads.

7. Frost heave only applies where frost penetrates to the assumed depth of the footings and the soil is moist. The potential frost action classes are taken from the United States Army Corps of Engineers (1962) pp. 5-8. Table 66 is reproduced from the above article.

8. See also definitions for stoniness and rockiness in the System of Soil Classification for Canada (Canada Soil Survey Committee, 1974) pp 217-218.

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

Table 64. Guides for assessing soil limitations for local roads and streets[1]

This guide applies to soils evaluated for construction and maintenance of local roads and streets. These are improved roads and streets having some kind of all-weather surfacing, commonly asphalt or concrete, and are expected to carry automobile traffic all year. They consist of: (1) the underlying local soil material (either cut or fill) called the subgrade; (2) the base material of gravel, crushed rock, or lime - or soil cement - stabilized soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They also are graded to shed water and have ordinary provisions for drainage. With the probable exception of the hardened surface layer, the roads and streets are built mainly from the soil at hand, and cuts and fills are limited, usually less than 2 meters. Excluded from consideration in this guide are highways designed for fast-moving, heavy trucks.

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth of hardrock, stoniness, rockiness, and wetness affect the ease of excavation and the amount of cut and fill to reach an even grade. Soil limitation ratings do not substitute for basic soil data or for on-site investigations.

Items Affecting Use	Degree of Soil Limitation			
	None to Slight	Moderate	Severe	Very Severe
Soil Drainage Class[2] (Wet)[3]	Very rapidly, rapidly, well, and moderately well drained.	Imperfectly drained.	Poorly and very poorly drained.	Permanently wet soils.
Flooding (Flood)	None	Infrequent (once in 5 years)	Occasional (once in 2 to 4 years)	Frequent (every year)
Slope (Slope)	0 to 9 (AD)	9 to 15 (E)	15 to 30 (F)	> 30 (GH)
Depth to Bedrock[4] (Rock - D)	> 100 cm	50 - 100 cm	< 50 cm	
Subgrade[5] (Str.)				
a. AASHO group index[6]	0 to 4	5 to 8	> 8	
b. Unified soil classes	GW, GP, SW, SP, SM and GC[7] and SC[7]	CL (with P.I.[8] < 15) and ML	CL (with P.I.[8] of 15 or more), CH, MH, OH, OL, and Pt	
Susceptibility to Frost Heave[9] (Frost)	Low (F1, F2)	Moderate (F3)	High (F4)	
Stoniness[10] (Stony)	Stones > 2 m apart. (Class 0 to 2)	Stones 0.5 to 2 m apart. (Class 3)	Stones 0.1 to 0.5m apart. (Class 4)	Stones < 0.1 m apart. (Class 5)
Rockiness[10] (Rock)	Rock exposures > 100 m apart and cover < 2% of the surface. (Class 0)	Rock exposures 30 to 100 m apart and cover 2 to 10% of the surface. (Class 1)	Rock exposures < 30 m apart and cover > 10% of the surface. (Class 2 to 4)	Rock exposures too frequent to permit location of roads and streets. (Class 5)

1. These guidelines, with some adjustment of slope and rockiness limits, will also be useful for assessing soils for use as parking lots.

2. For an explanation of soil drainage classes, see the System of Soil Classification for Canada (Canada Soil Survey Committee 1974) pp. 220-221.

3. The abbreviations in brackets are used in Table 67 to indicate the nature of the limitation.

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

5. This item estimates the strength of a soil as it applies to roadbeds. When available, AASHO Group Index values from laboratory tests were used; otherwide the estimated Unified classes were used. The limitations were estimated assuming that the roads would be surfaced. On unsurfaced roads, rapidly drained, very sandy, poorly graded soils may cause washboard or rough roads.

6. Group index values were estimated from information published by the Portland Cement Association (PCA, 1962) pp.23-25.

7. Downgrade to moderate if content of fines (less than 200 mesh) is greater than about 30 percent.

8. P.I. means plasticity index.

9. Frost heave is important where frost penetrates below the paved or hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing point. The susceptibility classes are taken from the United States Army Corps of Engineers (1962) pp. 5-8. Table 66 is reproduced from the above article.

10. See also definitions for rockiness and stoniness in the System of Soil Classification for Canada (Canada Soil Survey Committee, 1974) pp. 217-218.

Table 65. Guides for assessing soil susceptibility to water erosion.

The evaluations of soil susceptibility to water erosion are based on the assumption that natural geologic water erosion is expected and accepted. Thus, the predicted erosion potential applies only when man's activities (including fires) cause a loss of vegetation on the soil surface which leads to accelerated erosion of that soil surface. It is also assumed that most of the activities which occur within the Park will not cause a disturbance which is deep enough to penetrate below the solum. Accordingly, the predicted susceptibility to erosion applies only to the surface 25 to 50 centimeters of the soil.

The susceptibility to water erosion of the mapping units (Table 67) was evaluated by means of the graph which is presented in Figure 107.

The soil ratings, K, (Table 65a were estimated by the method of Wischmeier, Johnson and Cross (1971), (Figure 107) and the slope angle ratings were adopted in part from Rutter (1968). The divisions on the graph are arbitrary, and are based on observations and published data.

Field observations made during the soil survey indicate that in Yoho there are two main exceptions to the foregoing procedure for estimating susceptibility to water erosion. The soil erodibility factor, K (Figure 107) is a poor estimate of erodibility in lime rich horizons (Ck, Cca) or dense till materials. These materials are generally found below the solum and were not considered in the susceptibility to erosion ratings. Where the erosion potential of the parent materials or lime cemented tills is of interest, it can be evaluated by Rutter's (1968) method, using soils information which is presented in this report.

The second exception occurs when soils contain appreciable quantities of coarse fragments[1] (greater than 2 mm). Coarse fragments aren't evaluated by the soil erodibility factor, but the problem is partially evaluated by the dashed lines in Figure 108.

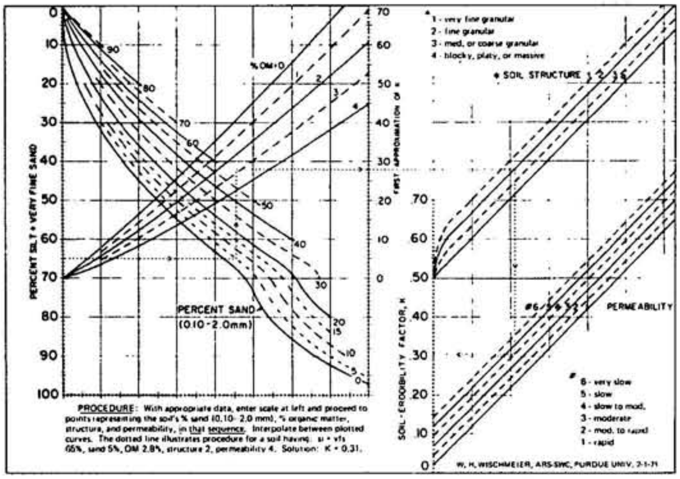


Figure 107. Soil-erodibility nomograph (taken from Wischmeier, Johnson, and Cross 1971).

Table 65a. Soil erodibility ratings (K values) determined using Figure 107.

Map Unit	K Value[1]	% Coarse Fragments[2]
BC 1	0.50	< 20
BC 2	0.60	< 20
BC 3	0.60	< 20
BG 2	0.25	> 20
BG 3	0.50	> 20
BG 4	0.45	> 20
BG 5	0.55	< 20
CM 1	0.30	< 20
CO 1	0.40	> 20
DS 1	0.45	< 20
FL 1	0.35	> 20
HO 1	0.60	< 20
HR 1	0.20	< 20
HR 2	0.45	< 20
KI 1	0.60	< 20
KI 2	0.60	< 20
MO 1	0.35	> 20
NI 1	0.40	< 20
OD 1	0.30	< 20
OG 1	0.30	< 20
OG 2	0.35	< 20
OH 1	0.25	> 20
OL 1	0.40	< 20
OL 2	0.45	< 20
OO 1	0.30	< 20
OO 2	0.30	< 20
OP 1	0.20	> 20
OT 1	0.35	< 20
SI 1	0.40	> 20
SI 2	0.35	< 20
SK 1	0.30	< 20
TA 1	0.40	< 20
TO 1	0.40	< 20
VA 1	0.35	< 20
WI 1	0.30	< 20
WR 1	0.20	> 20
WR 2	0.40	> 20
WR 3	0.55	< 20
WR 4	0.40	< 20
WR 5	0.50	< 20

1. The K value was determined from data provided in this report using the soil erodibility nomograph (Figure 107).

2. Percent coarse fragments were summarized from the brief pedon descriptions provided in this report.

Soils with greater than 20% coarse fragments (C.F. = 2 mm to 25 cm) are less susceptible to erosion and the band between the dashed lines indicates moderate erosion risk in such cases.

K values are poor estimates of erodibility in Ck or Cca horizons especially in tills which are also dense, and estimates made from this figure exclude lime-cemented horizons.

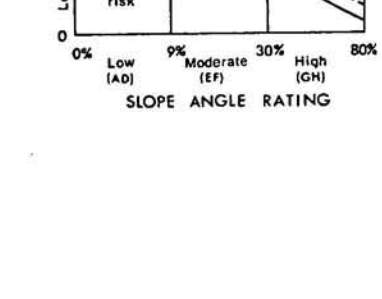


Figure 108. Erosion hazard of soils.

Table 66. Frost design soil classification.

Frost group	Kind of soil	Percentage, by weight, finer than 0.02 mm	Typical soil types under Unified Soil Classification System
F1	Gravelly soils	3 to 10	GW, GP, GW-GM, GP-GM
F2	(a) Gravelly soils	10 to 20	GM, GW-GM, GP-GM
	(b) Sands	3 to 15	SW, SP, SM, SW-SM, SP-SM
F3	(a) Gravelly soils	Over 20	GM, GC
	(b) Sands, except very fine silty sands	Over 15	SM, SC
	(c) Clays, PI>12		CL, CH
F4	(a) All silts		ML, MH
	(b) Very fine silty sands	Over 15	SM
	(c) Clays, PI<12		CL, CL-ML
	(d) Varved clays and other fine-grained, banded sediments		CL, and ML; CL, ML, and SM; CL, CH, and ML; CL, CH, ML, and SM

Note: Taken from the United States Army Corps of Engineers 1962

INTERPRETATIONS

Assumptions and Considerations which apply to the Interpretations in Table 67.

Ratings of the severity of limitations of the soils of Yoho for various recreational uses are shown in Table 67. These ratings are based on inherent soil characteristics, using guidelines from Table 58 to 64 as they apply to this specific area. Essentially the same procedure has been used by Greenlee (1976) in some Provincial Parks of Alberta, by Knapik and Coen (1974) in the Revelstoke Summit Area, and by Coen and Holland (1976) in Waterton Lakes National Park. By using such a system of rating soil limitations, comparisions and extrapolations may be made within the study area, as well as within the adjacent Mountain National Parks. It should also be noted that the severe limitation class of some authors has been subdivided into severe and very severe in this study. This was felt to be necessary to give a greater degree of separation among the map units due to the scarcity of map units with none to slight limitations.

Ratings of the severity of the limitations are shown in Table 67 (only the most severe limitations, and their nature, are specified). When using these interpretations, consideration must be given to the following:

1. Interpretations are based on predictions of soil behavior under defined conditions of use and management as specified in the preamble to each

of Tables 58 through 64. When conditions of use and management are not the same as those defined here, new guides should be established and appropriate revisions made in Table 67.

2. Soil ratings do not include site factors such as nearness to towns and highways, water supply , aesthetic values, etc.
3. Soil ratings are based on natural, undisturbed soil.
4. Soil suitability or limitation ratings are usually given for the entire soils, but for some uses, soil limitations are based on an individual soil horizon or other earthy layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1 to 2 meters, but in some kinds of soils, reasonable estimates can be given for soil material at greater depths. It should be noted here that the term "soil" has been used throughout the report in the pedologic sense and differs in concept from that commonly used by engineers.
5. Severe and very severe soil ratings do not imply that a site cannot be changed to remove, correct or modify the soil limitations. The use of soils rated as severe depends on the nature of the limitations, whether or not the soil limitation can be altered successfully and economically, and on the scarcity of good sites.
6. Interpretations of map units do not eliminate the need for on-site evaluation by qualified professionals. Due to the variable nature of soils, and the scale of mapping, small, unmappable inclusions of soils with different properties may be present in an area where a development is planned. The need for or importance of on-site studies depends on the use to be made of the soil and the kinds of soil and soil problems involved.

Table 67: Interpretations for selected uses - [The degree of limitation is designated as SL (slight), M (moderate), S (severe), and VS (very severe); the nature of the most severe limitations are also indicated]

Map Unit[1]	Playgrounds	Camp Areas	Picnic Areas	Paths & Trails	Septic Tank Absorption Fields	Permanent Buildings		Local Roads & Streets	Susceptibility to Water Erosion[2]
						with basements	without basements		
BC1/AC	VS - wet - flood - text	VS - wet - flood - text	VS - wet - flood - text	VS - wet - flood - text	VS - W.T. - flood	VS - wet - W.T. - flood	VS - wet - W.T. - flood	VS - wet - flood	SL - M
BC1/D	VS - wet - flood - text	VS - wet - flood - text	VS - wet - flood - text	VS - wet - flood - text	VS - W.T. - flood	VS - wet - W.T. - flood	VS - wet - W.T. - flood	VS - wet - flood	S
BC2/AC	VS - wet - flood	VS - wet - flood	VS - wet - flood	VS - wet - flood	VS - W.T. - flood	VS - wet - W.T. - flood	VS - wet - W.T. - flood	VS - wet - flood	SL - M
BC3/AC	VS - wet - flood	VS - wet - flood	VS - wet - flood	VS - wet - flood	VS - W.T. - flood	VS - wet - W.T. - flood	VS - wet - W.T. - flood	VS - wet - flood	SL - M
BG1[6]/e	VS - stony - slope	VS - stony	VS - stony	VS - stony	VS - rock-D	VS - stony	VS - stony	VS - stony	SL
BG1[6]/F	VS - stony - slope	VS - stony	VS - stony	VS - stony	VS - rock-D	VS - stony	VS - stony	VS - stony	SL
BG1/G BG1[6]/g	VS - stony - slope	VS - stony - slope	VS - stony - slope	VS - stony	VS - rock-D - slope	VS - stony	VS - stony	VS - stony	M
BG1[6]/H	VS - stony - slope	VS - stony - slope	VS - stony - slope	VS - stony - slope	VS - rock-D - slope	VS - stony	VS - stony	VS - stony	S
BG2[3,6]/F	VS - stony - slope	VS - stony	VS - stony	VS - stony	VS - stony	VS - stony	VS - stony	VS - stony	M
BG2/G BG2[3,6]/g	VS - stony - slope	VS - stony - slope	VS - stony - slope	VS - stony	VS - stony	VS - stony - slope	VS - stony - slope	VS - stony - slope	S
BG2[3,6]/H	VS - stony - slope	VS - stony - slope	VS - stony - slope	VS - stony - slope	VS - stony - slope	VS - stony - slope	VS - stony - slope	VS - stony - slope	S
BG3[3,6]/F	VS - slope	S - slope - stony	S - slope	M - slope - text - stony	S - slope[4]	S - stony - slope	S - stony - slope	S - slope	S
BG3/GF BG3[3,6]/G	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
BG3[3,6]/H	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
BG4[3,6]/C	S - stony - C.F.	S - stony - C.F.	S - C.F.	S - C.F.	SL[4]	S - stony	S - stony	M - stony	SL
BG4[3,6]/E	VS - slope	S - stony - C.F.	S - C.F.	S - C.F.	M - slope[4]	S - stony	S - stony	M - stony - slope	M
BG4[3,6]/F	VS - slope	S - stony - C.F. - slope	S - C.F. - slope	S - C.F.	S - slope[4]	S - stony - slope	S - stony - slope	S - slope	S
BG4[3,6]/G	VS - slope	VS - slope	VS - slope	S - C.F. - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
BG4[3,6]/H	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
BG5[3,6]/F	VS - slope	S - slope	S - slope	M - text - slope	S - slope[4]	S - slope	S - slope	S - slope	S
BG5[3,6]/G	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
BG5[3,6]/H	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
CM1[3]/AC	M - slope - C.F.	SL	SL	SL	SL	M - frost	M - frost	M - frost - str.	SL
CM1[3]/D	S - slope	SL	SL	SL	SL	M - frost	M - frost	M - frost - str.	SL
CM1/E CM1[3]/e	VS - slope	M - slope	M - slope	SL	M - slope	M - frost - slope	M - frost - slope	M - frost - str. - slope	M
CM1/F CM1[3]/f	VS - slope	S - slope	S - slope	M - slope	S - slope	S - slope	S - slope	S - slope	S
CM1/G CM1[3,6]/g	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
CM1[3,6]/H	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S

N.B. Footnotes at end of table.

(cont.)

