SOIL SURVEY OF BLUE LAKE CENTRE AND INTERPRETATION FOR RECREATIONAL USE

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CONTENTS

PREFACE

This report is one of a series describing detailed and semi-detailed soil surveys, which were conducted in the following Alberta Provincial Parks during the summer of 1976: Cypress Hills, Writing-on-Stone, Dry Island Buffalo Jump, Jarvis Bay, Wabamun Lake, Thunder Lake, Moose Lake and Moonshine Lake. Also included were the Blue Lake Centre in William A. Switzer Provincial Park; as well as areas in the vicinities of Carseland and Hilliard's Bay (on the northwestern shore of Lesser Slave Lake). The total area mapped was approximately 30 000 ha.

A general guidebook has been prepared to accompany soil survey reports written for Alberta Provincial Parks and recreation areas (Greenlee, 1981). It includes general discussions of the following: soil formation; the Canadian soil classification system; soil characteristics and other factors that affect the use of soils for recreational and related purposes; Luvisolic, Organic, and Solonetzic soils; soil erosion; methodology; soil and landform maps that accompany the soil survey reports; an explanation of soil interpreations and guidelines for developing them; chemical and physical properties of soils; and the landform classification system used by Canadian soil pedologists. Also included is a glossary. Specific results and interpretations for the areas covered by this study are presented in the ensuing report.

ACKNOWLEDGMENTS

The Alberta Research Council provided the staff, and the Outdoor Recreation Planning Branch of Alberta Recreation and Parks contributed the funds for the 1976-77 provincial parks soil survey program. Costs included field, office, laboratory, drafting, editing, and printing; as well as equipment and supplies. Office and laboratory space were provided by The University of Alberta. Mrs. Kathy Gates typed and assisted in compiling and proof reading the report. Mrs. J. Dlask drafted the soil, landform, and soil limitations for recreation maps, while Mr. J. Beres determined the soil physical properties. The soil chemical analyses were determined by the Alberta Soil and Feed Testing Laboratory. Able field assistance was given by Mr. M. Hennie.

Special acknowledgment is given to the Park Rangers and other park employees, who cooperated by allowing soil investigations to be conducted throughout the park, and who invariably offered assistance when needed.

SUMMARY

Blue Lake Centre is about 100 ha in size, and is located in William A. Switzer Provincial Park; about 16 km west and 6 km north of Hinton. Surficial deposits throughout the majority of the study area

consist of very coarse textured glaciofluvial sediments (gravel). Occasional patches of medium to moderately coarse textured fluvial sediments, and organic soil deposits, also occur. The region has a cold snow-forest climate with humid winters, characterized by frozen ground and a snow cover of several months duration. Summers are cool and short with less than four months with an average temperature above 10°C, and the average temperature of the coldest month is below -3°C. Blue Lake Centre is situated in the upper foothills section of the boreal forest region, where lodgepole pine is predominant.

Five map units were recognized in the study area. The key profile types are Orthic Gray Luvisols, Orthic Gray Luvisols peaty phase, Orthic Eutric Brunisols, Orthic Gleysols, Orthic Gleysols peaty phase, Terric Humisols, and undifferentiated Mesisols. These are distributed over the landscape in relation to landform, parent material, and drainage. Map units consist of single soil series, groupings of series (complexes), or catenas; and their distribution is shown on the soil map.

Soil interpretations of each map unit are made for primitive camping areas, picnic areas, lawns and landscaping, paths, trails, buildings (with and without basements), septic tank absorption fields, road location, and source of roadfill.

The soils best suited to recreational development in the study area are those of Map Unit 2; however they are of very limited extent. Map Unit 1 soils, widespread in the study area, have severe limitations due to surface stoniness; but the Orthic Gray Luvisols are otherwise well suited when found on suitable topography. These soils have developed on steep slopes for the most part, but a few patches of suitable topography do occur. The soils best suited to road construction are those of Map Unit 1, when found on suitable topography, and Map Unit 2 soils have moderate limitations.

Careful study of the soil map and tables 4 to 13 inclusive (soil limitation and suitability tables) will reveal areas suitable for particular uses.

A soil survey properly interpreted can be one of the most useful tools management has in making a proper design for a recreational area. However, all soil differences which occur in the field cannot be shown on the soil map. Thus for design and construction of specific recreational facilities, an on-site investigation is usually required.

INTRODUCTION

SIZE AND LOCATION

Blue Lake Centre is about 100 ha in size, and is located in William A. Switzer Provincial Park; about 16 km west and 6 km north of Hinton (figure 1), which in turn is located 286 km west of Edmonton along Highway 16. The study area includes part of the north half of section 8; the southwest quarter, and part of the southeast quarter of section 17; township 52, range 26, west of the fifth meridian.

