# DETAILED SOIL SURVEY
# of
# THE CANMORE CORRIDOR AREA

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M76-13

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# SECTION I

## PREFACE

This report is one of a series describing detailed soil surveys of areas found within the jurisdiction of the Calgary Regional Planning Commission. These soil surveys are conducted at sufficiently large scale to be useful for local planning.

The report contains information that can be used to evaluate soil properties for urban and recreational development, to evaluate the engineering properties of soils for construction materials and sites and to assess the agricultural capability of the land. The suitabilities or limitations of the soils for selected uses are described in tabular form in the report. These tables can easily be used to make interpretive maps for specific land uses.

There were seven areas surveyed in this program in 1974. These areas are adjacent to the following towns:

Strathmore (5,800 acres)
Okotoks (6,000 acres)
Airdrie (6,800 acres)
Black Diamond (7,700 acres)
Cochrane (10,000 acres)
High River (11,000 acres)
Canmore (15,000 acres)

Total acreage surveyed - 62,300.

There is a separate report for each area. A standard explanatory section which is pertinent to all areas is presented at the beginning of each report. Specific results and interpretations for a particular area are presented in the second section of the report.

## INTRODUCTION

Soil is one of our most important natural resources. Man bases his activities on soils and depends on their productivity. Misuse of land can have drastic environmental, economic and social effects. Soil surveys provide baseline data on the soil resources of an area. This information is essential to land characterization and evaluation which is

the natural basis for effective land use and land management policies.

Soils vary widely in their properties and as such their suitability or limitations for different uses also varies. A soil with low agricultural capability may be suitable for road construction and a soil that is unsuitable for road location due perhaps to periodic flooding hazard or high water table may be excellent pasture land. However soils often are suitable for several uses. For example, well drained, level soils that have a high capability for agriculture also are excellent locations for airports, highways and urban development. Soil surveys provide the planner with information useful for making decisions based on predicted soil performance and soil suitability for multiple uses.

## USE OF THE REPORT

This report consists of a written text and a map. The written part includes introductory and background information on soils, soil mapping, and soil interpretations in the first section and descriptions of the soils, analytical results, and interpretations for various uses in the second section.

The soil map is presented on an aerial photo-mosaic base. The photo base aids in identification and location of areas, however the linear and spatial distortion inherent in a photo mosaic must be appreciated. The soil-landscape units delineated on the map are described briefly in the map legend and in greater detail in the written report. The map and the report should be used together.

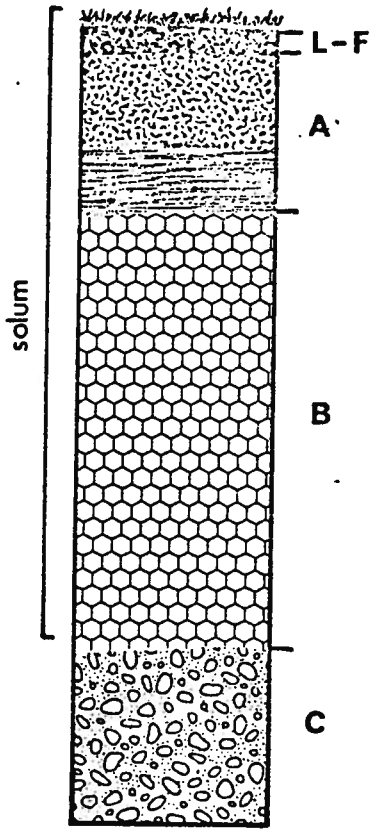
## THE SOILS

### Soil Formation

Soils are natural bodies present on the earth's surface that are an integral part of the environment. Soils display variation both vertically and horizontally and by examining these variations soil individuals may be recognized. Soils have evolved from their geological parent material through the action of a combination of

soil forming processes, which are controlled by environmental parameters or "soil forming factors". These soil forming factors are commonly listed as being the parent material, climate, biotic agents and topography all acting through time. The variations in relative importance or dominance of one or more of the soil forming processes such as addition and removal of organic matter, translocation of clays or iron and aluminum, and chemical and physical transformations result in the formation of horizons or layers of various kinds within the soil body. These horizons differ from one another in such properties as color, texture, structure, consistence, and chemical and biological activity. The major, or master horizons are designated O for organic layers developed mainly from mosses, rushes, and woody materials; L, F and H for organic layers developed mainly from leaves, twigs, woody materials, and a minor component of mosses; and A, B and C for mineral horizons. Subdivisions of the master horizons are denoted by suffix letters appended to the master horizon symbol (see Figure 1, Table13, and glossary).

FIGURE 1. DIAGRAM OF A SOIL PROFILE




-- Organic layer which may be subdivided into L, F, H or Of, Om, and Oh

--A mineral horizon at or near the surface. It may be a dark colored horizon in which there is an accumulation of humus (Ah), or a light colored horizon from which clay, iron, and humus have been leached (Ae).

--Mineral horizon that (1) may be altered to give a change in color or structure (Bm) or (2) may have an enrichment of clay (Bt) or (3) may have significant amounts of exchangeable Na and exhibit a columnar structure with pronounced stainings (Bn).

--Mineral horizon comparatively unaffected by the soil forming process operative in the A and B horizons except for the process of gleying (Cg). or the accumulation of carbonates and soluble salts (Cca, Csa, Ck, Cs, Csk).

Through observation of soil characteristics it is possible to classify soils into taxonomic units. In this report the System of Soil Classification for Canada (Canada Soil Survey Committee, 1973) is used (see Soil Unit Descriptions). The criteria used for making the taxonomic separations are significant for understanding soil genesis and for land use applications.

## Soil Mapping

When mapping soils the fieldman examines the soil at points in the landscape to characterize landscape units. Since soil is a continuum, and adjacent soils seldom have sharp boundaries, soil map units are defined as having a certain range of properties. These soil map units are based on geologic materials and landforms, soil development, and soil moisture conditions. The soil and land attributes recognized in mapping are important for various land uses.

The notations on the soil map consist of number and letters: for example

$$\frac{1 - 3}{de}$$

The first digit in the number represents a geologic landform or material (for example an alluvial fan or a glacial till); the second digit denotes soil profile development, moisture conditions, and sometimes textural differences; and the letter or letters denote the range of topographical classes. The topographical classes are those used by the Canada Soil Survey Committee, which are as follows:

| Simple topography Single slopes (regular surface) | | Slope % | Complex topography Multiple slopes (irregular surface) | |
|---|---|---|---|---|
| A | depressional to level | 0 to 0.5 | a | nearly level |
| B | very gently sloping | 0.5+ to 2 | b | gently undulating |
| C | gently sloping | 2+ to 5 | c | undulating |
| D | moderately sloping | 5+ to 9 | d | gently rolling |
| E | strongly sloping | 9+ to 15 | e | moderately rolling |
| F | steeply sloping | 15+ to 30 | f | strongly rolling |
| G | very steeply sloping | 30+ to 60 | g | hilly |
| H | extremely sloping | over 60 | h | very hilly |

The soils were mapped in the field by making observations at selected sites using available exposures or digging with a shovel, auger or pick. These point observations are extrapolated to an area basis through the use of aerial photograph interpretation and field checking. The principal soils were sampled to depths of 1.5 metres for chemical and engineering analyses.

## Soil Classification

The soils have been classified according to the System of Soil Classification for Canada (Canada Soil Survey Committee, 1973). This scheme classifies the soils in their natural state and thus indicates relationships between soils and their environment.

These relationships are often important for assessing limitations of soils for various uses. The classification system is described briefly in Table 12.

## Soil Texture

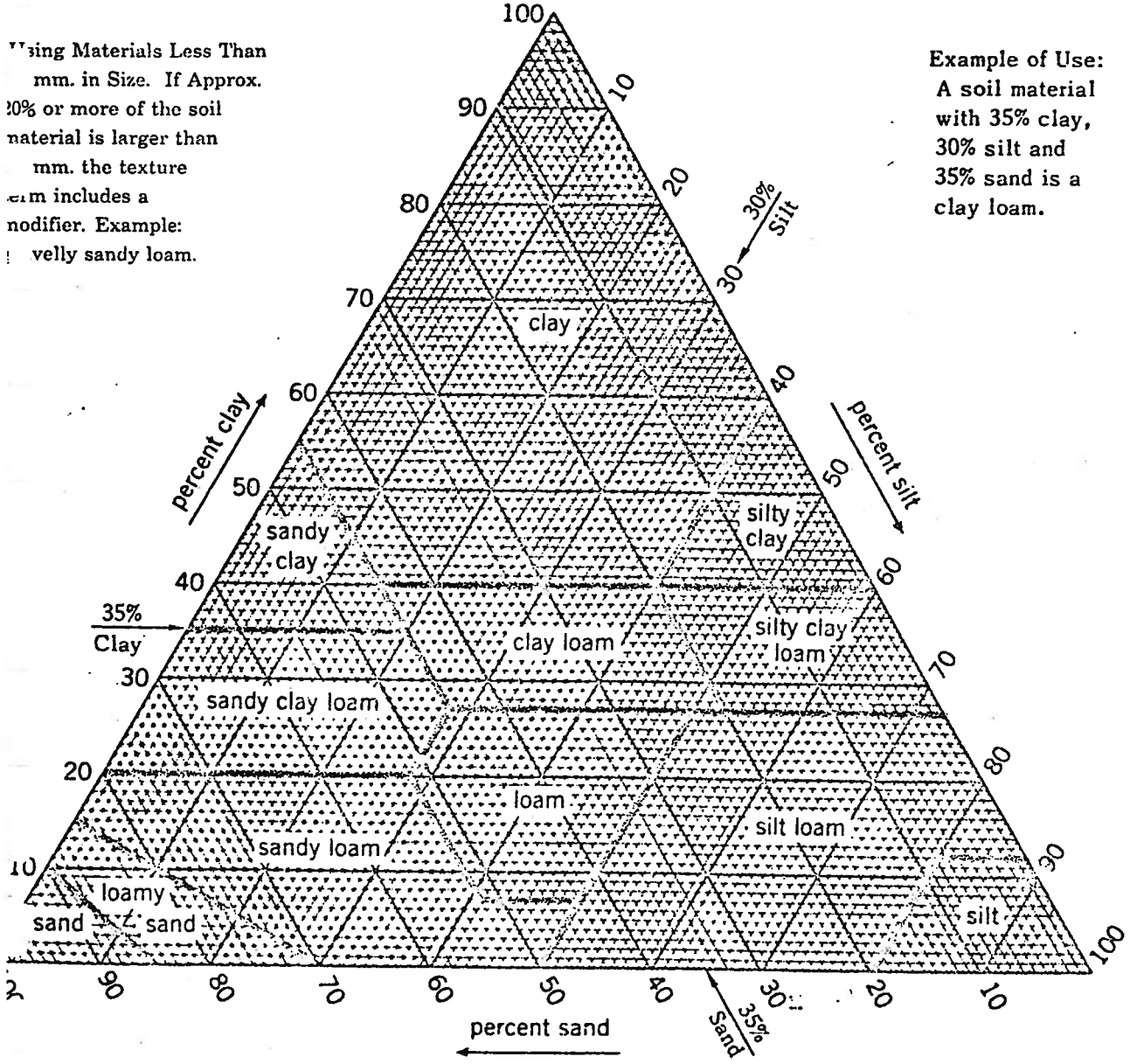
Throughout the report reference is made to soil texture and to soil drainage classes. Soil texture is according to the United States Department of Agriculture (USDA) textural classification which is described below. The soil drainage classes, according to the Canada Soil Survey Committee (1973) are outlined following the textural classification.