Table 67: Interpretations for selected uses - (The degree of limitation is designated as SL (slight), M (moderate), S (severe), and VS (very severe); the nature of the most severe limitations are also indicated)

Map Unit[1]	Playgrounds	Camp Areas	Picnic Areas	Paths & Trails	Septic Tank Absorption Fields	Permanent Buildings with basements	Permanent Buildings without basements	Local Roads & Streets	Susceptibility to Water Erosion[2]
CO1[5]/D	S - slope - C.F.	M - text - C.F.	M - text - C.F.	M - text - C.F.	SL[4]	SL	SL	SL	M
CO1[5]/E	VS - slope	M - text - C.F. - slope	M - text - C.F. - slope	M - text - C.F.	M - slope[4]	M - slope	M - slope	M - slope	M
CO1[5]/F	VS - slope	S - slope	S - slope	M - text - C.F. - slope	S - slope[4]	S - slope	S - slope	S - slope	S
CO1[5]/G	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
DS1/AC	S - perm	S - perm	M - text	M - text	S - perm	S - frost	S - frost	S - frost - str.	M
DS1/D	S - perm - slope	S - perm	M - text	M - text	S - perm	S - frost	S - frost	S - frost - str.	M
DS1/E	VS - slope	S - perm	M - text - slope	M - text	S - perm	S - frost	S - frost	S - frost - str.	S
DS1/F DS1/f	VS - slope	S - slope S - perm	S - slope	M - text - slope	S - perm - slope	S - frost - slope	S - frost - slope	S - frost - slope - str.	S
DS1/G	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
FL1[3,6]/E	VS - slope	M - slope - text - C.F.	M - slope - text - C.F.	M - text - C.F.	M - slope[4]	M - slope	M - slope	M - slope	M
FL1[3,6]/F	VS - slope	S - slope	S - slope	M - slope - text - C.F.	S - slope[4]	S - slope	S - slope	S - slope	S
FL1[3,6]/G	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
FL1[3,6]/H	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
HO1[5]/AC	S - wet	S - wet	S - wet	S - wet	VS - W.T.	S - wet - W.T. - frost	S - wet - W.T. - frost	S - wet - frost - str.	SL - M
HO1[5]/D	S - wet	S - wet	S - wet	S - wet	VS - W.T.	S - wet - W.T. - frost	S - wet - W.T. - frost	S - wet - frost - str.	S
HO1[5]/E	VS - slope	S - wet	S - wet	S - wet	VS - W.T.	S - wet - W.T. - frost	S - wet - W.T. - frost	S - wet - frost - str.	S
HR1/AC	M - slope - sand	SL	SL	SL	SL[4]	S - frost	S - frost	S - frost - str.	SL
HR1/G	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
HR2/D HR2[7]/d	S - slope - C.F.	M - text	M - text	M - text	SL[4]	M - frost	M - frost	M - frost	M
HR2[7]/E	VS - slope	M - text - slope	M - text - slope	M - text	M - slope[4]	M - frost - slope	M - frost - slope	M - frost - slope	S
HR2[7]/F	VS - slope	S - slope	S - slope	M - text - slope	S - slope[4]	S - slope	S - slope	S - slope	S
HR2/G HR2[7]/g	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
HR2[7]/h	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
KI1[7]/AC	S - sand	M - text - flood	M - text	M - text	M - W.T.[4]	S - flood	S - flood	M - flood	SL - M
KI1/D	S - sand - slope	M - text - flood	M - text	M - text	M - W.T.[4]	S - flood	S - flood	M - flood	S

N.B. Footnotes at end of table.

(cont.)

Table 67: Interpretations for selected uses - [The degree of limitation is designated as SL (slight), M (moderate), S (severe), and VS (very severe); the nature of the most severe limitations are also indicated]

Map Unit[1]	Playgrounds	Camp Areas	Picnic Areas	Paths & Trails	Septic Tank Absorption Fields	Permanent Buildings		Local Roads & Streets	Susceptibility to Water Erosion[2]
						with basements	without basements		
KI2/AC [7]	S - sand	S - flood	M - wet - flood - text	M - wet - flood - text	S - W.T.[4] - flood	S - wet - flood	S - flood	S - flood	SL - M
KI2/D [7]	S - sand - slope	S - flood	M - wet - flood - text	M - wet - flood - text	S - W.T.[4] - flood	S - wet - flood	S - flood	S - flood	S
MO1/AC [5]	S - C.F.	M - stony - C.F.	M - C.F.	M - C.F.	SL[4]	M - stony	M - stony	SL	SL
MO1/D [5]	S - C.F. - slope	M - stony - C.F.	M - C.F.	M - C.F.	SL[4]	M - stony	M - stony	SL	M
MO1/E [5]	VS - slope	M - stony - C.F. - slope	M - C.F. - slope	M - C.F.	M - slope[4]	M - stony - slope	M - stony - slope	M - slope	M
MO1/F [5]	VS - slope	S - slope	S - slope	M - C.F. - slope	S - slope[4]	S - slope	S - slope	S - slope	S
NA1/AC	VS - wet - text	VS - wet - text	VS - wet - text	VS - wet - text	VS - W.T.	VS - wet - W.T.	VS - wet - W.T.	VS - wet	SL
NA2/AC	VS - wet - text	VS - wet - text	VS - wet - text	VS - wet - text	VS - W.T.	VS - wet - W.T.	VS - wet - W.T.	VS - wet	SL - M
NI1/D [6]	VS - rock-D	M - text - rock	M - text - rock	M - text	VS - rock-D	VS - rock-D	VS - rock-D	S - rock-D - frost	M
NI1/E [6]	VS - rock-D - slope	S - rock	S - rock	M - text	VS - rock-D	VS - rock-D	VS - rock-D	VS - rock-D	S
NI1/F [6]	VS - rock-D - slope	VS - rock	VS - rock	M - text - slope	VS - rock-D	VS - rock-D	VS - rock-D	VS - rock-D	S
NI1/G [6]	VS - rock-D - slope	VS - rock - slope	VS - slope - rock	S - slope	VS - rock-D - slope	VS - rock-D - slope	VS - rock-D - slope	VS - rock-D - slope	S
NI1/GH NI1/H [6]	VS - rock-D - slope	VS - rock - slope	VS - slope - rock	VS - slope	VS - rock-D - slope	VS - rock-D - slope	VS - rock-D - slope	VS - rock-D - slope	S
OD1/E [3]	VS - slope	M - text - stony - slope	M - text - slope	M - text	M - slope	M - slope - frost - stony	M - slope - frost - stony	M - slope - str. - frost	M
OD1/F OD1/f [3]	VS - slope	S - slope	S - slope	M - text - slope	S - slope	S - slope	S - slope	S - slope	S
OD1/G OD1/g [3]	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
OD1/H [3]	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
OG1/D [3,6]	S - slope	M - text	M - text	M - text	SL	S - frost	S - frost	S - frost	M
OG1/E [3,6]	VS - slope	M - text - slope	M - text - slope	M - text	M - slope	S - frost	S - frost	S - frost	M
OG1/F OG1/f [3,6]	VS - slope	S - slope	S - slope	M - text - slope	S - slope	S - frost - slope	S - frost - slope	S - frost - slope	S
OG1/G OG1/g [3,6]	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
OG1/H [3,6]	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
OG2/D [3,6]	S - slope	M - text	M - text	M - text	SL	M - frost	M - frost	M - frost	M
OG2/E OG2/e [3,6]	VS - slope	M - text - slope	M - text - slope	M - text	M - slope	M - frost - slope	M - frost - slope	M - frost - slope	M
OG2/F OG2/f [3,6]	VS - slope	S - slope	S - slope	M - text - slope	S - slope	S - slope	S - slope	S - slope	S
OG2/G [3,6]	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
OG2/H [3,6]	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
OH1/e [3]	VS - slope	S - stony	S - stony	S - stony	M - slope	S - stony	S - stony	S - stony	M
OH1/F OH1/f [3]	VS - slope	S - stony - slope	S - stony - slope	S - stony	S - slope	S - stony - slope	S - stony - slope	S - stony - slope	M
OH1/G OH1/g [3]	VS - slope	VS - slope	VS - slope	S - stony - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
OH1/H [3,6]	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S

N.B. Footnotes at end of table.

(cont.)

Table 67: Interpretations for selected uses - [The degree of limitation is designated as SL (slight), M (moderate), S (severe), and VS (very severe); the nature of the most severe limitations are also indicated]

Map Unit[1]	Playgrounds	Camp Areas	Picnic Areas	Paths & Trails	Septic Tank Absorption Fields	Permanent Buildings with basements	Permanent Buildings without basements	Local Roads & Streets	Susceptibility to Water Erosion
OL1/D[3]	S - slope	M - text	M - text	M - text	SL	S - frost	S - frost	S - frost	M
OL1/E[3]	VS - slope	M - text - slope	M - text - slope	M - text	M - slope	S - frost	S - frost	S - frost	S
OL1/F OL1/f[3]	VS - slope	S - slope	S - slope	M - text - slope	S - slope	S - frost - slope	S - frost - slope	S - frost - slope	S
OL1/G[3]	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
OL1/H[3]	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
OL2/C[3]	S - wet - text	S - wet - text	S - wet - text	S - wet - text	S - W.T.	S - wet	M - wet - frost	M - wet - frost	M
OL2/D[3]	S - wet - text - slope	S - wet - text	S - wet - text	S - wet - text	S - W.T.	S - wet	M - wet - frost	M - wet - frost	M
OL2/E[3]	VS - slope	S - wet - text	S - wet - text	S - wet - text	S - W.T.	S - wet	M - wet - frost - slope	M - wet - frost - slope	S
OL2/F[3]	VS - slope	S - wet - text - slope	S - wet - text - slope	S - wet - text	S - W.T. - slope	S - wet - slope	S - slope	S - slope	S
OO1/F[3,6]	VS - slope	S - slope	S - slope	M - text - slope	S - slope[4]	S - slope	S - slope	S - slope	S
OO1/FG[3,6]	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
OO1/G OO1/g[3,6]	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
OO1/H[3,6]	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
OO2/e[6]	VS - rock-D - slope	S - rock	S - rock	M - text	VS - rock-D	VS - rock-D	VS - rock-D	VS - rock-D	M
OO2/F[6]	VS - rock-D - slope	VS - rock	VS - rock	M - text - slope	VS - rock-D	VS - rock-D	VS - rock-D	VS - rock-D	S
OO2/G OO2/g[6]	VS - rock-D - slope	VS - rock - slope	VS - rock - slope	S - slope	VS - rock-D	VS - rock-D	VS - rock-D - slope	VS - rock-D - slope	S
OO2/H[6]	VS - rock-D - slope	VS - rock - slope	VS - rock - slope	VS - slope	VS - rock-D	VS - rock-D	VS - rock-D - slope	VS - rock-D - slope	S
OP1/E[5,7]	VS - slope	S - C.F.	S - C.F.	S - C.F.	M - slope[4]	M - wet - slope	M - slope	M - slope	SL
OP1/G[5,7]	VS - slope	VS - slope	VS - slope	S - C.F. - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
OT1/AC	S - sand	M - text - stony	M - text	M - text	SL[4]	M - stony	M - stony	SL	SL
OT1/D	S - sand - slope	M - text - stony	M - text	M - text	SL[4]	M - stony	M - stony	SL	M
SI1/F[3,6]	VS - slope	S - slope	S - slope	M - text - C.F. - slope	S - slope[4]	S - slope	S - slope	S - slope	S
SI1/G[3,6]	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
SI1/H[3,6]	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
SI2/E[6]	VS - rock-D - slope	S - rock	S - rock	M - text	VS - rock-D	VS - rock-D	VS - rock-D	VS - rock-D	M
SI2/F[6]	VS - rock-D - slope	VS - rock	VS - rock	M - text - slope	VS - rock-D	VS - rock-D	VS - rock-D	VS - rock-D	S
SI2/G[6]	VS - rock-D - slope	VS - rock - slope	VS - rock - slope	S - slope	VS - rock-D	VS - rock-D	VS - rock-D - slope	VS - rock-D - slope	S
SI2/H[6]	VS - rock-D - slope	VS - rock - slope	VS - rock - slope	VS - slope	VS - rock-D	VS - rock-D	VS - rock-D - slope	VS - rock-D - slope	S

N.B. Footnotes at end of table.

(cont.)

Table 67: Interpretations for selected uses - [The degree of limitation is designated as SL (slight), M (moderate), S (severe), and VS (very severe); the nature of the most severe limitations are also indicated]

Map Unit[1]	Playgrounds	Camp Areas	Picnic Areas	Paths & Trails	Septic Tank Absorption Fields	Permanent Buildings with basements	Permanent Buildings without basements	Local Roads & Streets	Susceptibility to Water Erosion[2]
SK1/E [3,6]	VS - slope	M - text - slope	M - text - slope	M - text	M - slope	M - wet - slope - frost	M - slope - frost	M - slope - str. - frost	M
SK1/F SK1/f [3,6]	VS - slope	S - slope	S - slope	M - text - slope	S - slope	S - slope	S - slope	S - slope	S
SK1/G SK1/g [3,6]	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
SK1/H [3,6]	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
TA1/AC	S - C.F. - sand	M - text - C.F.	M - text - C.F.	M - text - C.F.	SL[4]	M - stony	M - stony	SL	SL
TA1/D	S - C.F. - sand - slope	M - text - C.F.	M - text - C.F.	M - text - C.F.	SL[4]	M - stony	M - stony	SL	M
TA1/E	VS - slope	M - text - C.F. - slope	M - text - C.F. - slope	M - text - C.F.	M - slope[4]	M - stony - slope	M - stony - slope	M - slope	S
TA1/F TA1/f	VS - slope	S - slope	S - slope	M - text - C.F. - slope	S - slope[4]	S - slope	S - slope	S - slope	S
TA1/FG	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
TA1/G TA1/g	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
TA1/H [2]	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
TO1/E [3,6]	VS - slope	M - wet - text - slope	M - wet - text - slope	M - wet - text	M - W.T. - slope	S - wet	M - wet - slope	M - wet - slope	S
TO1/F [3,6]	VS - slope	S - slope	S - slope	M - wet - text - slope	S - slope	S - wet - slope	S - slope	S - slope	S
TO1/G [3,6]	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
TO1/H [3,6]	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
VA1/AC [3]	VS - wet - text	VS - wet - text	VS - wet - text	VS - wet - text	VS - W.T.	VS - wet	VS - wet	VS - wet	SL - M
VA1/D [3]	VS - wet - text	VS - wet - text	VS - wet - text	VS - wet - text	VS - W.T.	VS - wet	VS - wet	VS - wet	M
VA1/E [3]	VS - wet - text - slope	VS - wet - text	VS - wet - text	VS - wet - text	VS - W.T.	VS - wet	VS - wet	VS - wet	S
VA1/F VA1/f [3]	VS - wet - text - slope	VS - wet - text	VS - wet - text	VS - wet - text	VS - W.T.	VS - wet	VS - wet	VS - wet	S
WI1/AC	S - stony - sand	S - stony	M - text - stony	M - text - stony	M - W.T.[4]	S - stony	S - stony	M - stony	SL
WR1/AC [5,7]	S - stony	S - stony	S - stony	S - stony	SL[4]	S - stony	S - stony	S - stony	SL
WR1/D [5,7]	S - stony - slope	S - stony	S - stony	S - stony	SL[4]	S - stony	S - stony	S - stony	SL
WR1/E [5,7]	VS - slope	S - stony	S - stony	S - stony	M - slope[4]	S - stony	S - stony	S - stony	SL
WR1/F WR1/f [5,7]	VS - slope	S - stony - slope	S - stony - slope	S - stony	S - slope[4]	S - stony - slope	S - stony	S - stony - slope	M
WR1/G [5,7]	VS - slope	VS - slope	VS - slope	S - stony - slope	VS - slope	VS - slope	VS - slope	VS - slope	S

N. B. Footnotes at end of table.

(cont.)