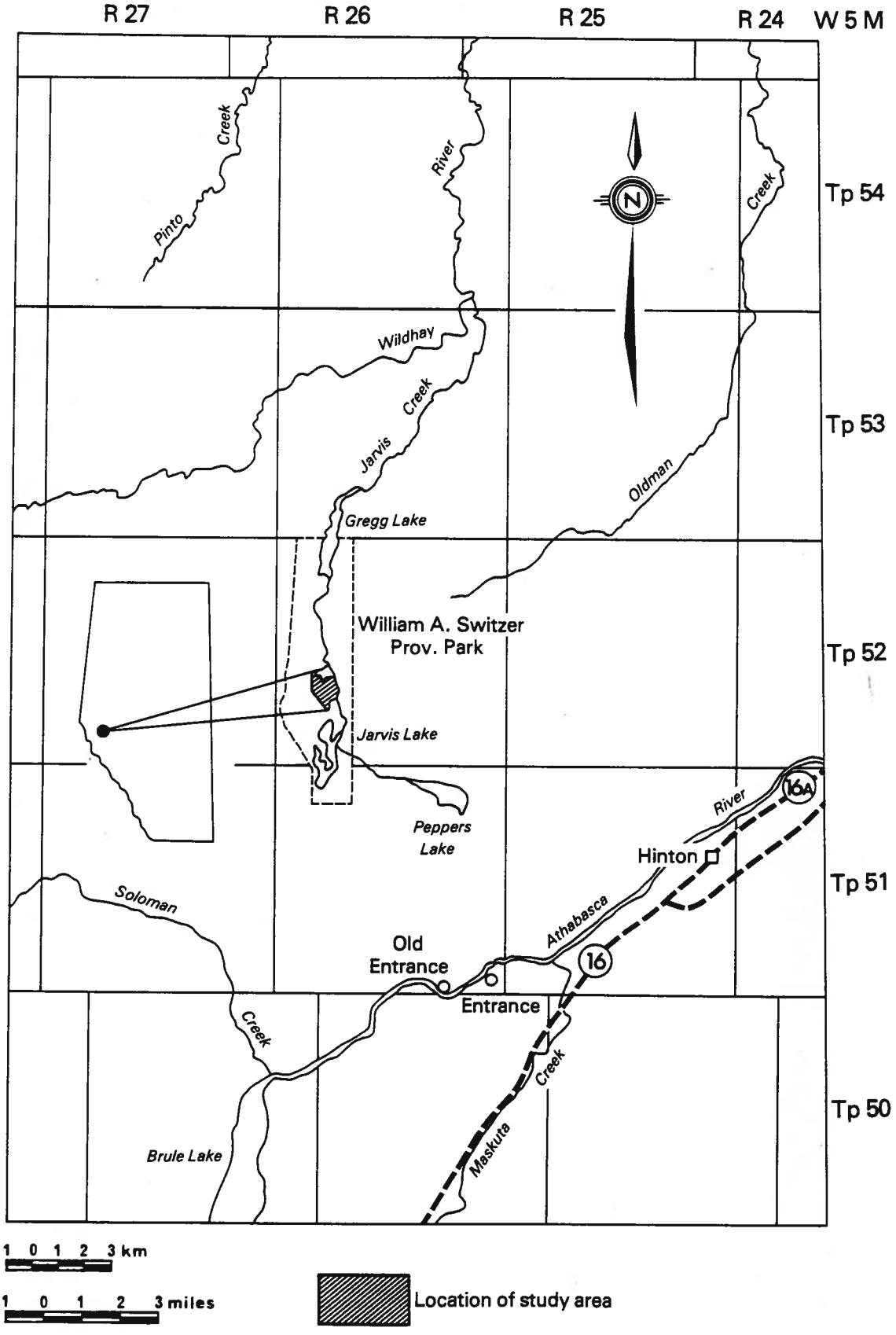

Figure 1. Map showing location of study area.

PHYSIOGRAPHY AND SURFICIAL DEPOSITS

Blue Lake Centre is situated in the Rocky Mountain Foothills division of the Western Cordillera physiographic region (Government and the University of Alberta, 1969). More specifically it is situated in the Jarvis Creek Valley; which is defined by Roed (1968) as a partly buried bedrock valley, partly filled with glacial and fluvial deposits. The bedrock has been classified as the Paleocene and Upper Cretaceous Paskapoo Formation, which is nonmarine (Green, 1972). Surface elevations are approximately 1160 m, and local relief appears to be about 30 m. The topography is hummocky throughout most of the study area, with the exception of occasional small level patches between highs. The study area is drained by Jarvis Creek to the north.

Surficial deposits throughout most of the study area consist of very coarse textured glaciofluvial sediments (gravel). Occasional patches of medium to moderately coarse textured fluvial sediments, and organic soil deposits, also occur.

CLIMATE

The climate of the mapped area is designated as humid microthermal in Koppen's climatic classification (Trewartha and Horn, 1980). This is described as a cold snow-forest climate with humid winters, characterized by frozen ground and a snow cover of several months duration. Summers are cool and short, having less than four months with an average temperature above 10° C. The average temperature of the coldest month is below -3° C.

Weather records from 1951 through 1980 for Entrance, about 18 km southeast of the study area and at an elevation of 1006 m were used to compile the following information (Environment Canada, 1982): the mean annual temperature is 2.0°C. July is the warmest month of the year with a mean temperature of 14.3°C, and January is the coldest month with a mean temperature of -14.1°C. The mean annual precipitation is 513 mm and 68% falls as rain. The average frost-free period is 60 days. Somewhat lower average temperatures might be expected in the study area, as elevations are more than 1000 m higher.

VEGETATION

Blue Lake Centre is situated in the upper foothills section of the boreal forest region, as classified by Rowe (1972). A distinctive feature is the relative scarcity of mixedwood stands; as trembling aspen, balsam poplar, and white birch are only sparsely represented. Lodgepole pine is predominant, white spruce is a major species, and black spruce is a frequent constituent north of the Red Deer River. Alpine fir is somewhat less prevalent than in the neighbouring mountains; while tamarack is scattered in distribution and rare at the higher altitudes.