Soil Separates (Particle Size) on which Textural Classes are Based.

| Separates | Diameter in Millimeters |
|---|---|
| Very Coarse Sand (VCS) | 2.0 to 1.0 |
| Coarse Sand (CS) | 1.0 to 0.5 |
| Medium Sand (MS) Sand (S) | 0.5 to 0.25 |
| Fine Sand (FS) | 0.25 to 0.10 |
| Very Fine Sand (VFS) | 0.10 to 0.05 |
| Silt (Si) | 0.05 to 0.002 |
| Clay (C) | less than 0.002 |

FIGURE 2. GUIDE FOR USDA SOIL TEXTURAL CLASSIFICATION.

...sing Materials Less Than ... mm. in Size. If Approx. ...0% or more of the soil ...aterial is larger than ... mm. the texture ...m includes a ...odifier. Example: ... velly sandy loam.




Example of Use: A soil material with 35% clay, 30% silt and 35% sand is a clay loam.

The soil textural classes are grouped according to the Canada Soil Survey Committee as follows:

Very coarse textured: sands, loamy sands.
Moderately coarse textured: sandy loam, fine sandy loam.
Medium textured: very fine sandy loam, loam, silt loam, silt.
Moderately fine textured: sandy clay loam, clay loam, silty clay loam.
Fine texiured: sandy clay, silty clay, clay (40 - 60% clay).
Very fine textured: heavy clay (more than 60% clay).

The gravelly class names are added to the textural class names according to the following rule:

| % gravel by volume | |
|---|---|
| less than 20 | - use textural class only. |
| 20 - 50 | - gravelly and texture. |
| 50 - 90 | - very gravelly and texture . |
| more than 90 in surface 8 inches | - cobble land type |

## Soil Drainage Classes

Soil drainage classes are defined in terms of (a) actual moisture content in excess of field moisture capacity, and (b) the extent of the period during which such excess water is present in the plant root zone.

Rapidly drained - soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.

Well drained - soil moisture content does not normally exceed field capacity in any horizon except possibly the C, for a significant part of the year.

Moderately well drained - soil moisture in excess of field capacity remains for a small but 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 12 inches of the surface most of the year.

Specific reference to surface drainage may be designated in terms of run-off and described as high, medium, low or ponded. Similarly, specific reference to the characteristics of horizons within the profile may be designated in terms of permeability or percolation and described as rapid, moderate, slow, very slow, and none.

# SOIL AND LAND USE

## Engineering Use of Pedological Information

Both the report and the map contain information of use to engineers and land use planners. A pedological soil classification, which describes the soil in its natural setting, describes not only the soil material but also the effects of soil climate, drainage, permeability and topography. When planning the construction of roads, airports, residential and other developments which are based on the soil this information can be very useful in predicting performance. Highway engineers make use of soil maps in planning materials investigations and for predicting subgrade and pavement performance (Allemeier, 1973). A recent soil survey in the Mill Woods area of Edmonton indicated areas where concrete corrosion due to sulfate attack was a potential problem (Lindsay, et al, 1973).

Several terms, such as soil, texture, structure, and consistence differ in usage between pedology and engineering. The pedological meanings are intended in this report and many of the terms are defined in the glossary.

## Engineering Properties of the Soils

Engineering properties including particle size distribution, Atterberg limits, and the Unified and AASHO classification are reported for the major soils. These data are derived from laboratory testing of samples representative of the soil map unit. The philosophy of pedology is involved here in extrapolating from a site to an area. These data are not intended to be site specific and do not substitute for on-site inspection and soil testing but do provide a basis for area planning and further soil investigations.

## Soils and Urban Development

In selecting sites for housing, schools, parks, shopping centres, sewage disposal and other community developments, soil suitability must be considered so as to avoid costly errors and to prevent waste, abuse and loss of valuable agricultural soils.

The soils have been evaluated for limitations to roads, buildings, and sewage lagoons and as suitability as a source of gravel, roadfill and topsoil. The soils have also been assigned ARDA capability ratings for agriculture in order to evaluate the loss of agricultural production potential.

These evaluations consider such soil properties as texture - which affects stability and bearing strength for roads and foundations, shrink-swell, risk of frost heaving, and rate of infiltration and internal drainage; soil moisture conditions - which affect location of buildings, roads, services and sewage disposal; topography - which affects drainage and site location; and flooding hazard - which affects location of buildings, roads and sewage lagoons.

Soil interpretations are included so that soils information may be more easily understood. These interpretations should be treated as evaluations of performance of soils not as recommendations for the use of soils. Many other factors are involved in the recommended use of soils. Also, because soil boundaries are not precise, soil survey interpretations do not eliminate on-site investigations. They are, however, intended as an aid in planning further investigations, to reduce the amount of investigation and minimize the cost.

For each use, the soils are rated in terms of degree of limitation - slight, moderate or severe, or in terms of suitability as a source of material - good, fair or poor.

A slight soil limitation is the rating given soils that have properties favourable for the use. Good performance and low maintenance can be expected.

A moderate soil limitation is the rating given soils that have properties moderately favourable for the use. This limitation can be overcome or modified by planning, design or maintenance.

A severe soil limitation is the rating given soils that have one or more properties that are seriously unfavourable for the use. This limitation generally requires major soil reclamation, special design or intensive maintenance. In most situations, it is difficult and costly to alter the soil or to design a structure so as to compensate for the severe degree of limitation but using these soils without employing corrective measures could result in failure.

TABLE 1. GUIDES FOR ASSESSING SOIL LIMITATIONS FOR ROAD LOCATION

Properties that affect design and construction of roads are (1) those that affect the load supporting capacity and stability of the subgrade; and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification, and the shrink-swell potential give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth of bedrock, 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 onsite investigations.

| Item Affecting Use | Degree of Soil Limitation | | |
|---|---|---|---|
| | NONE TO SLIGHT | MODERATE | SEVERE |
| Soil drainage class[1] | Rapidly[1], well and moderately well drained. | Imperfectly drained | Poorly and very poorly drained. |
| Flooding | None | Once in 5 years | More than once in 5 yrs. |
| Slope | 0 to 9% (AD). | 9 to 15% (E). | More than 15% (> E). |
| Depth to Bedrock | More than 40 inches | 20 to 40 inches. | Less than 20 inches. |
| Subgrade[2] | | | |
| a. AASHO Group index[3] | 0 to 4. | 5 to 8. | more than 8 |
| b. Unified soil classes | GW, GP, SW, GM, SM, and GC[4] and SC[4]. | CL (with PI[5] less than 15), ML, SP. | CL (with PI[5] 15 or more), CH, MH, OH, OL, Pt. |
| Shrink-swell 6 potential | Low (PI[5] less than 15). | Moderate (PI[5] 10 to 15). | High (PI[5] greater than 20). |
| Susceptibility to frost heave[7] | Low (F1, F2). | Moderate (F3) . | High (F4) (silty & peaty soils). |
| Stoniness | Stones greater than 5' apart. | Stones 2 to 5' apart. | Stones less than 2' apart. |
| Consolidated Bedrock exposures | Rock exposures greater than 300' apart and cover less than 2% of the surface | Rock exposures 300 to 100' apart and cover 2 to 10% of the surface. | Rock exposures less than 100' apart and cover greater than 10% surface. |

1. For an explanation of soil drainage classes see page 7.
2. This item estimates the strength of a soil as it applies to roadbeds. When available, AASHO Group Index values from laboratory tests were used; otherwise the estimated Unified classes were used. On unsurfaced roads, rapidly drained, very sandy poorly graded soils may cause washboard or rough roads.
3. Group Index values were estimated from information published by the Portland Cement Assn. 1962. pp 23-25.
4. Downgrade to moderate if content of fines (less than 200 mesh) is greater than about 30%.
5. PI means plasticity index.
6. Inherent swelling capacity is estimated as low when the plasticity index is less than 15, medium when the plasticity index is 10 to 15 and high when the plasticity index is greater than 20 (Terzaghi and Peck, 1967). Gravelly and stony soils may not exhibit shrink-swell as estimated by the plasticity index because of dilution of the fines with coarse fragments. In these situations decrease a severe limitation to moderate and a moderate limitation to slight.
7. Frost heave is important where frost penetrates below the hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front. The susceptibility classes are taken from the United States Army Corps of Engineers (1962), pp.5 - 8.