Table 67: Interpretations for selected uses - [The degree of limitation is designated as SL (slight), M (moderate), S (severe), and VS (very severe); the nature of the most severe limitations are also indicated]

Map Unit[1]	Playgrounds	Camp Areas	Picnic Areas	Paths & Trails	Septic Tank Absorption Fields	Permanent Buildings with basements	Permanent Buildings without basements	Local Roads & Streets	Susceptibility to Water Erosion[2]
WR2[5,6]/AC	VS - stony	VS - stony	VS - stony	VS - stony	SL[4]	VS - stony	VS - stony	VS - stony	SL
WR2[5,6]/E	VS - stony - slope	VS - stony	VS - stony	VS - stony	M - slope[4]	VS - stony	VS - stony	VS - stony	M
WR2[5,6]/F	VS - stony - slope	VS - stony	VS - stony	VS - stony	S - slope[4]	VS - stony	VS - stony	VS - stony	S
WR2[5,6]/G	VS - stony - slope	VS - stony - slope	VS - stony - slope	VS - stony	VS - slope	VS - stony - slope	VS - stony - slope	VS - stony - slope	S
WR2[5,6]/H	VS - stony - slope	VS - stony - slope	VS - stony - slope	VS - stony - slope	VS - slope	VS - stony - slope	VS - stony - slope	VS - stony - slope	S
WR3[5]/AC	S - sand	M - text	M - text	M - text	SL[4]	M - str.	M - str.	M - str.	SL - M
WR3[5]/D	S - sand - slope	M - text	M - text	M - text	SL[4]	M - str.	M - str.	M - str.	S
WR3[5]/E	VS - slope	M - text - slope	M - text - slope	M - text	M - slope[4]	M - str. - slope	M - str. - slope	M - str. - slope	S
WR3[5]/F	VS - slope	S - slope	S - slope	M - text - slope	S - slope[4]	S - slope	S - slope	S - slope	S
WR3[5]/G	VS - slope	VS - slope	VS - slope	S - slope	VS - slope	VS - slope	VS - slope	VS - slope	S
WR4[5]/AC	M - wet - text - slope	M - wet - text	M - wet - text	M - wet - text	S - W.T.[4]	S - wet - W.T. - frost	S - frost	S - frost - str.	SL
WR4[5]/E	VS - slope	M - wet - text - slope	M - wet - text - slope	M - wet - text	S - W.T.[4]	S - wet - W.T. - frost	S - frost	S - frost - str.	S
WR4[5]/F	VS - slope	S - slope	S - slope	M - wet - text - slope	S - W.T. - slope	S - W.T., wet - frost - slope	S - frost - slope	S - frost - str.	S
WR5[5]/AC	M - text	M - text	M - text	M - text	S - W.T.[4]	S - W.T. - frost	S - frost	S - frost	SL - M
WR5[5]/D	S - slope	M - text	M - text	M - text	S - W.T.[4]	S - W.T. - frost	S - frost	S - frost	S
WR5[5]/E	VS - slope	M - text - slope	M - text - slope	M - text	S - W.T.[4]	S - W.T. - frost	S - frost	S - frost	S
WR5[5]/F	VS - slope	S - slope	S - slope	M - text - slope	S - W.T.[4] - slope	S - W.T. - frost - slope	S - frost - slope	S - frost	S

FOOTNOTES:

1. The landform component of the map symbol has not been treated as independent of the soils component for the purposes of this table. The landform information considered most important to making the interpretations is also an inherent part of the soil symbol.

2. There are only three classes of susceptibility to erosion. These are designated slight (SL), moderate (M), and severe (S).

3. Rockiness and depth to bedrock may present additional limitations in these map units. Those units which are indicated as (map unit) +R, or R+ (map unit) on the soils map will have moderate or severe limitations due to rockiness for most recreational uses. Those map units which are designated as occurring on colluvial or morainal veneers have depths to bedrock of less than 2 meters and will also present additional limitations for some recreational uses.

4. The rapid permeability of these soils results in a potential for causing pollution to adjacent waters. The degree of limitation caused by this pollution hazard must be evaluated by an on-site investigation taking into account the proximity of the water body which may be affected.

5. These map units occur on alluvial fans which may be subject to an overland flow of water during spring run-off. This overland flow is usually restricted to those fans with slopes less than about 5%. On steeper fans, there is a possibility that the stream channels may change their courses in spring.

6. Snow avalanching may occur on these map units, and where significant is indicated by the presence of A or +A in the map unit symbol. BG4 and WR2 are associated with a high amount of avalanching. Snow avalanching presents a very severe limitation for all permanent structures and facilities and is also a factor to consider when planning hiking trails if these are to be used as cross-country ski or other trails in winter.

7. Some soils with high contents of gravels and cobbles and few fines, such as those on steep colluvial slopes and alluvial fans have little tendence to erode. This is in part a result of their low bulk density and extreme permeability which does not normally allow any surface runoff. However, if some act of nature or man should result in a significant flow of water along a trail or over the soil surface, these soils can erode very quickly, forming deep gullies.

GLOSSARY[1]

AASHO classification - The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Transportation officials.

Accretion - The gradual addition of new land to old by the deposition of sediments carried by a stream.

Adsorption complex - The group of substances in the soil capable of adsorbing water and ions (nutrients).

Aeolian (eolian) - Material accumulated through wind action; includes both loess and dune sand.

Aggregate - A group of soil particles cohering in such a way that they behave mechanically as a unit.

Alluvial deposit - Material deposited by running water.

Alluvium - A general term for all deposits of modern rivers and streams.

Alpine - Areas characterized by polar climates, represented vegetationally by areas that occur above the upper elevational limit of trees, roughly above 2100 to 2150 m a.s.l.

Atterberg limits - See plastic limit, liquid limit.

Available soil moisture - The portion of water in a soil that can be readily absorbed by plant roots; generally considered to be that water held in the soil against a pressure of up to approximately 15 bars.

Base saturation percentage - The extent to which the adsorption complex of a soil is saturated with exchangeable cations other than hydrogen and aluminum. It is expressed as a percentage of the total cation exchange capacity.

Bearing capacity - The average load per unit area that is required to rupture a supporting soil mass.

Bedrock - The solid rock that underlies soil and the regolith or that is exposed at the surface.

Blanket - Herein used as a term to describe a mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but which still conforms to the general underlying topography.

1 This material is abstracted from several sources and the definition given here is the one that corresponds to usage in this report (Agriculture Canada 1976, CSSC 1976, Gary, McAfee and Wolf 1972, Hutchinson, 1976).

Bog - Permanently wet land having low bearing strength.

Boulders - Stones which are larger than 60 cm in diameter.

Brunisolic - An order of soils whose horizons are developed sufficiently to exclude the soils from the Regosolic order, but lack the degrees and kinds of horizon development specified for soils of the other orders. See also CSSC (1974 or 1976).

Bulk density - The mass of dry soil per unit bulk volume. The bulk volume is determined before the soil is dried to constant weight at 105°C.

Calcareous soil - Soil containing sufficient calcium carbonate, often with magnesium carbonate, to effervesce visibly when treated with cold N hydrochloric acid.

Cation - An ion carrying a positive charge of electricity. The common soil cations are calcium, magnesium, sodium, potassium and hydrogen.

Cation exchange - The interchange between a cation in solution and another on the surface of any surface-active material such as clay or organic colloid.

Cation exchange capacity - The sum total of exchangeable cations that a soil can absorb and is usually expressed in milli-equivalents per 100 grams of soil.

Cemented - The soil has a hard, brittle consistency because the particles are held together by cementing substances such as humus, calcium carbonate, or the oxides of silicon, iron and aluminum.

Chernozemic - An order of soils that have developed under xerophytic or mesophytic grasses and forbs, or under grassland-forest transition vegetation, in cool to cold, subarid to subhumid climates. The soils have a dark-colored surface (Ah, Ahe or Ap) horizon and a B or C horizon, or both, of high base saturation.

Chroma - The relative purity, strength or saturation of a color. It is directly related to the dominance of the determining wave length of the light and inversely related to grayness. It is one of the three variables of color.

Classification, soil - The systematic arrangement of soils into categories on the basis of their characteristics. See The Canadian System of Soil Classification (CSSC, 1976) and Glossary of Terms in Soil Science (Agriculture Canada, 1976).

Clay - As a soil separate, the mineral soil particles less than 0.002 mm in diameter; usually consisting largely of clay minerals. As a soil textural class, soil materials that contain 40 or more percent clay, less than 45 percent sand and less than 40 percent silt.

Clay films (skins) - Oriented clay particles forming a coating on the surface of the soil aggregates, mineral grains and in pores. Clay bridges are similar to clay films, but instead of forming coatings, they form a latticework or bridges among the sand grains. The latter are found in medium and coarse textured soils.

Clod - A compact, coherent mass of soil produced artifically, usually by the activities of man by plowing, digging etc., especially when those operations are performed on soils that are either too wet or too dry.

Coarse fragments - Rock or mineral particles greater than 2 mm in diameter.

Cobbles - Rock fragments 7.5 to 25 cm in diameter.

Cobbly - Containing large quantities of cobblestones.

Colluvium - A deposit of heterogeneous material that as a result of mainly gravitational action has moved or is moving down a slope, and has accumulated a mantle of about 50 cm or more in thickness.

Color, soil - Soil colors are estimated by comparison with a Munsell color chart. The Munsell system specifies the relative degrees of the three simple variables of color; hue, value and chroma. For example 10YR 6/4 means a hue of 10YR, a value of 6, and a chroma of 4.

Concretion - A mass or concentration of a chemical compound, such as calcium carbonate or iron oxide, in the form of a grain or nodule of varying size, shape, hardness and color found in soil and in rock.

Consistence, soil - (i) The resistance of a material to deformation or rupture. (ii) The degree of cohesion or adhesion of the soil mass. Terms used for describing consistency at various soil moisture contents are (CSSC 1974):

> wet soil - non-sticky, slightly sticky, sticky, very sticky, non-plastic, slightly plastic, plastic and very plastic;
>
> moist soil - loose, very friable, friable, firm, very firm and extremely firm;
>
> dry soil - loose, soft, slightly hard, hard, very hard and extremely hard.

Control section - The vertical section upon which the taxonomic classification of soil is based. The control section usually extends to a depth of 100 cm (40 in) in mineral and to 160 cm (64 in) in organic materials.

Creep - Slow mass movement of soil and soil material down relatively steep slopes primarily under the influence of gravity, but facilitated by saturation with water and by alternate freezing and thawing.

Cryoturbation (Congeliturbation) - Ground surface modified by processes of frost action.

Drainage, soil - See soil drainage classes.

Drift, glacial - See glacial drift.

Drumlin - An elongated or oval hill of glacial drift, commonly till, deposited by glacier ice with its long axis parallel to the direction of ice movement.

Edaphic - (i) of or pertaining to the soil. (ii) resulting from, or influenced by, factors inherent in the soil or other substrate rather than by climatic factors.

Eluvial horizon - A soil horizon that has been formed by the process of eluviation. In Yoho these horizons are generally light colored and found directly under the forest litter.

Eluviation - The transportation of soil material in suspension or in solution within the soil by the downward or lateral movement of water.

Erosion - The wearing away of the land surface by running water, wind, ice or other geological agents including such processes as gravitational creep. It includes both normal and accelerated soil erosion. The latter is brought about by changes in the natural cover or ground conditions and includes those due to human activity (see Agric. Can. 1976).

Esker - A winding ridge of irregularly stratified sand, gravel and cobbles deposited under the ice by a rapidly flowing glacial stream.

Evapotranspiration - The loss of water from a given area during a specific time by evaporation from a soil surface and by transpiration from plants. Potential evapotranspiration is the maximum transpiration that can occur in a given weather situation with a low-growing crop that is not short of water and does not completely shade the ground.

Exchange capacity - The total ionic charge of the adsorption complex that is active in the adsorption of ions - see cation exchange capacity.

Fan - A fan-shaped form that can be likened to the segment of a cone, and possessing a perceptible gradient from apex to the toe. Fans commonly occur where there is a notable decrease in gradient.

Fibric layer - A layer of organic soil material containing large amounts of weakly decomposed fibre whose botanical origin is readily identifiable.

Field capacity - The percentage of water remaining in the soil 2 or 3 days after the soil has been saturated, and free drainage has practically ceased.

Fine earth - The fraction of mineral soil consisting of particles less than 2 mm in diameter.

Fine texture - Consisting of or containing large quantities of the fine fractions, particularly of silt and clay. Includes all clay loams, and clays; clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay, and clay textural classes. It is sometimes subdivided into clayey texture and moderately fine texture. See soil texture.

Firm - See consistence, soil.

Floodplain - The land bordering a stream, built up of sediments from overflow of the stream and subject to inundation when the stream is in flood stage.

Fluvial deposits - All sediments, past and present, deposited by flowing water, including glaciofluvial deposits. Wave worked deposits and deposits resulting from sheet erosion and mass wasting are not included.

Forb - A herbaceous plant which is not a grass, sedge or rush.

Formation (stratigraphy) - Any assembly of rocks that have some characteristic in common, whether of origin, age or composition. See glossary of geology (Gary et al. 1972).

Friable - Soil aggregates that are soft and easily crushed between thumb and forefinger (see consistence, soil).

Frost-free period - The period or season of the year between the last frost of spring and the first frost of autumn.

Frost heave - The raising of a surface caused by the growth of ice lenses or masses in the underlying soil.

Genesis, soil - The mode of origin of the soil especially the processes or soil forming factors responsible for the development of the solum, the true soil, from unconsolidated parent material.

Geomorphology - That branch of both physiography and geology that deals with the form of the earth, the general configuration of its surface, and the changes that take place in the evolution of landforms.

Glacial drift - All rock material transported by glacier ice and glacial meltwater or rafted by icebergs. This term includes till, stratified drift, and scattered rock fragments.

Glacial outwash - Glaciofluvial deposits of material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice.

Glacial till - See till.

Glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers, and kame terraces. See glacial drift and till.

Gleyed soil - Soil affected by gleysation.

Gleysation - A soil forming process, operative under poor drainage conditions, that results in reduction of iron and other elements and in gray color and mottles.

Gleysolic - An order of soils developed under wet conditions and permanent or periodic reduction. These soils have dull colors, or prominent mottling, or both, in some horizons (CSSC 1976).

Grain size - The effective diameter of a particle measured by semimentation, sieving or micrometric methods.

Gravel - Rock fragments 2 mm to 10 cm in diameter.

Great group - A category in the Canadian system of soil classification. It is a taxonomic group of soils having certain morphological features in common that reflect a similar pedogenic environment (CSSC 1976).

Groundwater - Water that is passing through or standing in the soil and the underlying strata. It is free to move under the influence of gravity (see water table).

Habitat - The natural environment of an organism.

Herb - Any flowering plant except those developing persistent woody bases and stems above ground.

Horizon, soil - See soil horizon.

Hue - The aspect of color that is determined by the wavelengths of light, and changes with the wavelength. Munsell hue notations indicate the visual relationship of a color to red, yellow, blue, green, or purple, or an intermediate of these hues. See also Munsell color system; chroma; and value, color.

Humic layer - A layer of highly decomposed organic soil material containing little fiber.

Humification - The process by which organic matter decomposes to form humus.

Hummocky - A very complex sequence of slopes extending from somewhat rounded hilly, uneven landscape resulting from deepseated soil movement usually of a rotational nature. Depressions or kettles of various size to irregular conical knolls or knobs. There is a general lack of concordance between knolls or depressions.

Humus - That more or less stable fraction of the soil organic matter remaining after the major portion of added plant and animal residues have decomposed. Usually it is dark colored.

Hydrophyte - A plant that grows in water, or in wet or saturated soils.

Illuvial horizon - A soil layer of horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. The layer of accumulation.

Illuviation - The process of deposition of soil material removed from one horizon to another in the soil; usually from an upper to a lower horizon in the soil profile. Illuviated compounds include silicate clay, hydrous oxides of iron and aluminum and/or organic matter.

Impeded drainage - A condition which hinders the movement of water through soils under the influence of gravity.

Impervious - Resistant to penetration by fluids or roots.

Infiltration - The downward entry of water into the soil.

Intergrade - A soil that possesses moderately well-developed distinguishing characteristics of two or more genetically related taxa.

Kame - An irregular ridge or hill of stratified glacial drift.

Kame terrace - A terrace-like ridge consisting of stratified sand and gravel deposited by a meltwater stream between a melting glacier or a stagnant ice lobe and a higher valley wall or lateral moraine, and left standing after the disappearance of the ice.

Kettle - A depression left after the melting of a detached mass of glacier ice buried in drift.

Krummholz - The stunted creeping growth habit resulting from the shaping by wind of some high elevation tree species near the upper limit of their distribution.

Lacustrine deposit - Material deposited in lakewater and later exposed either by lowering the water level or by uplift of the land. These sediments range in texture from sands to clays.

Landform - The various shapes of the land surface resulting from a variety of actions such as deposition or sedimentation (eskers, lacustrine basins), erosion (gullies, canyons) and earth crust movements (CSSC 1976).

Landslide - A mass of material that has slipped downhill by gravity, often assisted by water when the material is saturated.

Leaching - The removal, from the soil, of materials in solution.

Lime (in soil) - A soil constituent consisting principally of calcium carbonate; and including magnesium carbonate, and perhaps oxides and hydroxides of calcium and magnesium.

Liquid limit - The water content corresponding to an arbitrary limit between the liquid and plastic states of consistence of soil.

Lithic layer - Bedrock under the control section of a soil.

Loam - A soil textural class. See also texture, soil.

Loess - Material transported and deposited by wind and consisting mainly of silt-sized particles.

Luvisolic - An order of soils that have eluvial (Ae) horizons and illuvial (Bt) horizons in which silicate clay is the main accumulation product. The soils have developed under forest or forest-grassland transition in a moderate to cool climate.