Lodgepole pine is the predominant vegetation throughout most of the study area; and scattered white spruce and aspen also occur. Since the Outdoor Recreation Planning Branch of Alberta Recreation and Parks conducts

biological studies of provincial parks and recreation areas, the vegetation is not extensively discussed in this report. However, some of the common plants observed growing on different soils are indicated as part of the map unit descriptions, and these are listed as follows (Moss, 1959; Cormack, 1967): lodgepole pine (Pinus contorta var latifolia), white spruce (Picea glauca), aspen (Populus tremuloides), black spruce (Picea mariana), Canadian buffalo-berry (Shepherdia canadensis), willow (Salix spp), swamp birch (Betula pumila var glandulifera), wild rose (Rosa spp), common bearberry (Arctostaphylos uva-ursi), shrubby cinquefoil (Potentilla fruticosa), various forbs, grass (various species), Labrador tea (Ledum groenlandicum), and mosses (various species).

SOILS

Only five map units were recognized in the study area. The soils of two were classified in the Organic Order; and one in each of the Luvisolic, Brunisolic, and Gleysolic Orders in the Canadian soil classification system (Canada Soil Survey Committee, 1978). The system is outlined in Greenlee (1981). Pertinent features of the map units are outlined in table 1.

Soils of the Luvisolic Order are well to imperfectly drained mineral soils characterized by an Ae horizon near the surface, and it generally varies from 7.5 to 30 cm in thickness. It is a leached gray coloured horizon, very low in organic matter (humus) content and in plant nutrients. Luvisolic soils in their natural state commonly have surface L-H and Ah horizons as well. The L-H horizon ranges from 2.5 to 12.5 cm or more in thickness; however, the Ah horizon below is usually less than 5 cm thick, and often absent altogether. When Luvisolic soils are cultivated, the L-H and Ah horizons quickly become mixed with the Ae, resulting in gray coloured fields. Also, the L-H and Ah horizons rapidly become broken down under conditions of heavy foot traffic in recreation areas, and often disappear completely from a combination of physical destruction and soil erosion. When thoroughly dried out, the Ae horizon is often baked and hard, so that plant seedlings may be unable to push up through the crust. Also, entry of moisture from rainfall may be hampered and runoff increased, thereby enhancing soil erosion. This problem is especially serious on steep slopes.

Most of the study area is covered by rapidly drained Luvisolic soils developed on very coarse textured glaciofluvial sediments (gravel).

Soils of the Organic order include all soils that have developed largely from organic deposits, contain more than 30% organic matter by weight, and meet specifications of depth and horizon thickness within a defined control section. The majority of Organic soils are either water saturated or nearly so for much of the year unless artificially drained. The organic deposits are derived primarily from the decomposition of hydrophytic or mesohydrophytic vegetation. The further classification and naming of the great groups into Fibrisols, Mesisols and Humisols depends on the occurrence and identification of three major diagnostic layers: Fibric, Mesic and Humic. Fibric layers are the least decomposed of all the organic soil materials and have large amounts of well preserved fibres,

TABLE 1. KEY TO THE SOILS

MAP UNIT	CLASSIFICATION	PARENT MATERIAL	SURFACE TEXTURE	SLOPE (CLASS AND GRADIENT)	SURFACE STONINESS	DRAINAGE	COMMENTS AND LIMITATIONS
1	Orthic Gray Luvisol - 60% Orthic Gray Luvisol, peaty phase - 40%	very coarse textured glaciofluvial sediments (gravel)	gravelly fine sandy loam to gravelly sandy loam	b, c, d, f, g (>0.5 to 60%)	4	well to rapidly drained	The peaty phase soils occur on north-facing and east-facing slopes, and in depressions. Slight to very severe limitations for the Orthic Gray Luvisols, good to poor source of roadfill-surface stoniness, excessive slopes, erosion hazard, rapid permeability (droughtiness), groundwater contamination hazard, lack of Ah horizon. Slight to very severe limitations for the Orthic Gray Luvisols, peaty phase, good to poor source of roadfill - surface stoniness, organic surface layer more than 15 cm thick, excessive slope, erosion hazard, lack of Ah horizon, rapid permeability, groundwater contamination hazard.
2	Orthic Eutric Brunisol	medium to moderately coarse textured fluvial sediments	loam, fine sandy loam, or silt loam	b (>0.5 to 2%)	0	well drained	(1) Layers of variable textured sediments occur in unpredictable sequences. Occasional sand lenses occur below the 40 cm depth. (2) Gravel sometimes occurs within 90 cm of surface, but usually below 120 cm. Slight to moderate limitations, fair source of roadfill - lack of Ah horizon, susceptibility to frost heave, moderate shrink-swell potential.
3	Orthic Gleysol and Orthic Gleysol, peaty phase	very coarse textured glaciofluvial sediments (gravel)	gravel	a (0 to 0.5%)	5	poor	Severe to very severe limitations, poor source of roadfill - surface stoniness, seasonally high groundwater table or surface ponding, organic surface layer more

							than 15 cm thick, lack of Ah horizon, rapid permeability, groundwater contamination hazard.
TH	Terric Humisol	predominantly humic peat, overlying medium to very coarse textured fluvial sediments (gravel)	mesic or fibric peat	a, c (0 to 5%)	0	very poor	Very severe limitations, very poor source of roadfill - Organic soil, seasonally high groundwater table or surface ponding, lack of Ah horizon, high shrink-swell potential, groundwater contamination hazard.
M	undifferentiated Mesisol	predominantly mesic peat	mesic peat	a (0 to 0.5%)	0	very poor	Very severe limitations, very poor source of roadfill - Organic soil, seasonally high groundwater table or surface ponding, lack of Ah horizon, high shrink-swell potential, groundwater contamination hazard.