TABLE 2. GUIDES FOR ASSESSING SOIL LIMITATIONS FOR PERMANENT BUILDINGS[1]

This guide provides ratings for undisturbed soils evaluated for single storey buildings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundations; but soil slope, and susceptibility to flooding and other hydrologic conditions, such as seasonal wetness, that have effects beyond those related exclusively to foundations are considered. Also considered are soil properties, particularly depth to bedrock, which influence excavation and construction costs, both for the building itself and for the installation of utility lines. Excluded are limitations for soil corrosivity, landscaping and septic tank absorption fields. On site investigations are needed for specific placement of buildings and utility lines, and for detailed design of foundations. All ratings are for undisturbed soils based on information gained from observations to a depth of 4 to 6 feet.

| Item Affecting Use | Degree of Limitation SLIGHT | MODERATE | SEVERE[2] |
|---|---|---|---|
| Wetness[3] | With basements: Rapidly drained and well drained. Without basements: Rapidly, well and moderately well drained. | With basements: Moderately well drained. Without basements: Imperfectly drained. | With basements: Imperfectly, poorly & very poorly drained. Without basements: Poorly & very poorly drained. |
| Depth to seasonal water table (seasonal means 1 month or more) | With basements: Below 60 inches Without basements: Below 30 inches | With basements: Below 30 inches Without basements: Below 30 inches | With basements: Above 30 inches Without basements: Above 20 inches |
| Flooding | None | None | Subject to flooding |
| Slope[4] | 0 to 9% (AD). | 9 to 15% (E). | More than 15% ( > E). |
| Shrink-swell Potential | Low | Moderate | High |
| Unified soil group[5] | GW,GP,SW,SP,GM, GC,SM,SC | ML, CL. | CH,MH,OL,OH,Pt. |
| Potential frost action[6] | Low (F1, F2). | Moderate (F3). | High (F4). |
| Stoniness | Stones greater than 25' apart | Stones 5 to 25' apart | Stones less than 5' apart. |
| Potential Concrete Corrosion | 0.00 to 0.10% sulphate | 0.10 - 0.50% sulphate | greater than 0.50% sulphate |
| Depth to Bedrock | With basements: More than 60 inches. Without basements: More than 40 inches. | With basements: 40 to 60 inches. Without basements: 20 to 40 inches. | With basements: Less than 40 inches. Without basements: Less than 20 inches. |

1. By reducing the slope limits by $\frac{1}{2}$, this table can be used for evaluating soil limitations for buildings with large floor areas but with foundation requirements not exceeding those of ordinary 3-storey dwellings.
2. Some soils rated as having moderate or severe limitations may be good sites from an aesthetic or use standpoint but require more preparation or maintenance.
3. For an explanation of soil drainage classes see page 7.
4. Reduce slope limits by $\frac{1}{2}$ for those soils subject to hillside slippage.
5. This item estimates the strength of the soil, that is its ability to withstand applied loads.
6. The potential frost action classes are taken from the United States Army Corps of Engineers (1962), pp. 5-8.

TABLE 3. GUIDES FOR ASSESSING SOIL LIMITATIONS FOR SEWAGE LAGOONS.

A sewage lagoon (aerobic) is a shallow lake used to hold sewage for the time required for bacterial decomposition. Soils have two functions, (1) as an impounding vessel and (2) as material for the impounding embankment. When the lagoon is properly constructed it must be capable of holding water with minimum seepage.

| Item Affecting Use | Degree of Soil Limitation | | |
|---|---|---|---|
| | SLIGHT | MODERATE | SEVERE |
| Depth to water table[1] (seasonal or year round) | more than 60 in. | 40 - 60 in. | less than 40 in. |
| Flooding[2] | none | none | soils subject to flooding |
| Depth to Consolidated Bedrock | more than 60 in. | 40 - 60 in. | less than 40 in. |
| Slope | less than 2% | 2 - 9% | more than 9% |
| Organic Matter | less than 2% | 2 - 15% | more than 15% |
| Unified Soil Group[3] | GC,SC,CL,CH | GM,ML,SM,MH | GP,GW,SW,SP, OL,OH,Pt. |

1. If the floor of the lagoon is nearly impermeable material at least 2 feet thick, disregard depth to watertable.

2. Disregard flooding if it is not likely to enter or damage the lagoon (low velocity and depth less than five feet).

3. Rated mainly for the floor of the lagoon.

TABLE 4. GUIDES FOR ASSESSING SOIL LIMITATIONS FOR CAMP AREAS.

This guide applies to soils to be used intensively for trailers and tents 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 and for limited vehicular traffic[1]. Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

| Item Affecting Use | Degree of Soil Limitation NONE TO SLIGHT | MODERATE | SEVERE |
|---|---|---|---|
| Wetness | Rapidly, well and moderately well drained soils. Water table below 30" during season of use. | Moderately well and imperfectly drained soils. Water table below 20" during season of use. | Imperfectly, poorly, and very poorly drained soils. Water table above 20" during season of use. |
| Flooding | None. | None during season of use. | Floods during season of use. |
| Permeability | Very rapid to moderate. | Moderately slow and slow. | Very slow. |
| Slope | 0 to 9% (AD). | 9 to 15% (E). | Greater than 15% (greater than E). |
| Surface soil texture[2] | SL, FSL, VFSL, L. | SiL, CL, SCL, SiCL, LS and sand other than loose sand. | SC, SiC, C, loose sand subject to severe blowing, organic soils. |
| Coarse fragments on surface[3] | 0 to 20%. | 20 to 50%.[4] | Greater than 50%. |
| Stoniness[5] (stony) | Stones greater than 25' apart. | Stones 25 to 5' apart. | Stones less than 5' apart. |
| Rockiness[5] (rock) | no rock exposures. | Rock exposures greater than 30' apart and cover less than 25% of the area. | Rock exposures less than 30' apart & cover greater than 25% of the surface. |

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

2. Surface soil texture influences soil ratings as it affects foot trafficability, dust, soil permeability and erosion hazard.

3. Coarse fragments include both gravels and cobbles.

4. Some gravelly soils may be rated as slight 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 3/4 inch in size. See the definition for gravels in the System of Soil Classification for Canada (C.S.S.C., 1970), pp 213-214.

5. Very shallow soils are rated as having a severe soil limitation for rockiness and/or stoniness. See also definitions of rockiness and stoniness in the System of Soil Classification for Canada (C.S.S.C., 1970), pp 213-214.

TABLE 5. 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 access roads.[1] Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, 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 |
| Wetness | Rapidly, well and moderately well drained soils. Water table below 20" during season of use. | Moderately well and imperfectly drained soils. Water table during season of use may be less than 20" for short periods. | Poorly and very poorly drained soils. Water table above 20" and often near the surface for a month or more during season of use. |
| Flooding | None during season of use. | May flood once a year for short period during season of use. | Floods more than once a year during season of use. |
| Slope | 0 to 9% (AD). | 9 to 15% (E). | Greater than 15% (greater than E). |
| Surface soil texture[2] | SL, FSL, VFSL, L. | SiL, CL, SCL, SiCL, LS, and sand other than loose sand. | SC, SiC, C, loose sand subject to severe blowing, organic soils. |
| Coarse fragments on surface[3] | 0 to 20%. | 20 to 50% [4]. | More than 50% |
| Stoniness[3] | Stones greater than 5' apart. | Stones 2 to 5' apart. | Stones less than 2' apart. |
| Rockiness[3] | Rock exposures roughly 100 to 300 or more feet apart and cover less than 10% of the surface. | Rock exposures 30 to 100' apart and cover about 10 to 25% of the surface. | Rock exposures less than 30' apart and cover greater than 25% of the surface. |

1. For information specific to roads or parking lots see Table 1.

2. Surface soil texture influences soil ratings as it affects foot trafficability, dust, soil permeability and erosion hazard.

3. See also definitions for gravel, rockiness and stoniness in the System of Soil Classification for Canada (C.S.S.C., 1970), pp. 213-214. Coarse fragments include both gravels and cobbles.

4. Some gravelly soils may be rated as slight 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

TABLE 6. GUIDES FOR ASSESSING SOIL LIMITATIONS FOR PLAYING FIELDS.

This guide applies to soils considered for intensive use as playing fields for organized games such as baseball or football. Soil suitability for growing and maintaining vegetation is not a direct consideration in this guide, but is an important item to consider.

| Item Affecting Use | Degree of Soil Limitation | | |
|---|---|---|---|
| | SLIGHT | MODERATE | SEVERE |
| Flooding | none during season of use | subject to occasional flooding. Not more than once in 3 years. | subject to more than occasional flooding. |
| Wetness | rapidly to moderately well drained. | imperfectly drained soils subject to occasional ponding. | poorly and very poorly drained. |
| Depth to Water table | more than 30 inches during season of use. | 20 to 30 inches during season of use. | less than 20 inches during season of use. |
| Permeability | very rapid to moderate (20 in./hr to 0.6 in./hr.) | moderately slow (0.6 - 0.2 in./hr) | slow and very slow. (less than 0.2 in/hr) |
| Slope | 0 - 2% | 2 - 5% | more than 5% |
| Surface Texture | SL, FSL, VFSL, L | CL, SCL, SiCL, SiL, LS and S other than loose sand. | SC, SiC, C, loose sand, organic |
| Depth to Bedrock | more than 40 inches | 20 to 40 inches | less than 20 inches |
| Surface Stoniness | slightly stony | moderately stony | very to excessively stony. |

TABLE 7. SUITABILITY RATINGS OF SOILS AS SOURCES OF GRAVEL

The main purpose of these ratings is to indicate local sources of gravel. The ratings are based on the probability that soils contain sizable quantities of gravel.

| Item Affecting Use | Degree of Soil Suitability | | |
|---|---|---|---|
| | GOOD | FAIR | POOR |
| Unified Soil Group | GW, GP | GP-GM GW-GM | GM, GP-GC, GW-GC (all other groups unsuited) |
| Flooding | none or occasional | | frequent or constant |
| Wetness | better than poorly drained [1] | | poorly and very poorly drained |
| Depth of overburden | less than 2 feet | 2 to 5 feet | more than 5 feet |

1. See page 7 for an explanation of drainage classes.

TABLE 8. SUITABILITY RATINGS OF SOILS AS SOURCES OF ROADFILL

The ratings in this table indicate the performance of a soil after it is placed in a road embankment and also the degree of difficulty in excavating the fill material. Ratings of the material are the same as for road location (Table 3) however ratings of factors governing excavation differ.

| Item Affecting Use | Degree of Soil Suitability [1] | | |
|---|---|---|---|
| | GOOD | FAIR | POOR |
| Wetness | Rapidly to moderately well drained [2] | Imperfectly drained | Poorly and very poorly drained |
| Engineering Groups Unified Group | GW, GP, GC, SW, SP, SM, SC | ML, CL with P.I. [3] less than 15 | CH, MH, OL, OH, Pt, and CL with P.I. more than 15 |
| AASHO Group Index | 0 - 4 | 5 - 8 | greater than 8 |
| Stoniness | none to moderately stony | very stony | exceedingly stony |
| Depth to consolidated bedrock | more than 6 feet | 3 to 6 feet | less than 3 feet |
| Slope | 0 - 15% | 15 - 30% | more than 30% |

1. A rating of unsuited (u) is applied to land units, such as bedrock (R), where no conventional fill material is present.