Map unit, soilscape - A defined and named aggregate of soil bodies occurring together in an individual and natural characteristic pattern over the land surface. A subdivision of soilscape group based on variations in texture, coarse fragments, and depth to bedrock (lithic vs. non-lithic).

Matrix , soil - The main soil constituent or material that encloses other soil features, for example, concretions embedded in a fine-grained matrix.

Meander - One of a series of loop-like bends in the course of a stream.

Mechanical analyses - See particle-size analyses and particle size distribution.

Medium texture - Intermediate between fine textured and coarse textured soils. It includes the following textural classes: very fine sandy loam, loam, silt loam and silt. See also texture, soil.

Mesic layer - A layer of organic material at a stage of decomposition between that of the fibric and humic layers.

Mesophyte - A plant that grows under intermediate moisture conditions.

Microclimate - The climate of a small area resulting from the modification of the general climate by local differences in elevation or exposure.

Microrelief - Small scale local differences in relief, including mounds, swales or hollows.

Mineral soil - A soil consisting predominantly of, and having its properties determined predominantly by, mineral matter. It contains less than 17% organic carbon except for an organic surface layer that may be up to 40 cm thick if formed of mixed peat (bulk density 0.1 or more) or 60 cm if of fibric moss peat (bulk density less than 0.1).

Montane - Areas characterized by cold - snowy forest climate with no distinct dry season and cool summers, represented vegetationally by closed to open savanna forest of Douglas fir, aspen and lodgepole pine; Upper elevation 1550 - 1600 m ASL.

Moraine - An accumulation of earth, generally with stones, carried and finally deposited by a glacier.

Morphology, soil - The physical constitution, particularly the structural properties, of a soil profile as exhibited by the kinds, thickness and arrangement of the horizons in the profile, and by the texture, structure consistence and porosity of each horizon (CSSC 1974).

Mottles - Spots or blotches of different color or shades of color interspersed with the dominant color. Mottling in soils is usually considered to indicate poor aeration and drainage.

Munsell color system - See color, soil.

Order, soil - The highest category in the Canadian soil classification system (CSSC 1976). The soils of Canada are grouped into nine orders: Chernozemic, Solonetzic, Luvisolic, Podzolic, Brunisolic, Regosolic, Gleysolic, Cryosolic, and Organic. All of the soils within an order have one or more basic characteristics in common.

Organic - An order of soils that have developed dominantly from organic deposits. The majority are saturated for most of the year unless artificially drained.

Organic matter, soil - The organic fraction of the soil: includes plant and animal residues at various stages of decomposition, cells and tissues of soil organisms and substances synthesized by the soil population. It is usually determined on soils that have been sieved through a 2 mm sieve.

Orthic - A term used in soil classification to denote the Subgroup that typifies the central concept of the Great Group.

Outwash - Sediments "washed out" by flowing water beyond the glacier and laid down in beds as stratified drift. Particle size may range from boulders to silt.

Outcrop - That part of a geologic formation or structure that appears at the surface of the earth.

Paleosol (fossil soil) - A soil of the geologic past that was buried subsequent to its formation.

Parent material - The unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of a soil is developed by pedogenic processes.

Particles size analyses - The determination of the various amounts of the different separates in a soil sample, usually by sedimentation, sieving, micrometry or combinations of these methods.

Peat - Unconsolidated soil material consisting largely of undecomposed, or only slightly decomposed, organic matter.

Ped, soil - A unit of soil structure such as a prism, block, or granule, formed by natural processes (in contrast to a clod, which is formed artificially).

Pedology - Those aspects of soil science dealing with the origin, morphology, genesis, mapping and taxonomy of soils, and classification in terms of their use.

Pedon - The smallest volume of soil which we should describe and sample to represent the nature and arrangement of its horizons and variability in the other properties that are preserved in samples. A pedon is comparable in some ways to the unit cell of a crystal (Soil Survey Staff, 1975).

Percolation, soil water - The downward movement of water through soil; specifically the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of 1.0 or less.

Permeability, soil - The ease with which gasses, and liquids pass through a bulk mass of soil or a layer of soil. Because different soil horizons vary in permeability, the particular horizon should be designated.

pH, soil - The negative logarithm of the hydrogen-ion activity of a soil. The degree of acidity (or alkalinity) of a soil as determined by means of a glass, quinhydrone, or other suitable electrode or indicator at a specified moisture content or soil-liquid ratio, and expressed in terms of the pH scale.

Plastic limit (Atterberg limit) - The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of a soil.

Plasticity number (plasticity index) - The numerical difference between the liquid and the plastic limit. The plasticity index gives the range of moisture contents within which a soil exhibits plastic properties.

Profile, soil - A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil - The degree of acidity or alkalinity of a soil, which is usually expressed as a pH value. Descriptive terms commonly associated with certain ranges in pH are: extremely acid, <4.5; very strongly acid, 4.5-5.0; strongly acid, 5.1-5.5; moderately acid, 5.6-6.0; slightly acid, 6.1-6.5; neutral, 6.6-7.3; slightly alkaline, 7.4-7.8; moderately alkaline, 7.9-8.4; strongly alkaline, 8.5-9.0; and very strongly alkaline, >9.0.

Regolith - The unconsolidated mantle of weathered rock and soil material on the earth's surface.

Regosolic - An order of soils having no horizon development, or development of the A and B horizons insufficient to meet the requirements of the other orders.

Relief - The elevations or inequalities of the land surface when considered collectively.

Residual material - Unconsolidated and partly weathered mineral materials formed by the desintegration of consolidated rock in place.

Runoff - The portion of the total precipitation on an area that flows away through stream channels. Surface runoff does not enter the soil. Groundwater runoff or seepage flow from groundwater enters the soil before reaching the stream.

Science, soil - The science dealing with soil as a natural resource. It includes: soil formation, classification, and mapping; the physical, chemical and biological properties of soils; and the management of soils for various purposes such as the production of agricultural and forest crops, the construction of roads, and others.

Seepage (groundwater) - The emergence of water from the soil over an extensive area in contrast to a spring where it emerges from a local spot.

Series, soil - A category in the canadian system of soil classification (CSSC 1976). The soil series is the basic unit of soil classification and consists of soils that are essentially alike in all major profile characteristics except texture of the surface.

Silt - Soil mineral particles ranging between 0.05 and 0.002 mm in equivalent diameter. Soil of the textural class silt contains 80 percent silt and less than 12 percent clay.

Shaly - (1) containing a large amount of shale fragments (2) a soil phase - e.g. shaly phase (3) kind of fragment.

Shrink - swell potential - Susceptability to volume change due to loss or gain in moisture content.

Shrub - A woody perennial plant differing from a tree by its low stature and by generally producing several basal shoots instead of a single bole.

Slaty - Containing a considerable quantity of slate fragments. It is used to modify soil texture class names, such as slaty clay loam.

Slope - The degree of deviation of a surface from horizontal, measured in a numerical ratio, percent or degrees. The slope classes used in this report are defined as follows:

Depressional or nearly level	0 to 0.5%
Very gently sloping or gently undulating	0.5 to 2%
Gently sloping or undulating	2 to 5%
Moderately sloping or gently rolling	5 to 9%
Strongly sloping or moderately rolling	9 to 15%
Steeply sloping or strongly rolling	15 to 30%
Very steeply sloping or hilly	30 to 60%
Extremely sloping or very hilly	over 60%

Slump - A landslide characterized by a shearing and rotary movement of a generally independent mass of rock or earth along a curved slip surface (concave upward), and about an axis parallel to the slope from which it descends, and by backward tilting of the mass with respect to that slope so that the slump surface often exhibits a reversed slope facing uphill.

Soil - The naturally occurring unconsolidated material on the surface of the earth that has been influenced by parent material, climate (including the effects of moisture and temperature), macro-and micro-organism, and relief all acting over a period of time to produce soil that may differ from the material from which it was derived in many physical, chemical, mineralogical, biological, and morphological properties.

Soil consistency - See consistency, soil.

Soil drainage classes - The frequency and duration of periods when the soil is free of water saturation. The following drainage classes were used in this report (CSSC 1974):

Rapidly drained; soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.

Well drained; soil moisture does not normally exceed field capacity in any horizon (except possibly the C) for a significant period of the year.

Imperfectly drained; soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year.

Poorly drained; soil moisture in excess of field capacity remains in all horizons for a large part of the year.

Very poorly drained; free water remains at or within 30 cm (12 inches) of the surface for most of the year.

Soil formation factors - The variable, usually interrelated natural agencies that are responsible for the formation of soil. The factors are: parent rock, climate, organisms, relief and time.

Soil horizon - A layer of soil or soil material approximately parallel to the land surface that differs from adjacent genetically related layers in properties such as color, structure, texture, consistency, chemical, biological and mineralogical composition (CSSC 1976).

Organic horizons are found in Organic soils and commonly at the surface of mineral soils or at any depth beneath the surface in buried soils. They contain more than 17 percent organic carbon. Two groups of these horizons are recognized:

O - An organic horizon developed mainly from mosses, rushes and woody materials.

Of - Fibric horizon, an organic horizon which is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fiber that is readily identifiable as to botanical origin.

Om - Mesic horizon, an organic horizon which is intermediate in decomposition between the less decomposed fibric and more decomposed humic materials. This material has intermediate values for fiber content, bulk density and water contents. The material is partly altered both physically and biochemically.

Oh - Humic horizon, an organic horizon which is the most decomposed of all the organic soil materials. It has the least amount of plant fiber, the highest bulk density values and the lowest saturated water holding capacity. This material is relatively stable having undergone considerable change from the fibric state primarily because of oxidation and humification.

L,F,H - These are organic horizons developed mainly from leaves, twigs and woody materials with or without a minor component of mosses. Usually they are not saturated with water for long periods.

L - The original structures of the organic material are easily recognized.

F - The accumulated organic matter is partly decomposed.

H - The original structures of the organic material are unrecognizable.

Master mineral horizons and layers contain less than 17% organic carbon.

A - A mineral horizon or horizons formed at or near the surface in the zone of removal of materials in solution and suspension and maximum in situ accumulation of organic carbon, or both.

B - A mineral horizon characterized by one or more of the following: (1) an enrichment in silicate clay, iron, aluminum or humus, alone or in combination (Bt, Bf, Bfh, and Bh); (2) an alteration by hydrolysis, reduction or oxidation to give a change in color or structure from horizons above or below, or both.

C - A mineral horizon comparatively unaffected by the pedogenic processes operative in A and B, except gleying, and the accumulation of calcium and magnesium carbonates and more soluble salts (Cca, Csa, Cg and C).

R - Underlying consolidated bedrock that is too hard to break with the hands or dig when moist.

Lower case suffixes.

b - Buried soil horizon.

ca - A horizon with secondary carbonate enrichment where the concentration of lime exceeds that present in the unenriched parent material.

e - A horizon characterized by removal of clay, aluminum or organic matter alone or in combination. It is higher in color value by one or more units when dry than an underlying B horizon. It is used with A(Ae).

f - A horizon enriched with amorphous material, principally Fe and Al combined with organic matter. It usually has a chroma of 3 or more. The criteria for an f horizon except for Bgf are: it contains 0.6% or more pyrophosphate-extractable Fe plus Al in textures finer than sand and 0.4% or more in sands; the ratio of pyrophosphate-extractable Fe plus Al to clay (less than 2 μ) is greater than 0.5; and organic carbon exceeds 0.5%. These horizons are differentiated on the basis of organic carbon content into: Bf, 0.5% organic carbon Bhf, more than 5% organic carbon.

g - A horizon characterized by gray colors and/or prominent mottles indicative of permanent or periodic intense reduction.

h - An horizon enriched with organic matter.

Ah - An A horizon of organic matter accumulation. It contains less than 17% organic carbon. It is one Munsell unit of color value darker than the layer immediately below, or it has at least 0.5% more organic carbon than the IC, or both.

Ahe - This horizon has been degraded, as indicated by streaks and splotches of light and dark gray material and often by platy structure.

Bh - This horizon contains more than 1% organic carbon and less than 0.3% pyrophosphate-extractable Fe; the ratio of organic carbon to pyrophosphate-extractable Fe is 20 or more.

k - Presence of carbonate as indicated by visible effervescence with dilute HCl.

m - A horizon slightly altered by hydrolysis, oxidation or solution, or all of them to give a change in color or structure or both.

t - A horizon enriched with silicate clay, as indicated by a higher clay content (by specified amounts) than the overlying eluvial horizon, a thickness of at least 5 cm, oriented clay in some pores, or on ped surfaces, or both, and usually a higher ratio of fine (less than 0.2 μ) to total clay than in the IC horizon.

Soil structure - The combination or arrangement of primary soil particles into secondary particles, units or peds. The secondary units are characterized and classified on the basis of size, shape and degree of distinctness into classes, types and grades, respectively. The following structure descriptions are used in this report (CSSC 1976):

Platy - Thin, horizontal plates; the horizontal axis is longer than the vertical.

Prismatic - Aggregates with vertical axis longer than the horizontal and with well defined surfaces and edges.

Blocky - Block-like aggregates; the vertical and horizontal axes are about the same length, usually with sharp edges.

Subangular blocky - Block-like aggregates; the vertical and horizontal axes are about the same length with subrounded edges.

Granular - More or less rounded aggregates with an absence of smooth faces and edges.

Amorphous (massive) - A coherent soil mass with no evidence of any distinct arrangement of soil particles.

Single grain - A loose, incoherent mass of individual particles, as in sand.

Soil survey - The systematic examination, description, classification and mapping of soils in an area.

Soil texture - The relative proportions of the various soil separates in a soil as described by the classes of soil texture shown in Figure 110. Size groups from 2 mm to 0.05 mm in diameter are called sand, those from 0.05 to 0.002 mm are called silt, and those less than 0.002 mm in diameter are called clay. Sands are coarse textured, loams are medium textured, and clays are fine textured.

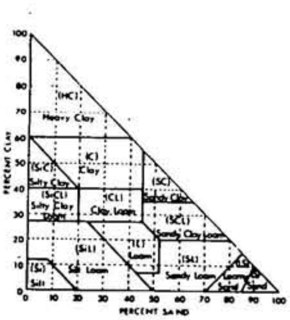


Figure 109. Soil textural classes (common abbreviations in brackets). Percentages of sand and clay in the main textural classes of soils; the remainder of each class is silt.

Soilscape group - A defined and named aggregate of soil bodies grouped together on the basis of similar parent materials, drainage, soil, and profile development.

Soilscape map unit - See map unit, soilscape.

Solifluction - A type of creep that takes place in regions where the ground freezes to a considerable depth, and as it thaws during the warm seasons the upper thawed portion creeps downhill over the frozen material. The soil moves as a viscous liquid down slopes of as little as 2 or 3 degrees and may carry rocks of considerable size in suspension.

Solum - The upper horizons of a soil in which the parent material has been modified and within which most plant roots are contained. It consists usually of the A and B horizons.

Stones - Rock fragments greater than 25 cm (10 inches) in diameter if rounded and greater than 38 cm (15 inches) along the greater axis is flat.

Stratification - The arrangement of sediments in layers of strata marked by a change in color, texture, dimension of particles, and composition. Stratified usually means layers of sediments that separate readily along bedding planes because of different sizes and kinds of material or some interruption in deposition that permitted changes to take place before material was deposited.

Stratified materials - Unconsolidated sand, silt and clay arranged in strata or layers.

Subalpine - Areas characterized by cold-snowy climates with no distinct dry season and short cool summers, represented vegetationally by closed to open forest of Engelmann spruce and subalpine fir in climatic climax stands; between approximately 1550 to 1600 and 2100 to 2150 m a.s.l.

Subgroup, soil - A category of the Canadian soil classification system. These soils are subdivisions of the Great Groups, therefore each soil is defined more specifically.

Talus - A sloping heap of loose rock fragments lying at the foot of a cliff or steep slope.

Terrace - A nearly level, usually narrow plain bordering a river or lake.

Terrain unit - Natural segments of the landscape grouped on the basis of similar landform and materials.

Terric layer - An unconsolidated mineral substratum underlying organic soil material.

Texture, soil - See soil texture.

Till - Unstratified glacial drift deposited directly by ice and consisting of clay, silt, sand, and boulders intermingled in any proportion.

Topography - The physical features of a district or region, such as those represented on a map, taken collectively; especially the relief and contours of the land.

Truncated - Having lost all or part of the upper soil horizon or horizons.

Turf - As used in this report it is the abundantly rooted surface(sometimes organic) layer common in alpine soils. This dense root mat extends into the surface mineral horizon.

Unified Soil Classification System (Engineering) - A classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

Valley train - An outwash terrace extending down a valley away from the ice front.

Value, color - The relative lightness of color, which is approximately a function of the square root of the total amount of light. See also Munsell color system, hue and chroma.

Varve - A distinct band representing the annual deposit of sedimentary materials, regardless of origin. It usually consists of two layers, a thick light-colored layer of silt and fine sand laid down in the spring and summer, and a thin dark-colored layer of clay laid down in the fall and winter.