which are readily identifiable as to botanic origin. The organic matter of humic layers is in a highly decomposed state, and often has a smooth greasy feel when moist. It has the least amount of recognizable plant fibre, and is usually darker in colour than fibric or mesic materials. It is relatively stable and changes little in physical or chemical composition with time. The organic matter of mesic layers is in an intermediate stage of decomposition between that of fibric and humic layers, and is partially altered both chemically and physically. Management problems in areas of cultivated Organic soils involve the maintenance of controlled drainage, adequate fertilization, and tillage practices necessary to maintain a firm bed for seed germination and root development. Over-drainage and dessication of peat are detrimental to crop production and to the maintenance of the organic layers in a desirable physical condition. Under cultivation, many Organic soils show deficiencies in macro and micro mineral nutrients, and most require the application of phosphorus and potassium to obtain maximum productivity. Special problems also exist in using Organic soils for construction purposes. These are their low bearing strength, high shrink-swell potential and susceptibility to frost heaving.

Three patches of Organic soils occur in depressional locations in the study area.

Soils of the Brunisolic order are rapidly to imperfectly drained mineral soils with sufficient profile development to exclude them from the Regosolic order, but that lack the degrees or kinds of horizon development specified for soils of other orders. Their common characteristic of identification is the development in situ of the prominent brownish Bm horizon with sufficient alteration by hydrolysis, oxidation or solution to produce significant changes in colour, structure and composition different from those of an A or C horizon. Because the processes of leaching and weathering are relatively weakly developed in Brunisolic soils, they tend to reflect the chemical characteristics, particularly the base status and acidity, of parent materials from which they have been derived.

Only two patches of well drained Brunisolic soils developed on medium to moderately coarse textured fluvial sediments are found in the study area. One sizeable patch is adjacent to the main entrance road leading into Blue Lake Centre, on the west side. These fluvial sediments are of relatively recent deposition, and the time elapsed has been sufficient for only minimal soil profile development.

Soils of the Gleysolic order are poorly drained mineral soils whose profiles reflect the influence of waterlogging for significant periods. Water saturation causes reducing conditions due to a lack of aeration. These conditions result in gleyed horizons having dull gray to olive, greenish or bluish-gray moist colours, frequently accompanied by prominent usually rust-coloured mottles resulting from localized oxidation and reduction of hydrated iron oxides.

Only one small patch of Gleysolic soils developed on very coarse textured glaciofluvial sediments (gravel) was mapped in the study area, near the northeastern corner.

The map units are described in chronological order, and horizon thicknesses represent averages. Thicknesses of comparative horizons in identical soil profiles often vary as much as 10 to 40 percent from the norm at different points in the landscape.

The dominant plant species are listed using common names. These are very general lists, and not purported to be complete.

MAP UNIT 1

Classification: Orthic Gray Luvisol - 60%
Orthic Gray Luvisol, peaty phase - 40%

Parent Material: very coarse textured glaciofluvial sediments (gravel)

Landform: hummocky glaciofluvial (Fh^G), level glaciofluvial ($F1^G$), undulating glaciofluvial (Fu^G)

Slope: gently undulating to hilly (0.5 to 60%)

Surface Stoniness: exceedingly stony (4)

Drainage: well to rapidly drained

Vegetation: predominantly lodgepole pine; scattered white spruce and aspen (white spruce dominant on some north-facing slopes); understory consists of Canadian buffalo-berry, willow, wild rose, common bearberry, grass; patches of swamp birch, Labrador tea, mosses.

Profile Description: Orthic Gray Luvisol

Horizon	Thickness Field (cm)	Texture	Structure	Consistence
L-H	2-8	needle, leaf, and root litter		
Ae	10-15	gravelly fine sandy loam to gravelly sandy loam	platy	very friable, moist; slightly hard, dry
Bt	20-40	very gravelly clay loam	subangular blocky	very friable, moist
Cca	50-65	gravel	amorphous	loose, dry or moist

Orthic Gray Luvisol, peaty phase

Horizon	Thickness (cm)	Field Texture	Structure	Consistence
L-H	15-25	moss, leaf, and root litter		
Ae	10-15	gravelly fine sandy loam to gravelly sandy loam	platy	very friable, moist; slightly hard, dry
Bt	20-40	very gravelly clay loam	subangular blocky	very friable, moist
Cca	50-65	gravel	amorphous	loose, dry or moist

Comments: (1) The peaty phase soils occur on north-facing and east-facing slopes; and in depressions.

(2) Pockets of Ae horizon, 20 to 30 cm thick, are sometimes found.

Limitations: Slight to very severe.

(1) For the Orthic Gray Luvisols: Slight on suitable topography for road location; severe due to surface stoniness but otherwise moderate on suitable topography for lawns and landscaping; severe for septic tank absorption fields; severe due to surface stoniness but otherwise slight on suitable topography for all other uses; good source of roadfill on suitable topography. Other limitations include excessive slopes, erosion hazard, rapid permeability (droughtiness), groundwater contamination hazard, and lack of Ah horizon.