2. See page 7 for an explanation of drainage classes.

3. P.I. means plasticity index.

## TABLE 9. SUITABILITY RATINGS OF SOILS AS SOURCES OF TOPSOIL

Topsoil, for these ratings, refers essentially to Ah horizon material. In some cases the B, and even C horizon materials could be used for dressing disturbed land. These ratings are intended for use by engineers, landscapers, planners and others who make decisions about selecting, stockpiling and using topsoil. These ratings are based on quality of topsoil and ease of excavation. In addition to the Good, Fair, and Poor ratings described below, an Unsuited (U) rating is used.

| Item Affecting Use | Degree of Suitability[1] | | |
|---|---|---|---|
| | GOOD | FAIR | POOR |
| Texture | SL, FSL, VFSL, L, SiL | CL, SCL, SiCL | LS, S, SC, SiC, C, Organic |
| Depth of topsoil | more than 6 in. | 3 - 6 in. | less than 3 in. |
| Flooding | none | may flood occasionally | frequently or constantly flooded |
| Wetness | Drainage class not determining if better than poorly drained | | Poorly and very poorly drained |
| Coarse fragments % by volume | less than 3% | 3 - 15% | more than 15% |
| Slope | less than 9% | 9 - 15% | more than 15% |
| Stoniness | none to slightly stony | moderately stony | very to excessively stony |
| Salinity of topsoil | E.C.[2] 0 - 1[3] | E.C. 1 - 3 | E.C. more than 3 |
| Permeability of upper subsoil | moderate | slow | very slow |

1. A rating of unsuited (U) is used for soil and land units that do not have topsoil present.
2. E.C. = electrical conductivity of a saturation extract in mmhos/cm.
3. These are the limits suggested by the Alberta Soil and Feed Testing Laboratory when considering lawn growth.

The decision as to whether or not a soil will be utilized for a specific use, regardless of the soil limitation, is beyond the scope of this report.

Agricultural Capability

The soils have been rated as to their suitability as agricultural cropland. This information is required to make sound decisions on land use where soils are being lost to agricultural production.

The ratings are made using the ARDA Canada Land Inventory, Soil Capability Classification for Agriculture. These classes and subclasses are defined in the Soil Capability Classification for Agriculture. (Canada Land Inventory, 1965).

Briefly the 7 classes are:

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

Class 2 - Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices.

Class 3 - Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices.

Class 4 - Soils in this class have severe limitations that restrict the range of crops.

Class 5 - Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible.

Class 6 - Soils in this class are capable of only producing perennial forage crops and improvement practices are not feasible.

Class 7 - Soils in this class have no capability for arable culture or permanent pasture .

The subclasses are as follows:

D - the depth of the rooting zone is restricted by soil conditions other than wetness or consolidated bedrock.
F - low fertility.
I - inundation by streams or lakes.
M - low moisture-holding capacity.
N - presence of enough soluble salts to adversely affect crop growth or restrict the range of crops that can be grown.
P - stoniness.
S - used in a collective sense for one or more subclasses.
T - adverse topography.
W - excess water other than from flooding.

# SECTION II

## LOCATION AND EXTENT OF AREA

The Canmore Corridor is situated west of the city of Calgary along Trans-Canada Highway #1 and Highway #1A. It is bounded on the east and northeast by the Kananaskis River and the Stony Indian Reserve and on the west by Banff National Park. It extends from the valley bottom of the Bow River to approximately 2000 metres elevation. The area consists of approximately 22,000 hectares (55,000 acres).

## PHYSIOGRAPHY OF AREA

The major landforms in the mapped area are fluvial fans and floodplains; glaciofluvial slopes, ridges and plains; inclined and ridged morainal and morainal veneer slopes; glaciolacustrine plains; eolian veneer; mountains; colluvial slopes; and bogs.

The area is situated in the eastern watershed of the Canadian Rocky Mountains section of the North American Cordilleran physiographic province. The Bow Valley is a broad U-shaped valley in the Front Ranges of the Rocky Mountains. Elevation of the valley bottom ranges from 1300 to 1400 metres and the mountains on either side of the valley approach 2700 metres.

The mountain ridges are formed of resistant Mississippian and Devonian-aged limestones and dolomites while the valleys are floored by less resistant Mesozoic shales, siltstones and sandstones. Thrusting is from the southwest and beds dip as much as $45^{\circ}$, with several hundred meters vertical displacement. Bedrock geology in the area has been described by Price (1971).

Surficial geology of the area was described and mapped by Rutter (1972). Surficial deposits consist of recent fluvial fan and floodplain materials; glaciofluvial gravels; till; glaciolacustrine sediments; eolian and undifferentiated deposits. Rutter cites evidence for two and possibly three major Wisconsin ice advances in this section of the Bow Valley. Patches of till from the latest (Canmore) advance overlie outwash

deposits associated with an earlier (Bow Valley) advance. Both tills contain an average of 40 percent gravel and cobble fragments which are predominantly dolomites and limestones. The finer fraction of these tills is an extremely calcareous loamy textured material.

The fluvial fan and floodplain deposits are poorly sorted gravels which may or may not be overlain by sandy or silty materials from 30 to 120 cm in thickness. The glaciofluvial gravels are unconsolidated and well sorted deposits over 30 metres thick. Medium textured till-like materials often overlie these gravels. These fluvial and glaciofluvial materials are also extremely calcareous.

Silty textured calcareous loess overlies much of the glaciofluvial gravels in the Bow Valley Provincial Park to depths varying from 15 to 90 centimetres. Moderately fine textured calcareous glaciolacustrine sediments occur as small pockets in the northeast portion of the area to depths varying from 30 to 120 centimetres.

Undifferentiated till-like deposits characterized by a high proportion of local bedrock occur on the south side of the river between Canmore and Pigeon Creek.

## VEGETATION

Vegetation patterns in the area are strongly influenced by climate, aspect and soils. A Douglas fir (Pseudotsuga menziesii) - lodgepole pine (Pinus contorta var. latifolia) association occupies the well drained glaciofluvial terraces along the southwest facing valley aspect north of Canmore while white spruce (Picea glauca) and lodgepole pine stands cover the northeast facing aspect. Trembling aspen (Populus tremuloides) occurs on fluvial fans and on medium to moderately fine textured eolian and glaciolacustrine deposits in the eastern portion of the area. The gravelly areas in the eastern portion have lodgepole pine and open grassland vegetation.

The Bow River floodplain consists of white spruce, dwarf birch (Betula glandulosa), lodgepole pine, white birch (Betula papyrifera), willow (Salix spp.) and river alder (Alnus tenuifolia). Horsetail (Equisetum spp.), mosses (various species, slough grass (Beckmannia syzigachne), and sedges (Carex, spp.) are found

in the poorly drained areas.

Information on shrubs and more detailed descriptions of the vegetation are available elsewhere and thus are not dealt with extensively in this report.

## THE SOILS

Soil development in the area reflects the influence of parent materials, climate, drainage aspect and vegetation.

Luvisolic soils have developed on medium to moderately fine textured fluvial floodplain deposits, moderately coarse textured till and fine textured undifferentiated deposits on the northeast facing valley aspect where the climate is cool and moist and there is sufficient forest leaf litter to contribute to the formation of an Ae and Bt horizon.

Regosolic soils with little or no profile development occur on recent fluvial fans and floodplains that are underlain by gravel and have a seasonal high water table. They also occur on steep slopes where erosion inhibits the development of soil horizons or on terraced gravelly materials that are high in carbonates and have a warm, dry climate and sparse tree cover.

Brunisolic soils with intermediate development between the Luvisolic and Regosolic soils are developed in areas where there is tree cover but the climate is too warm and dry for the development of a pronounced Ae and Bt horizon. There is, however a Bm horizon with either a very thin Ae horizon or no sharp demarcation between the A and B horizons. These soils are developed on the southwest facing valley aspect and also on medium to moderately fine textured glaciolacustrine and eolian deposits in the eastern portion of the area.

Gleysolic soils are found in the northwest corner of the area on fluvial fan characterized by groundwater discharge. These soils have highly gleyed and mottled Ckg horizons and from 15 to 30 centimeters of peat on the surface.

Organic soils occur in minor amounts throughout the area where there is a permanent high water table and very poor drainage.

## SOIL ASSOCIATION AND SOIL COMPLEX DESCRIPTIONS

1. Soils developed on fluvial fan deposits.

These soils vary in drainage from poorly to rapidly drained and may or may not have finer textured deposits overlying poorly sorted, extremely calcareous gravels with beds and lenses of sand and silt.