Veneer - Herein used as a term to describe a mantle of unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer will range from 10 cm to 1 m in thickness and will possess no form typical of the materials genesis.

Water table - The elevation of the upper limit in the soil or underlying material which is saturated by water (i.e. the pressure in the water is zero with respect to the atmospheric pressure).

Water table, perched - The water table of a saturated layer of soil which is separated from an underlying saturated layer by an unsaturated layer.

Weathering - The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

Xerophyte - A plant capable of surviving periods of prolonged moisture deficiency.

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Appendix A: Selected chemical data for pedons used to represent Soilscape Map Units in Yoho National Park

				Chemical Analyses of < 2 mm fract.			Particle Size Distribution						Moisture			
								% from fractions < 2 mm								
Map Unit	Lab No.[1]	Horizon	Depth (cm)	pH $CaCl_2$	Organic Carbon %	$CaCO_3$ equiv. %	Gravel[2] (% by wt.)	Sand	Silt	Coarse Clay	Fine Clay	Textural Class	1/3 Bar	15 Bar	Est. Avail. H_2O in cm/cm[3]	Estimated Perm-eability[4]
	D74,119	Om	18-1	6.6	40	tr[5]	-[6]	-	-	-	-	-	-	-		
		Oh	1-0			not sampled										
BC1		Ckg1	0-1			not sampled										moderate
	D74,120	Ckg2	1-19	7.3	1.9	26	nil	tr	76	18	6	SiL	-	-		
		Ahgb	19-20			not sampled										
	D74,121	Ckgb	20-32+	7.4	-	36	nil	tr	83	13	4	SiL	-	-		
		L	1-0			not sampled										
	D74,062	Ckg1	0-22	7.2	0.9	20	nil	tr	90	7	3	Si	-	-		
BC2	D74,063	Ckg2	22-40	7.3	0.5	24	nil	1	94	3	2	Si	-	-		moderately rapid
		Ofb	40-42			not sampled										
	D74,064	Ckgb	42-67	7.2	2.6	11	nil	3	88	6	3	Si	-	-		
	D74,065	Omb	67-80+	6.7	35	0.8	-	-	-	-	-	-	-	-		
		L-F	1-0			not sampled										
	D74,153	AC k	0-2	7.3	7.3	41	nil	4	86	6	4	Si	-	-		moderately rapid
BC3	D74,154	Ckg1	2-7	7.2	0.7	67	nil	5	88	4	3	Si	-	-		
	D74,155	Ckg2	7-20	-	tr	71	nil	71	27	0	2	VFSL	-	-		
	D74,156	IICkg	20-37+	-	0.2	80	73	92	8	tr	tr	VGCoS	-	-		
BG1						not sampled										
	D75,177	L-H	1-0	7.4	27	13	-	-	-	-	-	-	-	-		
BG2	D75,178	A&Ck	0-32	7.4	7.4	16	92	33	55	10	2	VGSiL	-	-		rapid
	D75,179	Ck	32-70+	7.5	3.4	31	94	32	58	8	2	VGSiL	-	-		
		L	2-0			not sampled										
BG3	D74,059	ABk	0-12	6.9	3.8	9.4	47	32	63	3	2	GSiL	27	11	0.08	rapid
	D74,060	Ck	12-70	7.2	-	33	88	37	54	6	3	VGSiL	31	12		
		R	70+			not sampled										
	D74,054	Ah	0-20	7.0	15	8.4	69	18	66	13	3	VGSiL	67	50		
BG4	D74,055	ACk	20-35	7.2	5.0	14	71	20	63	14	3	VGSiL	47	18		
	D74,056	Ck1	35-85	7.3	0.3	47	62	38	53	7	2	GSiL	28	4.6		rapid
	D74,057	Ck2	85-100+	7.3	1.3	40	75	38	52	8	2	VGSiL	-	-		
		L				not sampled										
BG5	D74,070	Ck1	0-20	7.2	1.1	31	42	33	59	7	1	GSiL	31	5.5	0.29	moderate rapid
	D74,071	Ck2	20-110+	7.5	0.4	16	34	35	56	8	1	GSiL	28	4.9		
	D75,180	L-F	10-0	3.5	45	-	-	-	-	-	-	-	-	-	-	
	D75,181	Ae	0-10	3.5	1.3	-	30	47	48	5	tr	FSL	24	3.3		
CM1	D75,182	Bm1	10-25	4.2	0.6	-	43	53	37	9	1	GFSL	15	2.9	0.15	moderately rapid
	D75,183	Bm2	25-50	4.3	0.5	-	10	51	37	11	1	L	-	-		
	D75,184	BC1	50-95	4.9	tr	-	29	48	35	16	1	L	13	0.5		
	D75,185	BC2	95-150+	5.8	tr	-	34	48	32	15	5	GL	-	-		
	D74,084	L-F	6-0	4.0	38	-	-	-	-	-	-	-	-	-		
	D74,085	Ae	0-2	3.8	2.1	-	33	16	77	6	1	SiL				
CO1	D74,086	Bm1	2-9	4.9	2.2	-	45	35	57	8	tr	GSiL	32	10	0.05	rapid
	D74,087	Bm2	9-65	6.5	0.3	-	79	43	50	5	2	VGSL	11	4.3		
	D74,088	Ck	65-85+	-	-	24	74	63	32	4	1	VGSL	-	-		
	D73,094	L-F	1-0	6.0	-	-	-	-	-	-	-	-	-	-		
		Ae	0-2			not sampled										
DS1	D73,095	Bm	2-18	6.2	1.1	-	nil	6	68	21	5	SiL	32	9.5	0.39	slow to moderate
	D73,096	Ck1	18-50	7.7	-	16	nil	tr	73	20	7	SiCL	36	8.6		
	D73,097	Ck2	50-80+	7.8	-	15	nil	tr	72	23	5	SiCL	-	-		
	D74,072	L-F	6-0	5.5	37	-	-	-	-	-	-	-	-	-		
		Ae	0-4			not sampled										
FL1	D74,073	Bm	4-45	6.1	1.8	-	62	42	52	6	tr	GSiL	35	11	0.11	rapid
	D74,074	Ck1	45-90	7.2	-	5.2	84	70	24	6	tr	VGCoSL	16	4.7		
	D74,075	Ck2	90-110+	7.4	-	2.0	92	64	30	6	tr	VGCoSL	-	-		
	D74,113	L-F	7-0	6.5	34	1.3	-	-	-	-	-	-	-	-		
	D74,114	Ckg1	0-7	7.3	2.3	17	nil	2	73	21	4	SiL	-	-		
	D74,115	Ckg2	7-25	7.3	0.4	34	nil	7	78	13	2	SiL	42	6.4		
HO1	D74,116	Ckg3	25-47	7.4	nil	34	nil	tr	91	5	4	Si	48	4.8		moderate
		Ahb	47-48			not sampled										
	D74,117	Ckgb1	48-50	7.5	nil	27	nil	1	85	12	2	SiL	-	-		
	D74,118	Ckgb2	50-90+	7.2	0.4	30	nil	7	85	4	4	Si	-	-		
	D74,168	L	2-0	3.9	54	-	-	-	-	-	-	-	-	-		
	D74,169	Ae	0-4	4.3	0.8	-	nil	35	59	6	tr	SiL	12	5.0		
	D74,170	Bm1	4-9	5.2	1.5	-	nil	70	24	6	tr	FSL	25	8.7		
HR1	D74,171	Bm2	9-33	5.3	0.1	-	1	83	14	3	tr	LS	11	3.4	0.09	rapid
	D74,172	Bm3	33-45	5.6	0.2	-	4	80	15	5	tr	LS	-	-		
	D74,173	Ck	45-105	7.4	-	44	16	87	11	2	tr	S	-	-		
	D74,174	IICk	105-130+	7.1	-	41	nil	20	62	16	2	SiL	-	-		
	D74,036	L-F	10-0	4.4	40	-	-	-	-	-	-	-	-	-		
	D74,037	Ae	0-2	4.4	1.5	-	24	29	66	5	tr	SiL	-	-		
HR2	D74,038	Bm1	2-9	5.2	1.4	-	45	30	63	6	1	GSIL	27	5.6	0.11	rapid
	D74,039	Bm2	9-20	7.0	1.2	-	29	34	58	6	2	SiL	28	4.6		
	D74,040	Ck1	20-40	7.3	-	29	57	42	52	5	1	GSiL	12	4.8		
	D74,041	Ck2	40-95	7.4	-	37	42	49	47	3	1	GSL	8.2	2.7		

See Footnotes at end of table

Appendix A: Selected chemical data for pedons used to represent Soilscape Map Units in Yoho National Park (continued)

Map Unit	Lab[(1)] No.	Horizon	Depth (cm)	Chemical Analyses of < 2 mm fract. pH $CaCl_2$	Organic Carbon %	$CaCO_3$ equiv. %	Particle Size Distribution Gravel[(2)] (% by wt.)	% from fractions < 2 mm Sand	Silt	Coarse Clay	Fine Clay	Textural Class	Moisture 1/3 Bar	15 Bar	Est. Avail. H_2O in cm/cm[(3)]	Estimated Permeability[(4)]
KI1		L-F	2-0			not sampled										
	D74,129	ACk	0-5	7.0	5.5	27	nil	17	64	16	3	SiL	41	23		moderately rapid
	D74,130	Ck	5-12	7.1	tr	73	nil	32	64	2	2	SiL	9.1	5.0	0.07	
	D74,131	IICk	12-15	7.1	tr	69	55	47	49	1	3	GFSL	-	-		
	D74,132	IICk2	15-33	7.2	0.3	58	81	80	18	1	1	VGLCoS	-	-		
	D74,133	IICk3	33-50+	7.3	0.4	60	2	86	11	2	1	LCS	-	-		
KI2		L-F	1-0			not sampled										
	D74,148	ACk	0-4	7.0	8.2	81	nil	24	62	11	3	SiL	-	-		moderately rapid
	D74,149	Ckg1	4-20	7.1	tr	78	nil	37	59	3	1	SiL	-	-		
	D74,150	Ckg2	20-29	7.0	0.9	71	3	44	53	2	1	SiL	-	-		
	D74,151	IICk1	29-40	7.1	tr	82	74	85	15	tr	tr	VGLCoS	-	-		
		IICk2	40-45			not sampled										
		IICkg1	45-50			not sampled										
	D74,152	IICkg2	50-63+	7.1	tr	80	73	87	13	tr	tr	VGLCoS	-	-		
MO1	D74,163	L-F	5-0	3.7	46	-	-	-	-	-	-	-	-	-		
	D74,164	Bf	0-20	4.8	2.1	-	59	57	42	1	tr	GFSL	-	-		moderately rapid
	D74,165	Bm	20-50	5.4	1.1	-	65	63	34	3	tr	GFSL	-	-		
	D74,166	BC	50-77	5.7	-	-	29	73	27	tr	tr	LS	-	-		
	D74,167	C	77-100+	5.8	-	-	48	56	40	4	tr	GVFSL	-	-		
NA1	D74,105	Om1	0-16	6.4	44	-	-	-	-	-	-	-	-	-		
	D74,106	Om2	16-31	6.2	41	-	-	-	-	-	-	-	-	-		
	D74,107	Om3	31-50	6.2	43	-	-	-	-	-	-	-	-	-		
	D74,108	Ckg	50-65+	7.2	-	87	nil	5	81	13	1	SiL	-	-		
NA2	D74,220	Oh1	0-10	5.8	38	-	-	-	-	-	-	-	-	-		
	D74,221	Of1	10-33	5.7	39	-	-	-	-	-	-	-	-	-		
	D74,222	Of2	33-60	5.5	38	-	-	-	-	-	-	-	-	-		
	D74,223	Of3	60-85	5.2	38	-	-	-	-	-	-	-	-	-		
	D74,224	Om1	85-95	6.0	15	-	-	-	-	-	-	-	-	-		
	D74,225	Oh2	95-115	6.1	17	-	-	-	-	-	-	-	-	-		
	D74,226	Ckg	115-125+	7.1	-	6.4	26	59	40	1	-	FSL	-	-		
NI1		L	2-0			not sampled										
	D74,067	Bm	0-8	6.3	1.8	0.5	12	22	66	10	2	SiL	28	7.8	0.30	moderately rapid
	D74,068	Ck	8-15	7.0	-	11	18	22	65	16	3	SiL	33	8.1		
		R	15+			not sampled										
OD1	D74,143	H	5-0	4.8	35	-	-	-	-	-	-	-	-	-		
	D74,144	Ae	0-2	4.5	3.7	-	nil	21	68	9	2	SiL	-	-		moderately rapid and moderate
	D74,145	Bhf	2-15	5.8	9.9	-	12	19	81	tr	tr	Si	64	4.6	0.19	
	D74,146	Bm	15-35	6.2	7.8	-	nil	58	36	5	1	FSL	12	5.3		
	D74,147	Ck	35-62+	7.3	-	64	51	48	42	7	3	GL	-	-		
OG1	D75,171	F-H	5-0	3.9	-	-	-	-	-	-	-	-	-	-		
	D75,172	Ae	0-3	4.3	0.9	-	6	29	68	2	1	SiL	-	-		moderately rapid and moderate
	D75,173	Bfh	3-12	4.7	4.0	-	16	26	69	4	1	SiL	42	7.5	0.41	
	D75,174	Bm	12-23	6.5	0.6	3.0	50	29	58	11	2	GSiL	29	2.3		
	D75,175	Ck1	23-50	7.3	-	10	38	30	57	10	3	GSiL	65	32		
	D75,176	Ck2	50-105+	7.5	-	42	31	30	60	8	2	SiL	52	16		
OG2	D73,126	L-F	8-0	3.9	-	-	-	-	-	-	-	-	-	-		
	D73,127	Ae	0-3	4.7	2.3	-	nil	17	75	7	1	SiL	42	4.2		moderately rapid and moderate
	D73,128	Bhf	3-6	4.3	13	-	3	15	72	9	4	SiL	54	28	0.29	
	D73,129	Bf	6-25	4.8	4.9	-	27	21	71	7	1	SiL	64	22		
	D73,130	IIBC	25-45	6.5	-	-	19	11	65	21	4	SiL	-	-		
	D73,131	IICk	45-75+	7.2	-	32	59	36	46	14	4	GL	-	-		
OH1	D73,104	L-F	7-0	3.4	-	-	-	-	-	-	-	-	-	-		
	D73,105	Ae	0-5	3.3	2.9	-	21	36	59	4	1	SiL	36	9.4		moderately rapid and moderate
	D73,106	Bhf	5-9	4.2	11	-	12	28	61	8	3	SiL	56	26	0.06	
	D73,107	Bm	9-38	4.5	0.8	-	56	84	12	3	1	GLS	5.5	2.5		
	D73,108	BC1	38-54	4.6	-	-	59	83	15	1	1	GLS	-	-		
	D73,109	BC2	54-66+	5.2	-	-	50	87	13	tr	tr	GS	-	-		
OL1	D73,110	L-F-H	4-0	4.5	-	-	-	-	-	-	-	-	-	-		
	D73,111	Ae	0-3	4.9	1.4	-	9	44	51	5	tr	SiL	25	6.7		moderately rapid
	D73,112	Bm1	3-10	6.0	1.5	-	23	46	50	3	1	SiL	25	6.7	0.15	
	D73,113	Bm2	10-42	6.7	0.2	-	54	61	32	5	2	GSL	12	1.1		
	D73,114	IICk	42-90+	7.6	-	27	16	39	40	16	5	L	17	7.2		
OL2	D74,227	L-F-H	13-0	6.0	39	0.9	-	-	-	-	-	-	-	-		
	D74,228	Ah	0-20	6.7	22	1.0	nil	17	83	tr	tr	Si	100	26	0.35	moderately rapid
	D74,229	Bmg	20-43	6.8	0.6	4.3	10	18	62	16	4	SiL	31	6.4		
	D74,330	Ckg	43-90+	7.4	-	32	71	38	52	8	2	VGSiL	-	-		
OO1	D74,093	Ah1	0-8	4.5	9.7	-	16	31	53	14	2	SiL	48	9.2		
	D74,094	Ah2	8-19	4.5	6.3	-	26	36	49	12	3	L	40	18		
	D74,095	Bf	19-40	4.6	1.8	-	36	39	47	13	1	GL	30	8.7	0.19	rapid
	D74,096	C	40-60	4.5	-	-	41	37	52	10	1	GSiL	-	-		
		R	60+			not sampled										
OO2	D74,076	Ah1	0-4	5.2	14	-	nil	21	54	23	2	SiL	-	-		
	D74,077	Ah2	4-11	5.2	6.7	-	5	26	54	19	1	SiL	61	18	0.35	rapid
	D74,078	Bf	11-16	5.7	2.9	-	nil	27	62	10	1	SiL	-	-		
		R	16+			not sampled										

See Footnotes at end of table

Appendix A: Selected chemical data for pedons used to represent Soilscape Map Units in Yoho National Park (continued)