(2) For the Orthic Gray Luvisols, peaty phase: Slight on suitable topography for road location; severe for primitive camping areas, and trails; severe to very severe for all other uses; good source of roadfill on suitable topography. Limitations include organic surface layer more than 15 cm thick, surface stoniness, excessive slope, erosion hazard, lack of Ah horizon, rapid permeability, and groundwater contamination hazard.

MAP UNIT 2

Classification: Orthic Eutric Brunisol

Parent Material: medium to moderately coarse textured fluvial sediments

Landform: level fluvial (F1)

Slope: gently undulating (0.5 to 2%)

Surface Stoniness: nonstony (0)

Drainage: well drained

Vegetation: open areas of grass and forbs; with patches of swamp birch, and scattered willow; occasional forested patches of lodgepole pine, white spruce, and aspen.

Profile Description: Orthic Eutric Brunisol

Horizon	Thickness Field (cm)	Texture	Structure	Consistence
L-H	5-8	root and leaf litter (turfy when developed under grass)		
Bm1	20-50	loam, fine sandy loam, or silt loam	platy	very friable to friable, moist
Bm2	50-80	loam, fine sandy loam, or silt loam	amorphous	very friable to friable, moist

Comments: (1) Layers of variable textured sediments occur in unpredictable sequences throughout these soil profiles, and thicknesses range from 20 to 50 cm. Occasional sand lenses, 10 to 20 cm thick are found below the 40 cm depth.

(2) Gravel sometimes occurs within 90 cm of the surface, but is usually deeper than 120 cm.

Limitations: Slight to moderate-moderate for lawns and landscaping, buildings with basements, and road location; slight for all other uses; fair source of roadfill. Limitations include lack of an Ah horizon, susceptibility to frost heave, and moderate shrink-swell potential.

MAP UNIT 3

Classification: Orthic Gleysol, and Orthic Gleysol peaty phase (these two phases are intimately and unpredictably associated).

Parent Material: very coarse textured glaciofluvial sediments (gravel)

Landform: level glaciofluvial ($F1^G$)

Slope: nearly level (0 to 0.5%)

Surface Stoniness: excessively stony (5)

Drainage: poor

Vegetation: swamp birch, willow, grass, forbs, mosses; scattered shrubby cinquefoil; patches of black spruce.

Profile Description: Orthic Gleysol, and Orthic Gleysol peaty phase

Horizon	Thickness Field (cm)	Texture	Structure	Consistence
Of	0-20	predominantly fibric peat		
Oh	10-25	predominantly humic peat		
Bg	100	gravel	amorphous	loose, moist

Limitations: Severe to very severe - severe for road location; very severe for septic tank absorption fields; very severe due to surface stoniness but otherwise severe for all other uses; poor source of roadfill. Other limitations include seasonally high groundwater table or surface ponding, organic surface layer more than 15 cm thick, lack of Ah horizon, rapid permeability, and groundwater contamination hazard.

TH (ORGANIC SOIL)

Classification: Terric Humisol

Parent Material: predominantly humic peat, overlying medium to very coarse textured fluvial sediments (gravel)

Landform: horizontal fen (Nh), undulating fen (Nu)

Slope: nearly level to undulating (0 to 5%)

Surface Stoniness: nonstony (0)

Drainage: very poor

Vegetation: swamp birch, willow, slough grass, forbs; scattered shrubby cinquefoil; patches of black spruce, Labrador tea, mosses

Profile Description: Terric Humisol

Horizon	Thickness Field (cm)	Texture	Structure	Consistence
Om–Of	0–25	mesic or fibric peat		
Oh	45–75	predominantly humic peat		
Cg	at 45–100	loam to gravel	amorphous	very friable to loose, moist

Limitations: Very severe for all uses; very poor source of roadfill. Limitations include Organic soil, seasonally high groundwater table or surface ponding, lack of Ah horizon, high shrink–swell potential, and groundwater contamination hazard.

M (ORGANIC SOIL)

Classification: undifferentiated Mesisol

Parent Material: predominantly mesic peat

Landform: horizontal fen (Nh)

Slope: nearly level (0 to 0.5%)

Surface Stoniness: nonstony (0)

Drainage: very poor

Vegetation: swamp birch, slough grass, mosses; occasional black spruce

Profile Description: Mesisol

Horizon	Thickness (cm)	Field description
Om	100	predominantly mesic peat
Oh	30+	predominantly humic peat

Limitations: Very severe for all uses; very poor source of roadfill. Limitations include Organic soil, seasonably high groundwater table or surface ponding, lack of Ah horizon, high shrink-swell potential, and groundwater contamination hazard.

Special Features

The soils in Alberta have been classified into broad general zones (figure 2) as established by Alberta Soil Survey during the normal course of soil surveys, and correlated with temperature and precipitation records. Annual precipitation amounts change gradually from one soil zone to another, and are not abrupt changes at the point where a zone boundary has been located. Thus a zone boundary is a broad transitional belt, which can be many kilometres across. Topsoil colours reflect this gradual change. For example, in the centre of the Brown Soil Zone (annual precipitation about 30 to 33 cm), topsoil colours are brown. Similarly in the centre of the Dark Brown Soil Zone (annual precipitation about 38 cm), topsoil colours are dark brown. Between these two zones, topsoil colours are brown to dark brown, and annual precipitation is about 35 cm. The boundary between the two soil zones has been placed approximately at that midpoint.