Soil Unit

1 - 1 Well drained Cumulic and Orthic Regosols developed on more than 30 centimeters of calcareous silt loam to loam material overlying calcareous gravels. Ahk horizons are from 10 to 20 centimetres thick.

1 - 2 Rapidly drained Cumulic Regosols developed on calcareous gravels. Ahk horizons are relatively thin. Buried organo-mineral horizons are common.

1 - 3 A complex of well to rapidly drained Cumulic and Orthic Regosols that may or may not have a sandy loam overlay from 0 to 50 centimetres thick. Ahk horizons are from 5 to 10 centimetres thick.

1 - 4 Well drained Orthic Gray Luvisols and Degraded Eutric Brunisols developed on more than 50 centimetres of medium to moderately fine textured, stone-free, calcareous material.

Profile Description of an Orthic Gray Luvisol: 15 cm L-H, semidecomposed leaf litter; 8 cm Ae light gray silt loam, friable; 20 cm Bt brownish yellow silty clay loam, friable; Ck grayish brown silty clay loam, layered, stone-free, extremely calcareous.

Soil Unit

1 - 5 Poorly drained peaty Rego Gleysols and Rego Gleysols developed on more than 50 centimetres of medium to moderately fine textured calcareous material. These soils occur in an area of groundwater discharge in the northwest corner of the area. They are characterized by a peaty surface horizon and a highly mottled and gleyed Ckg horizon.

2. Soils developed on fluvial floodplain deposits.

These soils vary in drainage from poorly to rapidly drained and may or may not have sandy loam textured deposits overlying poorly sorted calcareous gravels.

Soil Unit

2 - 1 Well drained Orthic Gray Luvisols and Degraded Eutric Brunisols developed on sandy loam fluvial deposits overlying calcareous gravels.
Profile Description of an Orthic Gray Luvisol: 15 cm L-H, semidecomposed leaf litter; 8 cm Ae, light gray fine sandy loam, friable; 20 cm Bt, yellowish brown sandy loam, friable; 50 cm Ck, grayish brown sandy loam; IICk very gravelly loamy sand and gravel.

2 - 2 Rapidly drained Cumulic Regosols developed on calcareous gravel and very gravelly loamy sand.

2 - 3 A complex of well to rapidly drained Cumulic and Orthic Regosols developed on sandy loam to gravelly fluvial deposits.

2 - 4 A complex of poorly to rapidly drained Cumulic and Orthic Regosols and Rego Gleysols developed on sandy loam and gravelly fluvial deposits. The depth to the water table in this area is highly variable.

2 - 5 Imperfectly drained Gleyed Cumulic Regosols developed on sandy loam to gravelly fluvial deposits.

3. Soils developed on outwash deposits occurring on terraced, ridged and hummocky glaciofluvial landforms.

The gravel that is found on the ridged glaciofluvial landforms north of Canmore, between the highway and the steep sloping rockland, is highly stratified in comparison to that occurring on the fluvial fans and floodplains, and the hummocky glaciofluvial landforms in the eastern portion of the area.

Soil Unit

3 - 1 Well to rapidly drained Degraded and Orthic Eutric Brunisols and Orthic Regosols developed on variable depths of sandy to silty textured till-like materials overlying calcareous gravels and very gravelly loamy sands.
Profile Description of a Degraded Eutric Brunisol: 8 cm L-H, semi-decomposed grass litter and pine needles; 3 cm Ae light gray loam; 15 cm Bm yellowish brown gravelly silt loam; 10 cm Cca gray brown gravelly silt loam; IICk gravelly loamy coarse sand and gravel, extremely calcareous.

3 - 2 Rapidly drained Orthic Regosols developed on gravels on steep slopes or on terraced glaciofluvial landforms with little or very sparse tree growth.

4. Soils developed on gravelly moderately coarse textured till.

Soil Unit

4 - 1 Well drained Orthic Gray Luvisols and Degraded Eutric Brunisols on the northeast facing valley aspect northwest of Canmore and south of Bow Valley Provincial Park.
Profile Description of an Orthic Gray Luvisol: 15 cm L-H semidecomposed leaf litter; 8 cm Ae light gray fine sandy loam; 20 cm Bt yellowish brown sandy loam, friable; Ck grayish brown gravelly sandy loam, extremely calcareous.

Soil Unit

4 - 2 Rapidly drained Orthic Regosols on steeply sloping eroded areas.

4 - 3 Well drained Degraded and Orthic Eutric Brunisols on the southwest facing valley aspect.

Profile Description of a Degraded Eutric Brunisol: 3 cm L-H semidecomposed leaf litter; 5 cm Ae light gray fine sandy loam; 15 cm Bm brown gravelly sandy loam, friable; Ck grayish brown gravelly sandy loam.

5. Soils developed on moderately fine textured glaciolacustrine deposits.

These Brunisolic soils occur in the northeast portion of the area on level to undulating topography under aspen poplar vegetation in contrast to neighbouring gravelly Regosolic soils with no tree cover.

Soil Unit

5 - 1 Moderately well drained Orthic Eutric Brunisols with well developed Bm horizons developed on grayish brown silty clay loam stratified material.

6. Soils developed on medium to coarse textured eolian deposits.

These soils occur in Bow Valley Provincial Park on level to ridged landforms.

Soil Unit

6 - 1 Well drained Orthic Eutric Brunisols developed on medium textured loess deposits that vary in depth from 30 to 80 cm overlying gravel. Such soils occur in a complex with soils of the 3-2 and 3-1 associations in small areas of aspen poplar vegetation. These areas contrast to the sparse lodgepole pine and open grassland vegetation on the gravel deposits. Ah horizons often occur and range from 5 to 10 cm in thickness.

6 - 2 Rapidly drained Orthic and Degraded Eutric Brunisols on deep, coarse textured eolian deposits. A small area of these soils occurs in the northwest portion of Bow Valley Provincial Park.

7. Soils developed on undifferentiated deposits.

Soil Unit

7 - 1 Rapidly drained Lithic Orthic Regosols developed on thin till-like material overlying limestone bedrock with numerous outcrops.

7 - 2 Moderately well drained Orthic Gray Luvisols and Degraded Eutric Brunisols developed on thin till-like material over unconsolidated shale bedrock with numerous outcrops. This material closely resembles unconsolidated shale bedrock except for the presence of quartzites in the top 80 cm of the profile.

Profile Description of an Orthic Gray Luvisol: 8 cm L-H semidecomposed leaf litter; 6 cm Ae brown silty clay loam; 20 cm Bt dark yellowish brown clay, firm when moist; Ck very dark grayish brown clay shale with numerous hard shale fragments and quartzite pebbles, moderately calcareous.

8. Soils developed on colluvial deposits that consist principally of rock debris.

Soil Unit

8 - 1 Rapidly drained Orthic Regosols.

9. Rockland - a miscellaneous land type with no soil development on steep mountain slopes.

Soil Unit

9 - 1 Refers to the Rockland.

10. Soils developed on organic material.

Soil Unit

10 - 1 Mesic Fibrisols and Fibric Mesisols developed on undecomposed and semi-decomposed peat material. These areas usually have free water near the surface throughout the summer months.

## SOIL INTERPRETATIONS

Soil interpretations are predictions of soil performance under different uses, not recommendations for land use. They do not eliminate the need for land use planning; rather they are valuable tools that can be used to assist the planner. Through their use, the planner can predict the type and degree of problem likely to be encountered, and plan the kind and amount of on-site investigations needed to determine corrective measures. However, the actual number of on-site investigations can be reduced considerably by the use of a detailed soil survey map.

Ratings of soil performance for certain selected uses are shown in Table 11 . These interpretations are made using the guidelines defined in Tables 1-9.

The soils on the floodplain of the Bow River generally have severe limitations for most uses due to a high flooding hazard and high water table. Steep slopes and coarse texture limit the uses of the soils on many of the other landforms. The most suitable soils for community development are found on the glaciolacustrine, and eolian landforms and medium textured fluvial fans.

Soils developed on gravelly deposits have severe limitations for most uses due to their droughtiness, gravelly surface or possible groundwater contamination hazard. Soil stability is a severe limitation on the shaley undifferentiated deposits south of Deadman's Flat.

Soil capability for agriculture is limited at best to Class 5, which is suitable for use as improved pasture. The agro-climatic classification of the area is 5H (Bowser, 1967) which means that the best soil capability possible for the area is Class 5. These soils are of limited extent and are those that occur on level to undulating lacustrine, till, medium textured eolian landforms and on medium textured fluvial fans. Limitations due to stoniness, poor drainage, droughtiness and steep slopes restrict the remainder of the soils to Class 6 and 7 as indicated in Table 11.

### Limiting Soil Properties and Hazards

1. Poor soil drainage
2. High flooding hazard
3. Steep slopes

## Limiting Soil Properties and Hazards (cont.)

4. Shallow depth to bedrock
5. Undesirable subsoil texture
6. Undesirable surface soil texture
7. High shrink-swell potential
8. High susceptibility to frost heave
9. Excessive surface stoniness
10. Excessive gravel on surface
11. Excessive consolidated bedrock exposures
12. High in organic matter
13. High groundwater contamination hazard
14. Deep overburden
15. Low soil stability
16. Thin topsoil

## Limitations for Road Location and Permanent Buildings with Basements

1. Shallow depth to a seasonal or permanent high watertable (poor soil drainage) affects the susceptibility to frost heave, shrink-swell potential and the cost of construction and maintenance.

2. Undesirable subsoil texture affects the bearing capacity, shrink-swell potential, susceptibility to frost heave and the cost of construction and maintenance.

3. Steep slopes and high flooding hazard affect the cost of construction and maintenance.

## Limitations for Sewage Lagoons

1. Undesirable subsoil texture affects the groundwater contamination hazard and the cost of construction if material must be transported from another site.

2. Shallow depth to a seasonal or permanent high watertable (poor soil drainage), steep slopes and high flooding hazard affect the cost of construction and maintenance.