Map Unit	Lab[1] No.	Horizon	Depth (cm)	Chemical Analyses of < 2 mm fract. pH $CaCl_2$	Organic Carbon %	$CaCO_3$ equiv. %	Particle Size Distribution Gravel[2] (% by wt.)	% from fractions < 2 mm Sand	Silt	Coarse Clay	Fine Clay	Textural Class	Moisture 1/3 Bar	15 Bar	Est. Avail. H_2O in cm/cm[3]	Estimated Perm-eability[4]
	D73,100	L-F	10-0	5.8	-	-	-	-	-	-	-	-	-	-		
	D73,101	C	0-27	6.2	1.8	-	85	56	28	12	4	VGSL	-	-		
OP1	D73,102	Ahb	27-43	5.8	6.6	-	73	34	28	26	12	VGCL	-	-		moderately rapid
		Bmb	43-61			not sampled										
	D73,103	Cb	61-75+	6.2	2.0	-	79	57	19	19	5	VGSCL	-	-		
	D74,216	L	8-0	3.5	45	-	-	-	-	-	-	-	-	-		
OT1	D74,217	Ae	0-3	4.7	2.6	-	14	25	71	3	1	SiL	9.4	-	0.04	rapid
	D74,218	Bm	3-15	5.6	2.1	-	64	33	59	7	1	GSiL	36	15		
	D74,219	Ck	15-85+	7.4	-	59	88	75	23	1	1	VGLS	-	-		
	D74,097	Ah	0-6	4.5	13	-	57	36	53	9	2	GSiL	47	34		
		Ae				not sampled										
SI1	D74,098	Bhf	6-21	5.0	5.1	-	18	27	71	1	1	SiL	64	22	0.11	rapid
	D74,099	Bm	21-38	5.0	0.9	-	72	48	48	4	tr	VGSL	20	5.5		
	D74,100	Ck1	38-85	5.2	-	63	80	58	37	5	tr	VGCoSL	-	-		
	D74,101	Ck2	85-95+	6.0	-	1.4	53	47	46	7	tr	GL	-	-		
		charcoal	1-0			not sampled										
	D74,080	Ae	0-3	4.0	2.6	-	nil	13	69	15	3	SiL	-	-		
SI2	D74,081	Bf1	3-8	4.7	2.8	-	2	17	58	21	4	SiL	40	7.1	0.24	moderately rapid
	D74,082	Bf2	8-15	4.6	1.6	-	8	21	54	21	4	SiL	38	14		
	D74,083	BC	15-19	5.7	-	-	nil	28	58	12	2	SiL	-	-		
		R	19+			not sampled										
	D74,042	Ah	0-15	4.5	8.1	-	nil	17	72	9	2	SiL	46	32		
	D74,043	Ae	15-22	4.7	3.7	-	8	17	68	14	1	SiL	-	-		
SK1	D74,044	Bhf	22-27	4.8	5.4	-	3	18	68	12	2	SiL	48	19	0.17	moderately rapid and moderate
	D74,045	Bf	27-45	4.7	1.1	-	11	25	49	21	5	L	27	9.3		
	D74,046	Bm	45-75	5.0	0.4	-	44	23	48	23	6	GCL	28	12		
	D74,047	Ck	75-100+	7.2	-	43	-	35	45	16	4	L	-	-		
	D74,089	L-F	5-0	4.2	45	-	-	-	-	-	-	-	-	-		
		Ae	0-1			not sampled										
TA1	D74,090	Bm	1-20	5.4	1.2	-	42	31	55	12	2	GSiL	29	6.1	0.06	rapid
	D74,091	BCk	20-37	6.7	-	-	86	39	49	10	2	VGL	15	6.7		
	D74,092	IICk	37-87+	6.9	-	54	87	72	23	4	1	VGCoSL	6.4	2.4		
	D74,109	L-F	18-0	5.1	47	-	-	-	-	-	-	-	-	-		
		Ck	0-1			not sampled										
TO1	D74,110	Bmb	1-6	6.7	5.2	-	50	38	50	10	2	GL	39	11	0.19	moderately rapid
	D74,111	Ckb1	6-42	7.3	-	23	71	48	42	8	2	VGL	44	6.3		
	D74,112	Ckb2	42-80+	7.4	-	35	65	58	36	5	1	GSL	-	-		
	D73,115	Oh	17-0	7.2	-	0.4	-	-	-	-	-	-	42	6.4		
VA1	D73,116	Ahg	0-14	7.0	18	0.5	-	11	61	20	8	SiCL	48	4.8		moderately rapid
	D73,117	Bg	14-32	7.2	2.7	13	-	34	56	8	2	SiL	-	-		
	D73,118	Ckg	32+	7.5	-	40	-	44	46	8	2	L	-	-		
	D74,175	Ah	0-2	5.8	12	-	nil	16	72	10	2	SiL	-	-		
	D74,176	Ae	2-6	5.1	6.1	-	nil	22	70	6	2	SiL	-	-		
WI1	D74,177	A & B	6-9	4.8	9.3	-	3	15	75	9	1	SiL	70	4.9	0.06	moderately rapid
	D74,178	Bhf	9-12	4.7	12	-	23	24	61	12	3	SiL	72	36		
	D74,179	IIBm	12-60	4.8	0.7	-	87	79	19	2	tr	VGLCoS	9	4.1		
	D74,180	IIBC	60-90+	5.3	-	-	67	83	14	3	tr	VGLCoS	-	-		
		L	1-0			not sampled										
WR1	D73,098	Ck1	0-15	7.5	3.1	68	-	70	28	1	1	GSL	-	-		rapid
	D73,099	Ck2	15-30+	7.6	2.7	68	79	82	16	2	tr	VGLCoS	-	-		
	D74,102	Ahk	0-12	6.8	15	8.0	88	51	44	3	2	VGFSL	32	28		
WR2	D74,103	Ck1	12-40	7.0	0.7	61	79	52	43	4	1	VGFSL	14	13	0.02	rapid
	D74,104	Ck2	40-100+	7.2	0.1	65	82	51	44	4	1	VGFSL	17	11		
	D74,030	L-F	8-0	6.0	27	-	-	-	-	-	-	-	-	-		
		Ae	0-1			not sampled										
WR3	D74,032	ACk	1-4	7.2	8.0	33	8	61	34	5	tr	SL	-	-	0.15	rapid
	D74,033	Ck1	4-40	7.3	tr	51	nil	24	65	10	1	SiL	20	5.4		
	D74,034	Ck2	40-90	7.2	tr	53	80	77	20	3	tr	VGLCoS	19	1.1		
	D74,035	Ck3	90-110+	-	tr	57	21	34	59	7	tr	SiL	-	-		
WR4	D73,124	Ck1	0-50	7.1	3.6	22	2	17	78	tr	5	SiL	38	9.1	0.51	moderately rapid
	D73,125	Ck2	50-86+	7.3	2.0	27	nil	7	80	8	5	SiL	43	5.9		
		L-F	2-0			not sampled										
	D73,139	Ck	0-17	7.3	1.7	79	nil	24	70	4	2	SiL	13	2.2		
	D73,140	Ahkb	17-20	7.2	3.5	58	nil	14	74	8	4	SiL	29	8.1		
WR5	D73,141	Ckgb1	20-33	7.3	1.9	76	nil	26	70	3	1	SiL	13	1.2	0.13	moderately rapid
	D73,142	Ckgb2	33-40	7.4	1.6	70	94	47	48	4	1	VGFSL	8.5	1.2		
	D73,143	Ckgb3	40-55	7.4	1.1	84	10	43	54	2	1	SiL	8.9	1.8		
	D73,144	Ckgb4	55-80+	7.5	2.3	73	30	54	41	3	2	FSL	11	2.5		

FOOTNOTES:

(1) Alberta Institute of Pedology laboratory number. See section on methodology for details of procedures

(2) The percentage of gravels by weight may be converted to an approximate percentage by volume by assuming a density of 2.6 g/cc for the gravels and a bulk density of 1.3 for the less than 2 mm fraction.

(3) The values for estimated available water (storage capacity) for plant growth are based on the differences between field capacity and wilting point. The total amount of available water may be estimated by multiplying the estimated available water in cm/cm^2 by the rooting depth. In Yoho, unless there is a lithic contact, the rooting depth is frequently in the order of 100 cm, but can vary from site to site.

(4) Permeability classes of slow, slow-moderate, moderate, moderately rapid and rapid were used roughly as defined by Soil Survey Staff. 1951. Soil Survey Manual, U.S. Dept. of Agric. Handbook 18, Govt. Printing Office, Washington, D.C. pp. 167-168.

(5) tr - trace; i.e. < 0.5% $CaCO_3$, < 0.1 Organic Carbon, < 1% sand, silt, coarse clay or fine clay.

(6) - dash - not determined or irrelevant.

Appendix B: Engineering test data for pedons used to represent Soilscape Map Units in Yoho National Park

Map Unit	Horizon	Mechanical Analysis from fract.< 3"(1) % Passing Sieve 3"	3/4	4	10	40	200	Plasticity(2) Liq.Lim. %	Plast. Index	D_{10}(3)	D_{30}(3)	D_{60}(3)	fract.< 0.002 mm(3)	Activity(4)	Opt. Moist. %(5)	Max. dry density p.c.f.(5)	Organic matter %(6)	Classification(8) Group Index(7)	AASHO(3)	Unified(3)	Textural Class(9)	Miscellaneous Comments
BC1	Om	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	70	-	-	Pt*	Of	Silty alluvial deposits with 15-60 cm of peaty surface material; less than 5% coarse fragments; water table near surface, seasonally flooded.
	Oh		not sampled																			
	Ckgl		not sampled																			
	Ckg2	100	100	100	100	100	83	-	-	-	-	-	-	-	-	-	3.2	-	-	ML*	Si	
	Ahgb		not sampled																			
	Ckgb	100	100	100	100	100	100	43	20	-	-	-	17	1.1	22	96.5	-	14	A-7-6	CL	Si	
BC2	L		not sampled																			Stratified silty alluvial deposit; organic surface horizon thinner than 15 cm; buried peaty layer may occur within the solum; very poorly drained, water table near the surface.
	Ckgl	100	100	100	100	100	100	-	-	-	-	-	-	-	-	-	1.6	-	-	MH*	Si	
	Ckg2	100	100	100	100	100	100	-	-	-	-	-	-	-	-	-	0.8	-	-	ML*	Si	
	Ofb		not sampled																			
	Ckgb	100	100	100	100	100	99	52	13	-	-	-	8	1.6	-	-	4.6	12	A-7-5	MH	Si	
	Omb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	61	-	A-8	Pt	Omb	
BC3	L-F		not sampled																			Stratified very gravelly coarse sandy alluvium overlain by silty deposits; high water table; periodic flooding.
	ACk	100	100	100	100	100	97	-	-	-	-	-	-	-	-	-	13	-	-	ML*	Si	
	Ckgl	100	100	100	100	100	97	-	-	-	-	-	-	-	-	-	1.1	-	-	ML*	Si	
	Ckg2	100	100	100	100	100	45	-	-	-	-	-	-	-	-	-	trace	-	-	SM*	VFSL	
	IICkg	100	62	39	28	10	3	NP	NP	0.43	2.0	15	0	-	-	-	0.4	0	A-1-a	GP	VGCoS	
BG1			not sampled																			Boulder field; boulders > 2 - 30 m across cover 80-90% of the ground surface; landslide area.
BG2	L-H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47	-	-	-	-	Greater than 50% by vol. gravels, cobbles and boulders, unstable; many of these colluvial slopes are avalanched.
	A&Ck	100	-	-	9	7	5	-	-	-	-	-	-	-	-	-	13	-	-	-	VGSiL	
	Ck	100	18	10	6	5	4	NP	NP	10	40	60	1	-	-	-	5.9	0	A-1-a	CW	VGSiL	
BG3	L		not sampled																			Very gravelly to gravelly silt loam; some cobbles and stones; > 50 cm to bedrock; steep, colluvial slopes; often avalanched.
	ABk	100	-	-	53	43	39	-	-	-	-	-	-	-	-	-	6.7	-	-	-	GSiL	
	Ck	100	48	43	24	22	15	48	2	-	-	-	2	1.0	-	-	-	0	A-1-a	GM	VGSiL	
	R		not sampled																			
BG4	Ah	100	-	-	31	31	27	-	-	-	-	-	-	-	-	-	25	-	-	-	VGSiL	These map units restricted to snow avalanche tracks; stoniness variable.
	ACk	100	-	-	39	38	25	-	-	-	-	-	-	-	-	-	8.6	-	-	-	VGSiL	
	Ck1	100	-	-	38	33	27	-	-	-	-	-	-	-	-	-	0.5	-	-	-	GSiL	
	Ck2	100	62	37	26	20	17	44	7	-	-	-	3	2.3	-	-	2.3	0	A-1-b	GM	VGSiL	
BG5	L		not sampled																			Gravelly medium textured colluvium, derived from schists and slates; few cobbles or boulders; unstable in spring.
	Ck1	100	-	-	59	54	43	-	-	-	-	-	-	-	-	-	2.0	-	-	SC*	GSiL	
	Ck2	100	94	80	66	62	47	33	9	-	-	-	6	1.5	24	95.0	0.8	3	A-4	SC	GSiL	
CM1	L-F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78	-	-	-	-	Slightly calcareous coarse textured till; cobbles and boulders common; a few imperfectly drained map inclusions.
	Ae	100	-	-	70	50	42	-	-	-	-	-	-	-	-	-	2.2	-	-	SM*	FSL	
	Bm1	100	-	-	57	48	32	-	-	-	-	-	-	-	-	-	1.1	-	-	SM*	GFSL	
	Bm2	100	-	-	90	75	48	-	-	-	-	-	-	-	-	-	0.9	-	-	SM*	L	
	BC1	100	-	-	71	60	41	-	-	-	-	-	-	-	-	-	0.2	-	-	SC*	L	
	BC2	100	77	69	66	53	48	17	5	-	-	-	8	0.6	-	-	0.1	8*	A-4	SC	GL	
CO1	L-F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65	-	-	-	-	Stratified very gravelly sandy loam with silty surface horizons; well drained stable aluvial fans.
	Ae	100	-	-	67	66	60	-	-	-	-	-	-	-	-	-	3.6	-	-	ML*	SiL	
	Bm1	100	-	-	55	48	42	-	-	-	-	-	-	-	-	-	3.9	-	-	SC*	GSiL	
	Bm2	100	-	-	55	48	40	-	-	-	-	-	-	-	-	-	0.6	-	-	SM*	VGSL	
	Ck	100	58	39	36	20	10	29	2	0.07	1.2	11	2	1.0	-	-	-	0	A-1-a	SP-SM	VGSL	
DS1	L-F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Well drained, medium textured soils of low permeability developed on shallow (often < 1 m) lacustrine deposits over till.
	Ae		not sampled																			
	Bm	100	100	100	100	100	97	-	-	-	-	-	-	-	-	-	2.0	-	-	ML*	SiL	
	Ck1	100	100	100	100	100	100	-	-	-	-	-	-	-	-	-	-	-	-	CL*	SiCL	
	Ck2	100	100	100	100	100	100	32	16	-	-	-	28	0.6	15	112.5	-	11	A-6	CL	SiCL	

N.B. Footnotes at end of table.