Zonal soils are soils with well developed soil characteristics that reflect the zonal or normal influences of climate and living organisms, mainly vegetation, as active factors of soil genesis. Examples are Brown, Dark Brown, or Black soils of the Brown, Dark Brown, or Black Soil Zones respectively. Intrazonal soils are soils with morphology that reflects the influence of some local factor of relief, parent material, or age; rather than of climate and vegetation. An example is Solonetzic soils, which develop as a result of salinization. This may originate internally from a saline parent material, or from saturation by external saline waters. Solonetzic soils are found across many soil zones (figure 2). Azonal soils are soils without distinct genetic horizons, and are represented by Regosolic soils in Canada. These occur across all the soil zones in the province.

Blue Lake Centre is situated in the Gray Luvisolic soil zone and the soils throughout the majority of the area are classified as Orthic Gray Luvisols, which are zonally normal. Patches of intrazonal Brunisolic, Organic, and Gleysolic soils also occur. Gleysolic soils occur across all the soil zones; and Brunisolic and Organic soils occur in most. Soils of the study area can be considered typical, both locally and regionally (Dumanski et al, 1972).

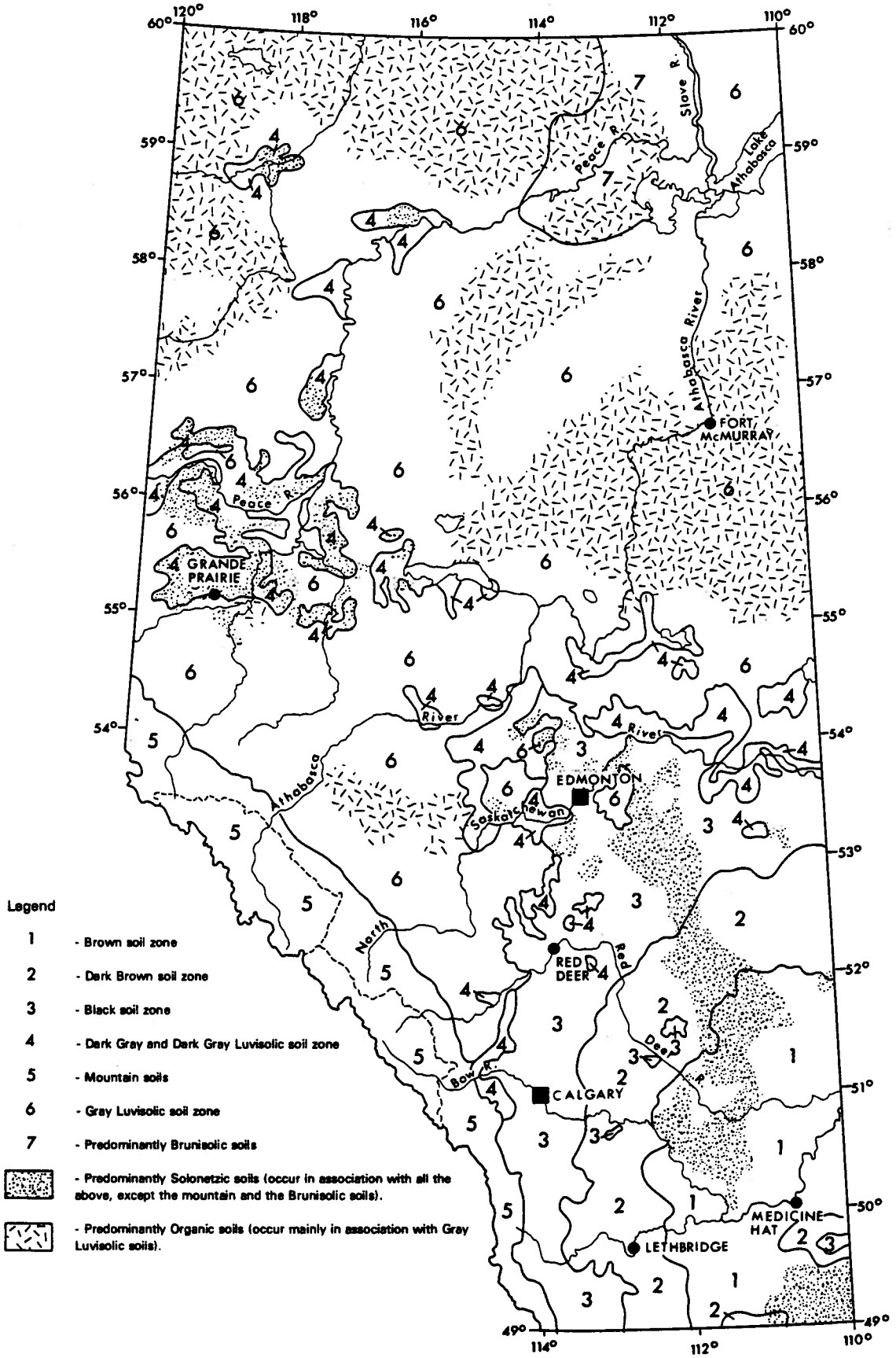

Figure 2. Map showing soil zones of Alberta (from Soil Group Map of Alberta, Alberta Institute of Pedology, undated).

Special features of soils in the study area are the inherent properties of Luvisolic and Organic soils, and the high gravel content of the Luvisolic soils. The Luvisolic soils in their natural state display surface leaf litter (L-H) and leached light gray coloured Ae horizons, typical of soils developed under forest vegetation. The Ae horizons are underlain by much finer textured Bt horizons of clay accumulation. The overwhelming feature of the Gray Luvisolic soil profiles in the study area is the preponderance of gravel, since these soils have developed in gravel. However, the inherent properties of Luvisolic soils can still be detected. The Organic soils are soft and spongy to walk on, and hold vast quantities of water. These soil profiles do not display well developed distinctive horizons that depict mineral soils. The soil materials resemble sponges and readily absorb water, which can easily be squeezed out in the hand.