## Limitations for Sewage Lagoons (cont.)

3. Poor soil drainage also results in a high percentage of organic matter which causes the growth of aquatic plants that are detrimental to the proper functioning of the lagoon.

## Limitations for Camp Areas, Lawns, Picnic Areas and Playing Fields

1. Shallow depth to a seasonal or permanent high watertable (poor soil drainage) and thin topsoil affect the soil's ability to sustain foot or vehicular traffic and makes a poor vegetative rooting medium for grasses.

2. Undesirable subsoil texture affects the ability to sustain foot or vehicular traffic and erosion potential.

3. High flooding hazard, excessive surface stoniness, excessive gravel on surface and shallow depth to bedrock affect the cost of construction.

## Suitability as a Source of Gravel

1. Undesirable subsoil texture with regard to the amount of boulders and cobbles affects the quality of the gravel.

2. High flooding hazard and deep overburden affect the cost of excavation.

## Suitability as a Source of Roadfill

1. Shallow depth to a seasonal or permanent high watertable (poor soil drainage), steep slopes and shallow depth to consolidated bedrock affect the cost of excavation.

2. Undesirable soil texture affects the bearing capacity.

## Suitability as a Source of Topsoil

1. Shallow depth to a seasonal or permanent watertable (poor drainage), and high flooding hazard, affect the cost of removal in the borrow area.

2. Thin topsoil and steep slopes affect the cost of removal and the erosion potential in the borrow area.

3. Undesirable soil texture, excessive surface stoniness and excessive gravel on the surface affect the quality of the topsoil.

# APPENDIX

## Engineering Properties of the Soils

Engineering test data determined on representative soil samples are presented in Table 10. The samples analyzed were taken from subsoils of the soil units at representative sites. Depth of sampling generally ranged between 0.75 and 1.25 meters below the surface. A brief description of the significance of each engineering parameter follows:

### 1. Atterberg Limits

In soil mechanics, plasticity is defined as that property of a material which allows it to be deformed rapidly, without rupture, without rebound, and without volume change (Means and Parcher. 1964).

Tests have been devised to determine the moisture content of a soil at which it changes from one major physical condition to another (PCA Soil Primer, 1962). These tests conducted on the material passing the no. 40 sieve (0.42 mm) have been used as key factors in classifying soils for structural purposes.

The tests used for estimating plasticity are plastic limit, liquid limit, and plasticity index. The plastic limit is the moisture content at which the soil passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the soil passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid and plastic limits. These three are known as Atterberg limits.

The plasticity index gives the range in moisture content at which a soil is in a plastic condition. A small plasticity index, such as 5, indicates that a small change in moisture content will change the soil from a semisolid to a liquid condition. A large plasticity index, such as 20, shows that a considerable amount of water can be added before a soil changes to a liquid condition.

### 2. Textural Classification

(a) AASHO Classification System (PCA Soil Primer, 1962)

The American Association of State Highway Officials system is an engineering property classification based on field performance of highways. In the AASHO system,

the sieve analyses and the Atterberg limits are used to separate the soil material into seven basic groups A-1 to A-7. The best soils for road subgrades are classified as A-1, the poorest as A-7.

In recent years these seven basic groups have been divided into subgroups with a group index that was devised to approximate within group evaluations. Group indices range from 0 for the best subgrade material to 20 for the poorest.

(b) Unified Soil Classification System (PCA Soil Primer, 1962)

In this system, the soils are identified according to their sieve analyses and Atterberg limits, and are grouped according to their performance as engineering construction materials. Soil materials are divided into coarse grained soils, fine grained soils and highly organic soils. The coarse grained soils are subdivided into eight classes; the finegrained into six classes; and there is one class of highly organic soils.

Coarse grained soils are those that have 50% or less of material passing the number 200 sieve; fine grained soils have more than 50% of material passing the number 200 sieve. The letters G, S, C, M, W, P, L and H stand for gravel, sand clay, silt, well graded, poorly graded, low liquid limit and high liquid limit, respectively.

The designation CL for example, indicates inorganic clays of low liquid limit; SW indicates well graded sand; and SC indicates clayey sands.

(c) United States Department of Agriculture Classification System

The system is defined on pages 5, 6 and 7 in section 1 of this report. A comparison of the different systems is given in the PCA Soil Primer.

# GLOSSARY

This is included to define terms commonly used in the report; it is not a comprehensive soil glossary.

aeolian (eolian) deposit - material deposited by wind, includes both loess and dune sand.

aggregate - a group of soil particles cohering so as to behave mechanically as a unit.

alluvial deposit - material deposited by moving water.

aspect - orientation of the land surface with respect to compass direction.

Atterberg limits - see plastic limit, liquid limit.

available plant nutrients - that portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

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

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

cation-exchange capacity (C.E.C.) - a measure of the total amount of exchangeable cations that can be held by the soil. It is expressed in terms of milliequivalents /100 grams of soil.

coarse fragments - rock or mineral particles greater than 2 mm in diameter.

colluvium - a heterogeneous mixture of material that has been deposited mainly by gravitational action.

creep - slow mass movement of soil material down rather steep slopes primarily under the influence of gravity, but aided by saturation with water and alternate freezing or thawing.

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.

eluviation - the removal of soil material in suspension or in solution from a layer or layers of the soil.

erosion - the wearing away of the land surface by running water, wind, or other erosive agents. 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.

field capacity - the percentage of water remaining in a soil after having been saturated and after free drainage has practically ceased.

fluvial deposit - accumulations of sediment (sand, gravel, silt, etc.) produced by the action of a stream or river.

glacio-fluvial deposits - material moved by glaciers and subsequently deposited by streams flowing from the melting ice.

gley - gleying is a reduction process that takes place in soils that are saturated with water for long periods of time. The horizon of most intense reduction is characterized by a gray, commonly mottled appearance, which on drying shows numerous rusty brown iron stains or streaks. Those horizons in which gleying is intense are designated with the subscript "g".

grain-size analysis - the determination of the various amounts of sand, silt, clay, gravel and cobbles in a soil sample.

groundwater - that portion of the total precipitation which at any particular time is either passing through or standing in the soil and the underlying strata and is free to move under the influence of gravity.

horizon - a layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil forming processes. Soil horizons may be organic or mineral.

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, iron and aluminum hydrous oxides and organic matter.

infiltration - the downward entry of water into the soil.

lacustrine deposit - material deposited in lake water and later exposed either by a lowering of the water or by uplift of the land.

landforms - the various shapes of the land surface resulting from a variety of actions, such as deposition, erosion, etc.

liquid limit (upper plastic limit) - the water content at which a pat of soil, cut by a groove of standard dimensions, will flow together for a distance of 12 mm under the impact of 25 blows in a standard liquid limit apparatus.

lithic - a soil subgroup modifier that indicates a bedrock contact within 50 cm (20 in.) of the soil surface.

loamy - intermediate in texture between fine-textured and coarse textured.

loess - material transported and deposited by wind and consisting of predominately silt-sized particles.

morphology, soil - the makeup of the soil, including the texture, structure, consistence, colour, and other physical, mineralogical and biological properties of the various horizons of the soil profile.

miscellaneous land type - a mapping unit for areas of land that have little or no natural soil - e.g. rough mountainous land.

moraina1 - accumulations of unsorted, unstratified till deposited by direct action of glacier ice in a variety of topographic landforms.

mottles - spots or blotches of different colour or shades of colour interspersed with the dominant colour. Mottling in soils usually indicates poor aeration and drainage.

organic matter - the decomposition residues of plant material derived from: (i) plant materials deposited on the surface of the soil, and (ii) roots that decay beneath the surface of the soil.

parent material - unconsolidated mineral material or peat from which the soil profile develops.

peat - unconsolidated soil material consisting largely of undecomposed to partially decomposed organic matter accumulated under conditions of excessive moisture.

ped - 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 involving the constitution, distribution, genesis and classification of soils.

percolation, soil water - the downward movement of water through soil. Especially the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of the order of 1.0 or less.

permeability - the ease with which gases, liquids, or plant roots penetrate or pass through a bulk mass of soil or a layer of soil. Since different horizons of soil vary in permeability, the particular horizon under question should be designated.

pH - a notation used to designate the relative acidity or alkalinity of soils and other materials. a pH of 7.0 indicates neutrality, higher values indicate alkalinity, and lower values acidity.

phase, soil - a subdivision of a taxonomic class based on soil characteristics or combinations thereof which are considered to be potentially significant of man's use or management of the land.

plastic limit - water content at which a soil will just begin to crumble when rolled into a thread approximately 3 mm in diameter.

plasticity index - the numerical difference between the liquid and the plastic limit.

profile - a vertical section of the soil throughout all its horizons and extending into the parent material.

relief - the elevations or inequalities of the land surface when considered collectively. Minor configurations are referred to as "microrelief".

residual material - unconsolidated and partly weathered mineral material accumulated by disintegration of consolidated rock in place.

saline soil - a soil containing enough soluble salts in such quantities that they interfere with the growth of most crop plants.

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.

soil consistency - (i) the resistance of a soil 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 conditions are:
wet soil - non-plastic, slightly plastic, plastic, very plastic.
moist soil - loose, friable, firm, very firm, extremely firm.
dry soil - loose, soft, hard, very hard, extremely hard.

soil structure - the combination or arrangement of primary soil particles into secondary particles, units or peds, e.g. prismatic, columnar, blocky, platy.

soil unit - a defined aggregate of soil bodies occurring together in an individual and characteristic pattern over the land surface.

solum (plural - sola) - the part of the soil profile that is above the parent material and in which the processes of soil formation are active. It comprises the A and B horizons.

terrace - a nearly level, usually narrow, plain bordering a river, lake or sea.

texture (soil) - the relative proportions of the various sized soil separates in a soil as described by the textural class names.

till - unstratified glacial drift deposited directly by ice and consisting of non-sorted clay, silt, sand and boulders.

topsoil - (i) the layer of soil moved in cultivation, (ii) the A horizon, (iii) the Ah horizon, (iv) presumably fertile soil material used to topdress roadbanks, gardens and lawns.

undifferentiated deposit - accumulations of unconsolidated deposits where differentiation into one of the other classes of deposits is impractical.

veneer - surface form in areas of very thin surficial deposits (10 cm to 1 m in thickness) which is strongly influenced by subsurface deposits.

watertable - the upper limit of the part of the soil or underlying rock material that is wholly saturated with water.