Appendix B: Engineering test data for pedons used to represent Soilscape Map Units in Yoho National Park (continued)

Map Unit	Horizon	Mechanical Analysis from fract.< 3"(1) % Passing Sieve 3"	3/4	4	10	40	200	Plasticity(2) Liq.Lim. %	Plast. Index	D_{10}(3)	D_{30}(3)	D_{60}(3)	fract.< 0.002 mm(3)	Activity(4)	Opt. Moist. %(5)	Max.dry density p.c.f.(5)	Organic Matter %(6)	Classification(8) Group Index(7)	AASHO(3)	Unified(3)	Textural Class(9)	Miscellaneous Comments
FL1	L-F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65	-	-	-	-	Very gravelly coarse sandy loams with gravelly silt loam surficial horizons; stable colluvial slopes (about 40%). < 2-4 m to bedrock.
	Ae		not sampled																			
	Bm	100	-	-	39	30	24	-	-	-	-	-	-	-	-	-	3.2	-	-	-	GSIL	
	Ck1	100	-	-	16	7	5	-	-	-	-	-	-	-	-	-	-	-	-	-	VGCoSL	
	Ck2	100	54	49	9	4	3	24	4	2.2	3.8	35	2	2.0	18	105.0	-	0	A-1-a	GP	VGCoSL	
HO1	L-F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59	-	-	-	-	Stratified silty alluvium with silt loam strata, poorly drained; fluctuating, seasonally high water table; gently sloping alluvial fans.
	Ckg1	100	100	100	100	100	99	-	-	-	-	-	-	-	-	-	4.0	-	-	ML*	SiL	
	Ckg2	100	100	100	100	100	97	-	-	-	-	-	-	-	-	-	0.7	-	-	ML*	SiL	
	Ckg3	100	100	100	100	100	100	-	-	-	-	-	-	-	-	-	trace	-	-	ML*	Si	
	Ahb		not sampled															-	-	ML*	SiL	
	Ckgb1	100	100	100	100	100	99	-	-	-	-	-	-	-	-	-	trace	-	-	ML*	SiL	
	Ckgb2	100	100	100	100	100	99	36	11	-	-	-	8	1.4	-	-	-	9	A-6	ML	Si	
HR1	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	95	-	-	-	-	Stratified deposits with strata of silt loam to sandy material; generally well drained; glaciofluvial.
	Ae	100	100	100	100	93	35	-	-	-	-	-	-	-	-	-	1.4	-	-	ML*	SiL	
	Bm1	100	100	100	100	96	73	-	-	-	-	-	-	-	-	-	2.6	-	-	ML*	FSL	
	Bm2	100	100	100	99	93	19	-	-	-	-	-	-	-	-	-	0.2	-	-	SM*	SL	
	Bm3	100	100	100	96	81	34	-	-	-	-	-	-	-	-	-	0.3	-	-	SP*	LS	
	Ck	100	100	95	87	62	12	-	-	-	-	-	-	-	-	-	-	-	-	SW*	S	
	IICk	100	100	100	100	97	83	24	11	-	-	-	18	0.6	12	122.5	-	8	A-6	CL	SiL	
HR2	L-F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	69	-	-	-	-	Stratified gravelly sandy loam with gravelly silt loam strata; gravel content increases with depth; glaciofluvial, till may be underneath.
	Ae	100	-	-	61	63	56	-	-	-	-	-	-	-	-	-	2.6	-	-	ML*	SiL	
	Bm1	100	-	-	55	47	40	-	-	-	-	-	-	-	-	-	2.4	-	-	SC*	GSIL	
	Bm2	100	-	-	100	83	68	-	-	-	-	-	-	-	-	-	2.1	-	-	ML*	SiL	
	Ck1	100	-	-	49	40	31	-	-	-	-	-	-	-	-	-	-	-	-	SC*	GSiL	
	Ck2	100	92	74	59	43	32	18	3	-	-	-	3	1.0	10	120.0	-	0	A-2-4	SM-SC	GSL	
KI1	L-F		not sampled																			Stratified alluvium; very gravelly loamy coarse sand overlain by silt loam deposits of variable thickness; some cobbles present; water table 1 - 2 m below surface, fluctuating seasonally, droughty in summer, risk of flooding in spring.
	ACk	100	-	-	100	99	91	-	-	-	-	-	-	-	-	-	9.5	-	-	ML*	SiL	
	Ck	100	-	100	99	83	4	-	-	-	-	-	-	-	-	-	trace	-	-	ML*	SiL	
	IICk1	100	-	50	19	10	6	-	-	-	-	-	-	-	-	-	trace	-	-	ML*	SiL	
	IICk2	100	59	50	18	10	17	-	-	-	-	-	-	-	-	-	0.5	-	-	SP*	VGLCoS	
	IICk3	41	34	19	17	4	2	NP	NP	0.08	8.0	50	0	-	-	-	0.7	0	A-1-a	GP	VGLCoS	
KI2	L-F		not sampled																			Stratified alluvium; very gravelly loamy coarse sand overlain by silt loam deposits; some cobbles present; seasonally fluctuating water table; soils are droughty in summer; imperfect internal drainage, risk of occasional flooding.
	ACk	100	100	100	100	46	80	-	-	-	-	-	-	-	-	-	14	-	-	ML*	SiL	
	Ckg1	100	100	100	100	99	77	-	-	-	-	-	-	-	-	-	trace	-	-	ML*	SiL	
	Ckg2	100	-	-	97	95	64	-	-	-	-	-	-	-	-	-	1.6	-	-	ML*	SiL	
	IICk1	100	-	-	25	20	6	-	-	-	-	-	-	-	-	-	trace	-	-	GP-CM*	VGLCoS	
	IICk2		not sampled																			
	IICkg1		not sampled																			
	IICkg2	100	80	39	28	19	8	NP	NP	0.03	2.5	6.5	2	-	-	-	trace	0	A-1-a	GP-GM	VGLCoS	
MO1	L-F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	80	-	-	-	-	Stratified gravelly very fine sandy loam with strata of loamy sand; coarse fragments mainly igneous; gravels and cobbles; well drained, stable fans.
	Bf	100	-	-	42	35	23	-	-	-	-	-	-	-	-	-	3.6	-	-	SM*	GFSL	
	Bm	100	-	-	35	28	12	-	-	-	-	-	-	-	-	-	1.9	-	-	SP-SM*	GFSL	
	BC	100	88	79	71	52	23	-	-	-	-	-	-	-	-	-	-	-	-	SP*	LS	
	C	100	54	53	52	50	31	NP	NP	-	-	-	2	-	-	-	-	0	A-2-4	SM	GVFSL	
NA1	Om1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	76	-	A-8	Pt*	-	Peat; > 40 cm over mineral material.
	Om2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	71	-	A-8	Pt*	-	
	Om3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	74	-	A-8	Pt*	-	
	Ckg	100	100	100	100	100	96	51	4	-	-	-	13	0.3	-	-	-	-	A-5	ML	SiL	
NA2	Oh1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	66	-	A-8	Pt*	-	Peat; > 40 cm over mineral material.
	Of1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	67	-	A-8	Pt*	-	
	Of2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	66	-	A-8	Pt*	-	
	Of3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	66	-	A-8	Pt*	-	
	Om1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	-	A-8	Pt*	-	
	Oh2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	A-8	Pt*	-	
	Ckg	100	68	62	32	22	16	22	NP	-	-	-	0	-	-	-	-	-	A-1-b	SM	FSL	

N.B. Footnotes at end of table.

Appendix B: Engineering test data for pedons used to represent Soilscape Map Units in Yoho National Park (continued)

Map Unit	Horizon	Mechanical Analysis from fract. < 3"[1] % Passing Sieve 3"	3/4	4	10	40	200	Plasticity[2] Liq. Lim. %	Plast. Index	D_{10}[3]	D_{30}[3]	D_{60}[3]	fract. < 0.002 mm[3]	Activity[4]	Opt. Moist. %[5]	Max. dry density p.c.f.[5]	Organic Matter %[6]	Classification[8] Group Index[7]	AASHO[3]	Unified[3]	Textural Class[9]	Miscellaneous Comments
NI1	L	not sampled																				Silt loam colluvium; < 50 cm to bedrock; on steep slopes susceptible to erosion and downslope creep.
	Bm	100	-	-	83	79	73	-	-	-	-	-	-	-	-	-	3.1	-	-	-	SiL	
	Ck	100	-	-	83	76	67	34	11	-	-	-	10	1.1	24	97.5	-	9	A-6	CL-ML	SiL	
	R	not sampled																				
OD1	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	61	-	-	-	-	Morainic landforms at approx. 2000 to 2150 m a.s.l.; stones common, boulders occasionally abundant; well drained with occasional map inclusions of seepage areas.
	Ae	100	100	100	100	100	86	-	-	-	-	-	-	-	-	-	6.4	-	-	ML*	SiL	
	Bhf	100	-	-	88	85	78	-	-	-	-	-	-	-	-	-	17	-	-	ML*	Si	
	Bm	100	100	100	100	92	48	-	-	-	-	-	-	-	-	-	13	-	-	SM*	FSL	
	Ck	100	70	57	50	43	38	20	4	-	-	-	5	0.8	12	117.5	-	8**	A-4	SC	GL	
OG1	F-H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Medium textured soils on shallow and deep morainic deposits, cobbles and boulders common.
	Ae	100	-	-	94	88	70	-	-	-	-	-	-	-	-	-	1.6	-	-	ML*	SiL	
	Bfh	100	-	-	84	72	64	-	-	-	-	-	-	-	-	-	6.9	-	-	ML*	SiL	
	Bm	100	-	-	51	47	38	-	-	-	-	-	-	-	-	-	1.0	-	-	SC*	GSiL	
	Ck1	100	-	-	62	57	46	-	-	-	-	-	-	-	-	-	-	-	-	SC*	GSiL	
	Ck2	100	92	80	69	65	52	18	5	-	-	-	7	0.7	-	125.0	-	4	A-4	CL-ML	SiL	
OG2	L-F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Compact silt loam till containing approximately 30 - 40% gravels and cobbles overlain by 20 to 40 cm of loose silt loam surficial deposit having approximately 5% gravels and cobbles.
	Ae	100	100	100	100	100	83	-	-	-	-	-	-	-	-	-	4.0	-	-	ML*	SiL	
	Bhf	100	-	-	97	95	85	-	-	-	-	-	-	-	-	-	22	-	-	ML*	SiL	
	Bf	100	-	-	73	70	63	-	-	-	-	-	-	-	-	-	8.5	-	-	ML*	SiL	
	IIBC	100	-	-	81	78	73	-	-	-	-	-	-	-	-	-	-	-	-	ML*	SiL	
	IICk	100	69	52	41	33	28	27	11	-	-	-	9	1.2	14	115.0	-	0	A-2-6	SC	GL	
OH1	L-F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Slightly to non-calcareous coarse textured bouldery till; O'Hara lake area.
	Ae	100	-	-	79	77	56	-	-	-	-	-	-	-	-	-	5.0	-	-	ML*	SiL	
	Bhf	100	-	-	88	85	70	-	-	-	-	-	-	-	-	-	19	-	-	ML*	SiL	
	Bm	100	-	-	45	34	10	-	-	-	-	-	-	-	-	-	1.4	-	-	SM*	GLS	
	BC1	100	-	-	42	33	9	-	-	-	-	-	-	-	-	-	-	-	-	SM*	GLS	
	BC2	100	72	58	50	42	13	NP	NP	-	-	-	0	-	-	-	-	0	A-1-b	SM	GS	
OL1	L-F-H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Medium textured till with 10 - 20% coarse fragments; silty surficial deposit in upper 40 cm.
	Ae	100	-	-	91	83	57	-	-	-	-	-	-	-	-	-	2.4	-	-	ML*	SiL	
	Bm1	100	-	-	77	65	47	-	-	-	-	-	-	-	-	-	2.6	-	-	ML*	SiL	
	Bm2	100	68	53	46	35	20	-	-	-	-	-	-	-	-	-	0.4	-	-	SM*	GSL	
	IICk	100	100	95	84	77	56	18	7	-	-	-	18	0.4	10	125.0	-	3	A-4	CL-ML	L	
OL2	L-F-H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	67	-	-	-	-	Medium textured till with many gravels, cobbles and boulders overlain by silty, organic rich surface horizon; moderately well drained.
	Ah	100	-	-	90	89	78	-	-	-	-	-	-	-	-	-	38	-	-	ML*	Si	
	Bmg	100	-	-	29	28	25	-	-	-	-	-	-	-	-	-	1.0	-	-	ML*	SiL	
	Ckg	100	56	37	31	10	8	27	10	0.1	1.8	27	3	3.3	16	112.5	-	0	A-2-4	GP-GC	VGSiL	
OO1	Ah1	100	-	-	84	76	64	-	-	-	-	-	-	-	-	-	17	-	-	ML*	SiL	Loose colluviated materials generally greater than 2150 m a.s.l. (krummholz and alpine zones); active frost processes and downslope creep.
	Ah2	100	-	-	74	65	55	-	-	-	-	-	-	-	-	-	11	-	-	CL-ML*	L	
	Bf	100	-	-	64	55	53	-	-	-	-	-	-	-	-	-	3.1	-	-	SC	GL	
	C	100	90	72	59	55	42	26	10	-	-	-	14	0.7	14	115.0	-	8**	A-2-4	SC	GSiL	
	R	not sampled																				
OO2	Ah1	100	100	100	100	95	84	-	-	-	-	-	-	-	-	-	23	-	-	ML*	SiL	Shallow (less than 50 cm to bedrock) colluvial and till materials generally greater than 2150 m a.s.l.; active frost processes.
	Ah2	100	-	-	95	86	75	-	-	-	-	-	-	-	-	-	12	-	-	ML*	SiL	
	Bf	100	100	100	100	96	78	NP	NP	-	-	-	11	-	-	-	5.0	-	A-4	ML	SiL	
	R	not sampled																				
OP1	L-F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Stratified very gravelly coarse and medium textured, non-calcareous moderately sloping (10%) fans; periodically flooded shifting watercourse; elevation 2000 m.
	C	100	-	-	15	11	8	-	-	-	-	-	-	-	-	-	3.1	-	-	GP-GC*	VGSL	
	Ahb	100	-	-	27	25	20	-	-	-	-	-	-	-	-	-	11	-	-	GC*	VGCL	
	Bmb	not sampled																				
	Cb	100	33	25	22	16	10	46	14	0.05	7.0	60	6	2.3	-	-	3.5	0	A-2-6	GP-GC	VGSCL	

N. B. Footnotes at end of table.

Appendix B: Engineering test data for pedons used to represent Soilscape Map Units in Yoho National Park (continued)

Map Unit	Horizon	Mechanical Analysis from fract.< 3"[(1)] % Passing Sieve 3"	3/4	4	10	40	200	Plasticity[(2)] Liq. Lim. %	Plast. Index	D_{10}[(3)]	D_{30}[(3)]	D_{60}[(3)]	fract.< 0.002 mm[(3)]	Activity[(4)]	Opt. Moist. %[(5)]	Max. dry density p.c.f.[(5)]	Organic Matter %[(6)]	Classification[(8)] Group Index[(7)]	AASHO[(3)]	Unified[(3)]	Textural Class[(9)]	Miscellaneous Comments
OT1	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78	-	-	-	-	Stratified alluvium; very gravelly silt loam with about 25 cm of silt loam surficial deposit; well drained with some moderately well to imperfectly drained map inclusions.
	Ae	100	-	-	86	80	70	-	-	-	-	-	-	-	-	-	4.5	-	-	ML*	SiL	
	Bm	100	-	-	36	30	26	-	-	-	-	-	-	-	-	-	3.6	-	-	SC*	GSiL	
	Ck	100	55	50	12	8	3	NP	NP	1.0	3.0	25	1	-	-	-	-	0	A-1-a	SP	VGSiL	
SI1	Ah	100	-	-	43	33	28	-	-	-	-	-	-	-	-	-	22	-	-	SC*	GSiL	Loose colluviated soils with variable amounts of gravels, cobbles and boulders; located from 2000 to 2150 m a.s.l.
	Ae		not sampled																			
	Bhf	100	-	-	83	78	72	-	-	-	-	-	-	-	-	-	8.8	-	-	ML*	SiL	
	Bm	100	-	-	28	22	17	-	-	-	-	-	-	-	-	-	1.6	-	-	GP*	VGSL	
	Ck1	100	-	-	20	13	9	-	-	-	-	-	-	-	-	-	-	-	-	GP*	VGCoSL	
	Ck2	100	65	63	47	39	29	25	5	-	-	-	4	1.3	18	105.0	-	0	A-2-4	SM-SC	GL	
SI2	charcoal		not sampled																			Shallow (less than 50 cm to bedrock) loose, colluviated soils with variable amounts of gravels, cobbles and boulders located from 2000 to 2150 m a.s.l.
	Ae	100	100	100	100	98	93	-	-	-	-	-	-	-	-	-	4.5	-	-	ML*	SiL	
	Bf1	100	-	-	98	95	87	-	-	-	-	-	-	-	-	-	4.8	-	-	ML*	SiL	
	Bf2	100	-	-	92	84	76	-	-	-	-	-	-	-	-	-	2.8	-	-	ML*	SiL	
	BC	100	100	100	100	97	83	62	NP	-	-	-	19	-	-	-	-	12**	A-5	ML	SiL	
	R		not sampled																			
SK1	Ah	100	100	100	100	100	93	-	-	-	-	-	-	-	-	-	14	-	-	ML*	SiL	Morainic landforms generally greater than 2150 m a.s.l. (krummholz and alpine zones); silty surficial deposit; frost processes often active.
	Ae	100	-	-	92	90	83	-	-	-	-	-	-	-	-	-	6.4	-	-	ML*	SiL	
	Bhf	100	-	-	97	92	88	-	-	-	-	-	-	-	-	-	9.3	-	-	ML*	SiL	
	Bf	100	-	-	90	85	72	-	-	-	-	-	-	-	-	-	1.9	-	-	SC*	L	
	Bm	100	-	-	56	53	46	-	-	-	-	-	-	-	-	-	0.7	-	-	SC*	GCL	
	Ck	100	93	83	62	52	43	19	5	-	-	-	12	0.4	10	122.5	-	8**	A-6	SC	L	
TA1	L-F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78	-	-	-	-	Gravelly coarse sandy loam with a gravelly silt loam surficial deposit; some cobbles and stones; well to excessively drained; glacio-fluvial landforms.
	Ae		not sampled																			
	Bm	100	-	-	58	53	43	-	-	-	-	-	-	-	-	-	2.1	-	-	SC*	GSiL	
	BCk	100	-	-	14	12	9	-	-	-	-	-	-	-	-	-	-	-	-	GC*	VGL	
	IICk	100	40	19	14	10	5	NP	NP	0.4	8.5	55	4	-	-	-	-	0	A-1-a	GW	VGCoSL	
TO1	L-F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	82	-	-	-	-	Steeply sloping till landforms; seasonally high moisture content may result in slope instability.
	Ck		not sampled																			
	Bm	100	-	-	50	41	33	-	-	-	-	-	-	-	-	-	9.0	-	-	SC*	GL	
	Ckb1	100	-	-	29	23	17	-	-	-	-	-	-	-	-	-	-	-	-	GC*	VGL	
	Ckb2	100	62	43	35	27	17	26	12	-	-	-	2	-	-	-	-	1	A-2-6	GC	GSL	
VA1	Oh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Located in poorly drained groundwater discharge areas on morainic landforms; 10 - 20 cm organic surface; cobbles and boulders increase with depth.
	Ahg	100	-	-	95	92	87	-	-	-	-	-	-	-	-	-	31	-	-	SC*	SiCL	
	Bg	100	-	-	79	78	61	-	-	-	-	-	-	-	-	-	4.7	-	-	ML*	SiL	
	Ck	100	65	51	45	43	30	21	NP	-	-	-	5	-	-	-	-	0	A-2-4	ML	L	
WI1	Ah	100	100	100	100	98	88	-	-	-	-	-	-	-	-	-	21	-	-	ML*	SiL	Stratified very gravelly loamy coarse sand with silt loam surficial deposits; gravel and cobbles increase with depth; stable, moderately well drained fans; elevation about 1900 to 2100 m.
	Ae	100	100	100	100	99	85	-	-	-	-	-	-	-	-	-	11	-	-	ML*	SiL	
	A & B	100	-	-	97	96	87	-	-	-	-	-	-	-	-	-	16	-	-	ML*	SiL	
	Bhf	100	-	-	77	73	67	-	-	-	-	-	-	-	-	-	21	-	-	ML*	SiL	
	IIBm	100	83	57	22	11	6	-	-	-	-	-	-	-	-	-	1.2	-	-	GP-GC*	VGLCoS	
	IIBC	100	88	67	23	14	10	29	6	0.2	1.9	5	3	2.0	23	97.5	-	0	A-1-a	GP-GC	VGLCoS	
WR1	L		not sampled																			Stratified coarse textured alluvial fans with about 50% rounded gravels and cobbles; shifting water channels, occasional flooding.
	Ck1	100	-	-	89	66	33	-	-	-	-	-	-	-	-	-	5.4	-	-	SM*	GSL	
	Ck2	100	60	23	21	12	4	NP	NP	0.3	6.0	18	2	-	-	-	4.7	0	A-1-a	GP	VGLCoS	
WR2	Ahk	100	-	-	11	10	6	-	-	-	-	-	-	-	-	-	25	-	-	GP*	VGFSL	Stratified coarse textured alluvial fans; more than 50% angular cobbles and boulders; periodic avalanching on many areas.
	Ck1	100	38	35	20	18	13	-	-	-	-	-	-	-	-	-	1.2	-	-	GP-GC*	VGFSL	
	Ck2	100	38	25	18	13	10	35	13	0.07	6.5	40	2	6.5	22	96.5	0.2	1**	A-2-5	GP-GC	VGFSL	