MISCELLANEOUS SYMBOLS

This symbol indicates escarpments. These have very severe limitations for all uses because of extreme slopes and erosion hazard.

This symbol indicates water-filled depressions characterized by the growth of hydrophytic vegetation, consisting mainly of slough grass; and willows around the fringes.

SOIL INTERPRETATIONS

An explanation of soil interpretations and definitions of the soil limitation and suitability ratings are given in Greenlee (1981). The results of soil chemical and physical analyses are given in tables 2 and 3.

The soils best suited to recreational development in the study area are those of Map Unit 2; however they are of very limited extent. Map Unit 1 soils, widespread in the study area, have severe limitations due to surface stoniness; but the Orthic Gray Luvisols are otherwise well suited when found on suitable topography. These soils have developed on steep slopes for the most part, but a few patches of suitable topography do occur. The Orthic Gray Luvisols, peaty phase have severe limitations because of the organic surface layers more than 15 cm thick, and surface stoniness. Map Unit 3 soils have severe limitations due to seasonally high groundwater tables or surface ponding, and very severe limitations due to surface stoniness. The Terric Humisol and Mesisol Map Units have very severe limitations because of the inherent properties of Organic soils, and extreme wetness.

The soils best suited to road construction are those of Map Unit 1 when found on suitable topography. Map Unit 2 soils have moderate limitations because of moderate shrink-swell potential and susceptibility to frost heave. Map Unit 3 soils have severe limitations due to seasonally high groundwater tables or surface ponding. The Terric Humisol and Mesisol Map Units have very severe limitations because of the inherent properties of

Table 2. Chemical Analyses of Selected Map Units[1]

Map Unit	Depth cm	pH H_2O	[2] EC	[3] Na	[3] SO_4	[3] OM	[3] $CaCO_3$
1	0 - 15	5.7	0.2	L-	[4]nd	M-	-
	15 - 30	6.5	0.1	L	nd	L	-
2	0 - 15	5.8	0.2	L	nd	M-	-
	15 - 30	5.4	0.1	L-	nd	M-	-

[1]Chemical Analyses done by Alberta Soil and Feed Testing Laboratory,

[2]EC-electrical conductivity, millimhos/cm, [3]These tests are rated into 4 categories: High(H), Medium(M), Low(L), and none(-). The degree within each category is indicated by a + or - sign. The test for OM (organic matter) and $CaCO_3$ (free lime) are visual estimates only. [4]nd - not determined.

able 3. Physical Analyses of Selected Map Units (1)

ap nit	Depth cm	Field Moisture %	Mechanical Analysis											Liquid Limit	Plasticity Index	Optimum Moisture %(2)	Maximum Dry Density lb/ft.^{3} (2)	Classification		
			Percentage Passing Sieve							Percentage Smaller Than								AASHO	Unified	USDA
			1 inch	3/4 inch	5/8 inch	#4 (4.7 mm.)	#10 (2.0 mm.)	#40 0.42 mm.)	#200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.	0.001 mm.							
2	90-120	27	100	100	100	100	100	100	80	70	35	26	20	33	12	21	101.0	A-6(9)	CL	L

) Map Units developed on similar parent material:

) These values are obtained from charts worked out by the Highways Testing Laboratory, Alberta Transportation.

Organic soils, extreme wetness, and high shrink-swell potential.

Specific limitations and suitabilities of the various soils for selected uses are shown in tables 4 to 13 inclusive. The ratings were determined on the basis of morphological, physical, and chemical properties of the soils, as well as steepness of slope. The principal limiting properties are indicated, and are generally listed in decreasing order of importance. In tables 4 to 12 inclusive, the soil limitations for various uses have been designated as none to slight, moderate, severe, and very severe. In table 13, the suitability of soils as sources of roadfill has been designated as good, fair, poor, and very poor.

TABLE 4. SOIL LIMITATIONS FOR PRIMITIVE CAMPING AREAS

MAP SYMBOL[1]	DEGREE OF LIMITATION[2]	MAP SYMBOL	DEGREE OF LIMITATION	MAP SYMBOL	DEGREE OF LIMITATION
[3]1/b4 1/c4 1/d4	S - Stony, otherwise SL	3/a5	S - Wet, Org Surf VS - Stony		
1/f4	M - Slope, Er S - Stony	TH/ao TH/co	VS - Org, Wet		
1/g4	S - Slope, Er Stony	M/ao	VS - Org, Wet		
[4]1/b4 1/c4 1/d4	S - Org Surf, Stony				
1/f4	S - Org Surf, Stony, Slope				
1/g4	S - Slope, Er, Org Surf				
2/bo	SL				

1. For explanation, see Soil Map
2. SL-None to slight, M-Moderate, S-Severe, VS-Very severe
3. These ratings are for the Orthic Gray Luvisols.
4. These ratings are for the Orthic Gray Luvisols, peaty phase.