## REFERENCES

Allemeier, K. A. 1973. Application of pedological soil surveys to highway engineering in Michigan. Geoderma 10: 87-98.

Bartelli, L. J., A. A. Klingebiel, J. V. Baird and M. R. Heddleson (eds.).1966. Soil Surveys for Land Use Planning. Soil Sci. of Amer. and Amer. Soc. of Agronomy, Madison, Wisconsin.

Bowser, W. E. 1967. Agro-Climatic Areas of Alberta. Alberta Soil Survey, Univ. of Alberta. Edmonton, Alberta.

Canada Land Inventory. 1965. Soil Capability Classification for Agriculture. CLI Report No. 2, Dept. of Forestry, Canada.

Canada Soil Survey Committee. 1970. The System of Soil Classification for Canada. Queen's Printer for Canada. Ottawa.

_____ 1973. Proceedings of the ninth meeting of the C.S.S.C. at U. of Sask., Saskatoon. Soil Research Inst. Ottawa.

Greenlee, G. M. 1974. Soil survey of Bow Valley provincial park and adjacent Kananaskis area and interpretation for recreational use. Alberta Institute of Pedology. M-74-2.

Knapik, L. 1974. Detailed Soil Survey of the Canmore Area. Alberta Institute of Pedology. M-74-20.

Lindsay, J. D., M. D. Scheelar, and A. G. Twardy. 1973. Soil survey for urban development. Geoderma 10: 35-45.

Means, R. E. and J. V. Parcher. 1974. Physical Properties of soils. Charles E. Merrill, Columbus, Ohio. 464 pp.

Portland Cement Association. 1962. PCA Soil Primer, 33 West Grand Ave., Chicago, Ill.

Price, R. A. 1971. A section through the Eastern Cordillera at the latitude of the Kicking Horse Pass. in A Guide to the Geology of the Eastern Cordillera along the Trans-Canada Highway between Calgary and Revelstoke, B. C. Alta. Soc. of Petroleum Geol. p 17-24.

Price, R. A. and E. W. Mountjoy. 1972. Geology. Banff (east half). Geol. Surv. Can. Map Series. Map 1294A.

Rutter, N. W. 1972. Geomorphology and multiple glaciation in the area of Banff, Alberta. Geol. Surv. Can. Bull. 206.

Terzaghi, K. and R. B. Peck. 1967. Soil Mechanics in Engineering Practice. J. Wiley & Sons, New York.

U. S. Army Corps of Engineers. 1962. Pavement design for frost conditions. E. M. 1110-1-306, p. 5-8.

U. S. Dept. of Agriculture, Soil Conservation Service. 1971. Guide for Interpreting Engineering Uses of Soils. 87 p.

## ACKNOWLEDGEMENTS

Mr. Z. Widtman drafted the final soils map and Mr. L. Knapik compiled section I of the report. Mr. J. Beres determined the engineering properties and Messrs. W. McKean and A. Schwarzer the chemical properties of the soils. Mrs. Pal Foster edited and typed the report. Field assistance was given by Mr. H. van Waas.

TABLE 10. ENGINEERING AND CHEMICAL SOIL DATA OF REPRESENTATIVE SOIL SAMPLES

| Soil Unit | Horizon | Depth from Surface (cm) | pH | % $CaCO_3$ | Grain Size Analysis | | | | | | | | | | Atterberg Limits | | Textural Classification | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | % Passing Sieve | | | | | | | | % smaller than | | Liquid Limit | Plastic Limit | AASHO | Unified | USDA |
| | | | | | 3" | 1" | 3/4" | 5/8" | #4 | #10 | #40 | #200 | .05 mm | .002 mm | | | | | |
| 1-1 | Ck | 63-75 | 7.5 | 45.6 | 100 | 100 | 100 | 100 | 99 | 99 | 98 | 74 | 67 | 14 | 28 | 6 | A4(8) | ML | SiL |
| 1-2 | Ck | 90-120 | n.d.* | n.d. | 79 | 65 | 56 | 52 | 29 | 18 | 8 | 2 | n.d. | n.d. | NP** | NP | A1(0) | GP | G |
| 1-4 | Ck | 40-75 | 7.2 | 43.1 | 100 | 100 | 100 | 100 | 100 | 99 | 99 | 98 | 95 | 34 | 33 | 10 | A6(10) | ML-CL | SiCL |
| 2-2 | Ck | 30-75 | 7.0 | 42.2 | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | 40 | 35 | 4 | NP | NP | A1(0) | GM | VGSL |
| 2-4 | Ck | 25-75 | 7.0 | 49.9 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 5 | n.d. | n.d. | n.d. | n.d. | Si |
| 3-1 | Ck | 20-75 | 7.1 | 56.5 | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | 80 | 58 | 17 | NP | NP | n.d. | GM | GL |
| 3-1 | Ck | 25-90 | n.d. | n.d. | 84 | 76 | 70 | 66 | 47 | 34 | 20 | 6 | n.d. | n.d. | NP | NP | A1(0) | GP | G |
| 3-2 | Ck | 0-90 | n.d. | n.d. | 80 | 72 | 63 | 58 | 31 | 23 | 6 | 2 | n.d. | n.d. | NP | NP | A1(0) | GP | G |
| 4-1 | Ck | 40-90 | 7.0 | 60.4 | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | 70 | 53 | 12 | NP | NP | n.d. | n.d. | GL |
| 4-2 | Ck | 30-90 | n.d. | n.d. | 91 | 91 | 89 | 86 | 70 | 64 | 63 | 44 | n.d. | n.d. | 14 | 4 | A1 | ML-CL | GL |
| 5-1 | Ck | 90-120 | 8.0 | n.d. | 100 | 100 | 100 | 100 | 100 | 99 | 98 | 98 | 76 | 34 | 39 | 16 | A6(10) | CL | CL |
| 6-1 | Ck | 90-120 | n.d. | n.d. | 100 | 100 | 100 | 100 | 100 | 100 | 99 | 75 | 64 | 13 | 33 | 4 | A4(8) | ML | SiL |
| 7-2 | Ck | 50-90 | n.d. | n.d. | 89 | 89 | 87 | 87 | 84 | 81 | 79 | 67 | n.d. | n.d. | 27 | 8 | A6(10) | CL | CL |

* n.d. not determined

** NP – non-plastic

TABLE 11. LIMITATIONS AND SUITABILITY OF SOILS FOR SELECTED USES.

| Map Unit | Degree of Limitation for: | | | | | | Suitability as Source of: | | | Soil Capability for Agriculture (5) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Road Location | Permanent Buildings with Basements | Sewage Lagoons (1) | Camp Areas and Lawns | Picnic Areas | Playing Fields (4) | Gravel | Roadfill | Topsoil | |
| 1-1/bc | S-M5 | S-M5 | M5,13 | M6 | M6 | M3,6 | F14,5 | F-G5 | F16 | 5C |
| 1-2/de | M3 | M3 | V3,5,13 | V3,5,6,10, 16 | V3,6,10,16 | V3,6,10 | F5 | G | U | 6M |
| 1-2/f | M-V3 | M-V3 | V3,5,13 | V3,5,6,10, 16 | V3,6,10 | V3,6,10 | F5 | G | U | $6^{M}_{T}$ |
| 1-2/bc | S | S | V5, 13 | V5,6,10,16 | V6,10,16 | V6,10 | F5 | G | U | 6M |
| 1-3/de | M3 | M3 | V3,5,13 | M3,16 | M3,16 | V3 | F5,14 | G | P16 | 6M |
| 1-3/bc | S | S | V5,13 | S | S | M3 | F5,14 | G | P16 | 6M |
| 1-4/bc | S-M5 | S-M5 | S | M6 | M6 | M3,6 | U | F5 | F16 | 5C |
| 1-4/de | M3,5 | M3,5 | V3 | M3,6 | M3,6 | V3,6 | U | F5 | F16 | 5C |
| 1-5/de | V1,3,5,8 | V1,3,5,8 | V1,3,12 | V1,3 | V1,3 | V1,3,6 | U | P1 | P1 | 6W |
| 2-1/AC | V2,5 | V2 | V2 | M2 | M2 | M2,3 | F5,14 | F5 | F16 | 6I |
| 2-2/AC | M-V2 | M-V2 | V2 | V2,10,16 | V2,10,16 | V2,10,16 | F5 | G | U | $6^{M}_{I}$ |
| 2-3/AC (3) | M-V2 | M-V2 | V2 | M2 | M2 | M2 | F5,14 | G | F16 | 6M |
| 2-4/AC (3) | V1,2,8 | V2,1,8 | V2,1,12 | V1,2 | V1,2 | V1,2 | P1 | P1 | P1 | $6^{M}_{I}$ |
| 2-5/AC (3) | V1,2,8 | V2,1,8 | V2,1 | V1,2 | V1,2 | V1,2 | P1,5 | P1 | F16 | 6I |
| 3-1/de | M3 | M3 | V3,5,13 | V3,5,6,16, 10 | V3,6,16,10 | V3,6,16,10 | G | G | U | 6M |
| 3-1/f | M-V3 | M-V3 | V3,5,13 | V3,5,6,16, 10 | V3,16,6,10 | V3,6,16,10 | G | G | U | $6^{M}_{T}$ |
| 3-1/g | V3 | V3 | V3,5,13 | V3,5,6,16, 10 | V3,6,16,10 | V3,6,16,10 | G | G | U | $7^{M}_{T}$ |
| 3-2/bc | S | S | V5,13 | V5,6,16,10 | V6,16,10 | V3,6,16,10 | G | G | U | 6M |
| 3-2/gh | V3 | V3 | V3,5,13 | V3,5,6,10 | V3,6,16,10 | V3,6,16,10 | G | G | U | $7^{M}_{T}$ |
| 3-1 6 &6-1 4 /f (2) & (3) | M-V3,5 | M-V3 | V3,5,13 | V3,5,6,10 | V3,6,16,10 | V3,6,16,10 | G | G | U | $6^{M}_{T}$ |
| 3-1 6 & 6-1 4 /g (2) & (3) | V3,5 | V3 | V3,5,13 | V3,5,6,10 | V3,6,16,10 | V3,6,16,10 | G | G | U | $7^{M}_{T}$ |
| 3-1 6 & 6-1 4 /de (2) & (3) | M3,5 | M3 | V3,5,13 | V3,5,6,10 | V3,6,16,10 | V3,6,16,10 | G | G | U | $6M^{6}\ 5C^{4}$ |
| 4-1/bc | S | S | M6,13 | M9 | M9 | M3,9 | U | F5 | P16 | 5C |
| 4-1/de | M3 | M3 | V3,5,13 | M3,9 | M3,9 | V3,9 | U | F5 | P16 | 5C |
| 4-1/f | M-V3 | M-V3 | V3,5,13 | V3,9 | V3,9 | V3,9 | U | F5 | P16 | 6T |
| 4-1/ghG | V3 | V3 | V3,5,13 | V3,9 | V3,9 | V3,9 | U | F5 | P16 | 7T |
| 4-2/de | M3 | M3 | V3,5,13 | M3,9 | M3,9 | V3,9 | U | F5 | P16 | 5C |
| 4-2/f | M-V3 | M-V3 | V3,5,13 | V3,9 | V3,9 | V3,9 | U | F5 | P16 | 6T |
| 4-3/f | M-V3 | M-V3 | V3,5,13 | V3,9 | V3,9 | V3,9 | U | F5 | P16 | 6T |
| 5-1/bc | S-M5 | S-M5 | S | M6 | M6 | M3,6 | U | F5 | F16 | 5C |
| 6-1 6 &3-2 4 /bc (2) & (3) | S-M5 | S-M5 | S-M5 | M6 | M6 | M3,6 | U | F5 | F16 | $5C^{6}\ 6M^{4}$ |
| 6-2/f | M-V3 | M-V3 | V3,5 | V3,6 | V3,6 | V3,6 | U | G | P16 | 6M |
| 7-1/fgh | V3,4,11 | V3,4,11 | V3,4 | V3,4 | V3,4 | V3,4 | U | P4 | P16 | $7^{T}_{R}$ |
| 7-2/f | V3,7,15 | V3,7,15 | V3,6 | V3,6 | V3,6 | V3,6 | U | P5 | P16 | 6T |
| 8-1/gh | V3 | V3 | V3,4 | V3,4 | V3,4 | V3,4 | U | U | U | $7^{T}_{R}$ |
| 9-1/gh | V3 | V3 | V3,4 | V3,4 | V3,4 | V3,4 | U | U | U | $7^{T}_{R}$ |
| 10-1/A | V1 | V1 | V1,12 | V1 | V1 | V1 | U | P1 | P1 | O |