N. B. Footnotes at end of table.

Appendix B: Engineering test data for pedons used to represent Soilscape Map Units in Yoho National Park (continued)

Map Unit	Horizon	Mechanical Analysis from fract. <3" (1) % Passing Sieve 3"	3/4	4	10	40	200	Plasticity (2) Liq. Lim. %	Plast. Index	D_{10} (3)	D_{30} (3)	D_{60} (3)	fract. < 0.002 mm (3)	Activity (4)	Opt. Moist. % (5)	Max. dry density p.c.f. (5)	Organic Matter % (6)	Classification (8) Group Index (7)	AASHO (3)	Unified (3)	Textural Class (9)	Miscellaneous Comments
WR3	L-F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47	-	-	-	-	
	Ae		not sampled																			Stratified silt loams with strata of silt and
	ACk	100	-	-	93	73	42	-	-	-	-	-	-	-	-	-	14	-	-	SM*	SL	very gravelly coarse sandy loam; well
	Ck1	100	100	100	100	90	78	-	-	-	-	-	-	-	-	-	trace	-	-	ML*	SiL	drained alluvial fan.
	Ck2	100	78	28	20	12	6	-	-	-	-	-	-	-	-	-	trace	-	-	GP*	VGLCoS	
	Ck3	100	93	83	79	76	60	23	4	-	-	-	6	-	-	-	trace	6	A-4	ML	SiL	
WR4	Ck1	100	-	-	98	93	85	-	-	-	-	-	-	-	-	-	6.2	-	-	ML*	SiL	Stratified, medium textured, calcareous,
	Ck2	100	100	100	100	100	95	40	15	-	-	-	13	1.2	26	93.5	3.5	10	A-6	ML-CL	SiL	imperfectly drained alluvial fans.
WR5	L-F		not sampled																			
	Ck	100	100	100	100	100	90	-	-	-	-	-	-	-	-	-	2.9	-	-	ML*	SiL	Stratified medium textured, calcareous
	Ahkb	100	100	100	100	95	88	-	-	-	-	-	-	-	-	-	6.1	-	-	ML*	SiL	alluvial fan; coarser texture and increased
	Ckgb1	100	-	-	98	97	85	-	-	-	-	-	-	-	-	-	3.3	-	-	ML*	SiL	gravels with depth; imperfectly drained,
	Ckgb2	100	-	-	62	60	44	-	-	-	-	-	-	-	-	-	2.8	-	-	SM*	VGFSL	seasonally wet.
	Ckgb3	100	-	-	90	87	65	-	-	-	-	-	-	-	-	-	1.9	-	-	ML*	SiL	
	Ckgb4	100	85	80	70	57	41	16	NP	-	-	-	4	-	-	-	4.0	2	A-4	SM	FSL	

FOOTNOTES:

(1) Mechanical analysis determined by the pipet procedure (Toogood and Peters 1953) and gravels by dry sieving. Cumulative curves were then drawn and the percentage passing, 4, 10, 40 and 200 mesh sieves was read from these curves.

(2) Annual Book of ASTM Standards, Part II. (Amer. Soc. for Testing Materials 1970).

(3) AASHO and Unified classification was based on "PCA Soil Primer" published by Portland Cement Association. (See also AASHO 1961, United States Army Corps of Engineers 1957)

(4) Activity was calculated from plastic index and percent separates less than 0.002 mm ($A = \frac{I_p}{\% \text{ less than } 0.002 \text{ mm}}$; Means and Parcher 1963).

(5) Standard Proctor tests for maximum density and optimum moistures were based on the correlation method outlined by Ring and Sallberg (1962) using the nomograph charts developed by the Highways Laboratory, Alberta Department of Highways.

(6) Percent organic matter = % organic carbon x 1.73.

(7) Group index numbers (AASHO) marked by a double asterisk (**) were read from graph (PCA Soil Primer p.23).

(8) Unified classifications marked with asterisk (*) were estimated using Moore (1969).

(9) Textural classification is based on the System of Soil Classification for Canada (CSSC 1974, 1976a).

(10) Dash (-) not determined or irrelevant; NP - non-plastic.

Appendix C: Field test data for infiltration, percolation and bulk density on selected pedons.

Soilscape Map Unit	Horizon	Bulk Density	Infiltration[1] cm/hr	Percolation[2] min/cm
CO1	-	-	38.2	0.48
DS1[3]	Bm	1.3	19.0	120
	Ck1	1.4		
HO1	Ckg1	0.8	-	-
	Ckg2	1.2		
NA2	Om1	0.1	-	-
	Of1	0.2		
	Of2	0.1		
	Of3	0.1		
	Om2	0.3		
	Om3	0.3		
OT1	-	-	24.3	0.21
WI1	-	-	21.5[4]	0.15
WR5			1.8[4]	15.7
			0.5[5]	

1. Infiltration rates apply to the surface horizons and are influenced more or less by the horizons below.

2. Percolation rates apply to the horizons at 50 to 75 cm (20 to 30 in) from the surface and are governed more or less by the horizons below.

3. A drastic change in rate from infiltration to percolation is related to the coarser textures and more friable nature of the top 20 cm of this pedon.

4. These areas have received moderate use by campers.

5. This area was heavily used by campers.

Appendix D: Common names and their Latin Equivalents for some plants in Yoho National Park.

TREES

Common Names	Latin Names
Aspen, trembling	*Populus tremuloides*
Birch, white	*Betula papyrifera*
Cedar, western red	*Thuja plicata*
Douglas fir	*Pseudotsuga menziesii*
Fir, subalpine	*Abies lasiocarpa*
Hemlock	*Tsuga heterophylla*
Larch, subalpine	*Larix lyallii*
Maple, rocky mountain	*Acer glabrum*
Pine, limber	*Pinus flexilis*
Pine, lodgepole	*Pinus contorta var. latifolia*
Pine, western white	*Pinus monticola*
Pine, whitebark	*Pinus albicaulis*
Poplar, balsam	*Populus balsamifera*
Spruce, Engelmann	*Picea engelmannii*
Spruce, white	*Picea glauca*
Willows	*Salix* spp

SHRUBS

Common Names	Latin Names
Alder	*Alnus* spp
Alder, river, mountain	*Alnus tenuifolia*
Anemone	*Anemone* spp
Bearberry	*Arctostaphylos uva-ursi*
Bearberry, alpine	*Arctostaphylos rubra*
Bilberry, tall	*Vaccinium membranaceum*
Birch, dwarf	*Betula glandulosa*
Blueberry	*Vaccinium myrtilloides*
Buffalo-berry	*Shepherdia canadensis*
Cinquefoil	*Potentilla* spp
Cinquefoil shrubby	*Potentilla fruticosa*
Cranberry	*Viburnum edule*
Currant, black	*Ribes hudsonianum*
Devils club	*Oplopanax horridum*
Grape, Oregon	*Berberis repens*
Grouseberry	*Vaccinium scoparium*

Note: Latin names correspond to Hitchcock and Cronquist (1973)

SHRUBS (cont)

Common Names	Latin Names
Heather, white & pink	*Cassiope* spp
Heather, red	*Phyllodoce empetriformis*
Honeysuckle, bracted	*Lonicera involucrata*
Huckleberry, false	*Menziesia ferruginea*
Juniper, creeping	*Juniperus horizontalis*
Juniper, ground	*Juniperus communis*
Labrador tea	*Ledum groenlandicum*
Meadowsweet	*Spirea* spp
Prince's pine	*Chimaphila umbellata*
Raspberry	*Rubus idaeus (R. strigosis)*
Rhododendron	*Rhododendron albiflorum*
Rose, prickly	*Rosa acicularis*
Rose, wild	*Rosa woodsii*
Saskatoon	*Amelanchier alnifolia*
Snowberry	*Symphoricarpos albus*
Thimbleberry	*Rubus parviflorus*
Twinflower	*Linnaea borealis*
Willow	*Salix* spp

HERBS

Common Names	Latin Names
Anemone	*Anemone* spp
Anemone, Western	*Anemone occidentalis*
Arnica	*Arnica* spp
Arnica, Heart leaved	*Arnica cordifolia*
Aster, purple	*Aster sibiricus*
Baneberry	*Actaea rubra*
Bedstraw, northern	*Galium boreale*
Bishop's cap	*Mitella breweri*
Bluebell	*Mertensia* spp
Blue-bur (stickseeds)	*Lappula echinata*
Bunchberry	*Cornus canadensis*
Buttercup, yellow	*Ranunculus acris*
Buttercup, snow	*Ranunculus escholtzii*
Camas, white	*Zygadenus elegans*
Clematis	*Clematis columbiana*
Coltsfoot, palmate-leaved	*Petasites palmatus*

HERBS (cont)

Common Names	Latin Names
Cow Parsnip	*Heracleum lanatum*
Crowberry	*Empetrum nigrum*
Elephant head	*Pedicularis groenlandica*
Everlasting, pearly	*Anaphalis margaritacea*
Fireweed	*Epilobium angustifolium*
Fleabane	*Erigeron* spp
Fleabane, showy	*Erigeron peregrinus*
Foam flower	*Tiarella unifoliata*
Groundsel	*Senecio* spp
Hawkweed	*Hieracium* spp
Horsetail	*Equisetum arvense*
Laurel, swamp	*Kalmia polifolia var. microphylla*
Lily, snow	*Erythronium grandiflorum*
Lousewort	*Pedicularis* spp
Lousewort, bracted	*Pedicularis bracteosa*
Lupine	*Lupinus* spp
Meadow rue, western	*Thalictrum occidentale*
Moss campion	*Silene acaulis*
Mountain avens	*Dryas* spp
Paintbrush, alpine	*Castilleja occidentalis*
Parsnip, cow	*Heracleum lanatum*
Plantain, rattlesnake	*Goodyera oblongifolia*
Prairie groundsel	*Senecio canus*
Pussytoes	*Antennaria lanata*
Queen's cup	*Clintonia uniflora*
Ragwort	*Senecio* spp
Ragwort, alpine	*Senecio fremontii*
Rice grass, rough-leaf	*Oryzopsis asperifolia*
Saxifrage	*Saxifraga* spp
Sedges	*Carex* spp
Solomon's-seal, false	*Smilacina racemosa*
Sorrel	*Oxyera digyna*
Stickseeds	*Hackelia jessicae*
Strawberry	*Fragaria* spp
Twisted-stalk	*Streptopus amplexifolius*
Valerian, mountain	*Valeriana sitchensis*
Vetchling	*Lathyrus ochroleucus*
Violet	*Viola* spp
Wintergreen	*Pyrola* spp
Wintergreen, one-flowered	*Pyrola uniflora*
Wintergreen, skinny leaf	*Pyrola* spp
Yarrow, common	*Achillea millefolium*

HERBS (cont)

Common Names	Latin Names
Buttercup, snow	*Ranunculus eschschdtzii*
Camas, white	*Zygadenus elegans*
Clematis	*Clematis columbiana*
Coltsfoot, palmate-leaved	*Petasites palmatus*
Cow Parsnip	*Heracleum lanatum*
Crowberry	*Empetrum nigrun*
Elephant head	*Pedicularis groenlandica*
Everlasting, pearly	*Anaphalis margaritacea*
fireweed	*Epilobium angustifolium*
Fleabane, golden	*Erigeron* spp
Fleabane, showy	*Erigeron peregrinus*
Foam flower	*Tiarella unifoliata*
Groundsel	*Senecio* spp
Hawkweed	*Hieracium* spp
Horsetail	*Equisetum arvense*
Laurel, swamp	*Kalmia polifolia var. microphylla*
Lily, snow	*Erythronium grandiflorum*
Lousewort	*Pedicularis* spp
Lousewort, bracted	*Pedicularis bracteosa*
Lupine	*Lupinus* spp
Meadow rue, western	*Thalictrum occidentale*
Moss campion	*Silene acaulis*
Mountains avens	*Dryas* spp
Paintbrush, alpine	*Castilleja occidentalis*
Parsnip, cow	*Heracleum lanatum*
Plantain, rattlesnake	*Goodyera oblongifolia*
Prairie groundsel	*Senecio canus*
Pussytoes	*Antennaria lanata*
Queen's cup	*Clintonia uniflora*
Ragwort	*Senecio* spp
Ragwort, alpine	*Senecio fremontii*
Rice grass, rough-leaf	*Oryzopsis asperifolia*
Saxifrage	*Saxifraga* spp
Sedges	*Carex* spp
Solomon's-sea, false	*Smilacina racemosa*
Sorrel	*Oxyera digyna*
Stickseeds	*Hackelia jessicae*
Strawberry	*Fragaria* spp
Twisted-stalk	*Streptopus amplexifolius*
Valarian, mountain	*Valeriana sitchensis*
Vetchling	*Lathyrus ochroleucus*
Violet	*Viola* spp
Wintergreen	*Pyrola* spp
Wintergreen, one-flowered	*Pyrola uniflora*
Wintergreen, skinny leaf	*Pyrola* spp
Yarrow, common	*Achillea millefolium*

MOSSES

Common Names	Latin Names
Cladina mitis	*Cladina mitis*
Cladonia rangeferina	*Cladonia rangeferina*
Clubmoss, common	*Lycopodium clavatum*
Dicranum spp	*Dicranum* spp
Fern, bracken	*Pteridium aquilinum*
Ground cedar	*Lycopodium complanatum*
Hylocomium splendens	*Hylocomium splendens*
Letharia vulpina	*Letharia vulpina*
Mnium spp	*Mnium* spp
Peltigera apthosa	*Peltigera aphthosa*
Pleurozium schreberi	*Pleurozium schreberi*
Phylictrum spp	*Phylictrum* spp
Polytichum spp	*Polytrichum* spp
Ptilium crista-castrensis	*Ptilium crista-castrensis*