S - slight; M - moderate; V - severe; G - good; F - fair; P - poor; U - unsuited.

(1) Limitations may be lessened considerably if lagoon is made of impermeable materials from another site and embankments are sufficiently high to prevent overflow.

(2) Small Arabic numerals placed after a class numeral or soil unit gives the proportion of the class or soil unit out of a total of 10.

(3) On-site investigations required in complex areas. Limitations indicated are for the dominant map unit.

(4) On-site investigations required in all areas for playing fields.

(5) See page 18 in Section 1 of the report.

LIMITING SOIL PROPERTIES AND HAZARDS:

1. Poor soil drainage
2. High flooding hazard
3. Steep slopes
4. Shallow depth to bedrock
5. Undesirable subsoil texture
6. Undesirable surface texture
7. High shrink-swell potential
8. High susceptibility to frost heave
9. Excessive surface stoniness
10. Excessive gravel on surface
11. Excessive consolidated bedrock exposures
12. High in organic matter
13. High groundwater contamination hazard
14. Deep overburden
15. Low soil stability
16. Thin topsoil

TABLE 12. CANADIAN SOIL CLASSIFICATION SYSTEM

| ORDER | GREAT GROUP | DISTINGUISHING CHARACTERISTICS |
|---|---|---|
| 1. Chernozemic (Developed under grassland and transitional grassland-forest communities) | Brown | Light Brown Ah horizon |
| | Dark Brown | Dark Brown Ah horizon |
| | Black | Black Ah horizon |
| | Dark Gray | Have L-H surface horizons typical of forest vegetation |
| 2. Solonetzic (Columnar or prismatic B horizon and a saline C horizon; Ca/Na ratio of B horizon is less than 10) | Solonetz | Ah horizon — Bnt horizon |
| | Solodized Solonetz | Ah — Ae — Bnt |
| | Solod | Ah — Ae — AB — Bnt |
| 3. Luvisolic (Developed in forest areas; accumulation of clay in the B horizon) | Gray Brown Luvisol | (L-H) — Ah — Ae — Bt; Mull-like Ah horizon |
| | Gray Luvisol | L-H — (Ah) — Ae — Bt |
| 4. Podzolic (Accumulation of Fe+Al and/or organic matter in the B horizon) | Humic Podzol | Bh > 4" which contains > 1% O.C. < 0.3% Fe |
| | Ferro-Humic Podzol | Bhf > 4" which contains > 5% O.C. > 0.6% Fe+Al |
| | Humo-Ferric Podzol | Bf > 2" which contains < 5% O.C. > 0.6% Fe+Al |
| 5. Brunisolic (Generally weakly developed B horizons) | Melanic Brunisol | Ah > 2", Bm > 2"; pH > 5.5 |
| | Eutric Brunisol | Ah < 2", Bm > 2"; pH > 5.5 |
| | Sombric Brunisol | Ah > 2", Bm > 2"; pH < 5.5 |
| | Dystric Brunisol | Ah < 2", Bm > 2"; pH < 5.5 |
| 6. Regosolic (Weakly developed or young soils; no B horizon) | Regosol | (L-H) — Ah — C; no B horizon |
| 7. Gleysolic (Poorly drained and show mottling and gleying) | Humic Gleysol | Ah > 3" |
| | Gleysol | Ah < 3" |
| | Luvic Gleysol | Have Aeg and Btg horizons |
| 8. Organic (Contains > 17% organic carbon are > 24" in depth if dominantly fibric or > 16" if dominantly mesic or humic) | Fibrisol | Large amount of well preserved fiber |
| | Mesisol | Partially decomposed fiber |
| | Humisol | Well decomposed fiber (Black) |
| | Folisol | |

TABLE 13. DEFINITION OF SOIL HORIZON SYMBOLS (after C.S.S.C., 1973)

Organic Layers

Organic layers are found at the surface of some mineral soils, and may occur at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon by weight. Two groups of these layers are recognized.

O - This is an organic layer developed mainly from mosses, rushes, and woody materials.

Of - The fibric layer is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fibre that are readily identifiable as to botanical origin.

Om - The mesic layer is the intermediate stage of decomposition with intermediate amounts of fibre, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic layer is one that fails to meet the requirements of fibric or of humic.

Oh - The humic layer is the most highly decomposed of the organic soil materials. It has the least amount of fibre, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes very little physically or chemically with time unless it is drained.

L-F-H- These organic layers develop primarily from leaves, twigs, woody materials, and a minor component of mosses.

L - This is an organic layer characterized by an accumulation of organic matter in which the original structures are easily discernible.

F - This is an organic layer characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The layer may be partly comminuted by soil fauna, as in moder[1], or it may be partly decomposed mat permeated by fungal hyphae, as in mor[1].

H - This is an organic layer characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F layer by its greater humification chiefly through the action of organisms. This layer is a zoogenous humus form consisting mainly of spherical or cylindrical droppings of microarthropods. It is frequently intermixed with mineral grains, especially near the junction with a mineral layer.

Master Mineral Horizons and Layers

Mineral horizons are those that contain less organic matter than that specified for organic layers.

A - This is a mineral horizon or horizons formed at or near the surface in the zone of removal of materials in solution and suspension, or of maximum in situ accumulation of organic matter, or both. Included are:

[1] Bernier, B. 1968. Soils under forest. Proceedings of the Seventh Meeting of the National

(TABLE 13 - cont.)

(1) horizons in which organic matter has accumulated as a result of biological activity (Ah);
(2) horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of these (Ae).

B - This is a mineral horizon or horizons characterized by one or more of the following:
(1) an enrichment in silicate clay (Bt).
(2) an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below (Bm and Bg).

(3) a prismatic or columnar structure that exhibits pronounced coatings or stainings and significant amounts of Na (Bn).

C - This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting the process of gleying or the accumulation of carbonates and soluble salts.

R - This is consolidated bedrock that is too hard to break with the hands or dig with a spade when moist, and that does not meet the requirements of a C horizon. The boundary between the R layer and any overlying unconsolidated material is called a lithic contact.

Lowercase Suffixes

b - A buried soil horizon.

e - A horizon characterized by the removal of clay, iron, aluminum, or organic matter alone, or in combination. When dry, it is higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae, Ahe).

g - A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less.

h - A horizon enriched with organic matter. When used with A it must show one Munsell unit of value darker than the horizon below, or have 0.5% more organic matter than the IC. It contains less than 17% organic carbon by weight.

k - Denotes the presence of carbonate as indicated by visible effervescence when dilute HCl is added.

m - A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color or structure, or both.

n - A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. When used with B it must also have the following properties: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistence when dry.

(TABLE 13 - cont.)

s - A horizon with salts which may be detected as crystals or veins, as surface crusts, by distressed crop growth or by presence of salt-tolerant plants. It is most commonly used with C and k.

t - A horizon enriched with silicate clay. It is used with B (Bt, Btg).