Abbreviations

BR - Shallow depth to bedrock
Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
Org - Organic soil
Org Surf - Organic surface layer >15 cm thick
Sandy - Sandy surface texture
Slip - Slippery or sticky when wet
Slope - Excessive slope
Sl Perm - Slow permeability
Solz - Solonetzic soil
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

TABLE 5. SOIL LIMITATIONS FOR PICNIC AREAS

MAP SYMBOL[1]	DEGREE OF LIMITATION[2]	MAP SYMBOL	DEGREE OF LIMITATION	MAP SYMBOL	DEGREE OF LIMITATION
[3]1/b4 1/c4 1/d4	S - Stony, otherwise SL	3/a5	S - Wet, Org Surf VS - Stony		
1/f4	S - Slope, Er, Stony	TH/ao TH/co	VS - Org, Wet		
1/g4	VS - Slope, Er, Stony	M/ao	VS - Org, Wet		
[4]1/b4 1/c4 1/d4	S - Org Surf, Stony				
1/f4	S - Slope, Er, Org Surf				
1/g4	VS - Slope, Er, Org Surf				
2/bo	SL				

1. For explanation, see Soil Map
2. SL-None to slight, M-Moderate, S-Severe, VS-Very severe
3. These ratings are for the Orthic Gray Luvisols.
4. These ratings are for the Orthic Gray Luvisols, peaty phase.

Abbreviations

BR - Shallow depth to bedrock
Clay - High clay content
Er - Erosion hazard
Org - Organic soil
Org Surf - Organic surface layer >15 cm thick
Sandy - Sandy surface texture
Slip - Slippery or sticky when wet
Slope - Excessive slope
Sl Perm - Slow permeability
Solz - Solonetzic soil
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

TABLE 6. SOIL LIMITATIONS FOR LAWNS AND LANDSCAPING

MAP SYMBOL[1]	DEGREE OF LIMITATION[2]	MAP SYMBOL	DEGREE OF LIMITATION	MAP SYMBOL	DEGREE OF LIMITATION
[3]1/b4 1/c4 1/d4	M - R Perm, Thin Ah S - Stony	2/bo	M - Thin Ah		
1/f4	S - Slope, Er, Stony	3/a5	S - Wet, Org Surf, Thin Ah VS - Stony		
1/g4	VS - Slope, Er, Stony	TH/ao TH/co	VS - Wet, Org, Thin Ah		
[4]1/b4 1/c4 1/d4	S - Org Surf, Stony, Thin Ah	M/ao	VS - Wet, Org, Thin Ah		
1/f4	S - Slope, Er, Stony				
1/g4	VS - Slope, Er, Stony				

1. For explanation, see Soil Map
2. SL-None to slight, M-Moderate, S-Severe, VS-Very severe
3. These ratings are for the Orthic Gray Luvisols.
4. These ratings are for the Orthic Gray Luvisols, peaty phase.

Abbreviations

BR - Shallow depth to bedrock
Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
Lime - High lime content (soil nutrient imbalance)
Org - Organic soil
Org Surf - Organic surface layer > 15 cm thick
R Perm - Rapid permeability (droughtiness)
Saline - Surface soil salinity
Sandy - Sandy surface texture
Slope - Excessive slope
Sl Perm - Slow permeability
Solz - Solonetzic soil
Stony - Surface stoniness
Thin Ah - Thin or no Ah horizon
Wet - Seasonally high groundwater table or surface ponding

TABLE 7. SOIL LIMITATIONS FOR PATHS

MAP SYMBOL[1]	DEGREE OF LIMITATION[2]	MAP SYMBOL	DEGREE OF LIMITATION	MAP SYMBOL	DEGREE OF LIMITATION
[3]1/b4 1/c4 1/d4	S - Stony, otherwise SL	TH/ao TH/co	VS - Org, Wet		
1/f4	S - Slope, Er, Stony	M/ao	VS - Org, Wet		
1/g4	VS - Slope, Er, Stony				
[4]1/b4 1/c4 1/d4	S - Org Surf, Stony				
1/f4	S - Slope, Er, Org Surf				
1/g4	VS - Slope, Er, Org Surf				
2/bo	SL				
3/a5	S - Wet, Org Surf VS - Stony				

1. For explanation, see Soil Map
2. SL-None to slight, M-Moderate, S-Severe, VS-Very severe
3. These ratings are for the Orthic Gray Luvisols
4. These ratings are for the Orthic Gray Luvisols, peaty phase

Abbreviations

Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
Org - Organic soil
Org Surf - Organic surface layer >15 cm thick
Sandy - Sandy surface texture
Slip - Slippery or sticky when wet
Slope - Excessive slope
Solz - Solonetzic soil
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

TABLE 8. SOIL LIMITATIONS FOR TRAILS

MAP SYMBOL[1]	DEGREE OF LIMITATION[2]	MAP SYMBOL	DEGREE OF LIMITATION	MAP SYMBOL	DEGREE OF LIMITATION
[3]1/b4 1/c4 1/d4	S - Stony, otherwise SL	TH/ao TH/co	VS - Org, Wet		
1/f4	M - Slope, Er S - Stony	M/ao	VS - Org, Wet		
1/g4	S - Slope, Er, Stony				
[4]1/b4 1/c4 1/d4	S - Org Surf, Stony				
1/f4	S - Org Surf, Stony, Slope				
1/g4	S - Slope, Er, Org Surf				
2/bo	SL				
3/a5	S - Wet, Org Surf VS - Stony				

1. For explanation, see Soil Map
2. SL-None to slight, M-Moderate, S-Severe, VS-Very severe
3. These ratings are for the Orthic Gray Luvisols
4. These ratings are for the Orthic Gray Luvisols, peaty phase.

Abbreviations

Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
Org - Organic soil
Org Surf - Organic surface layer > 15 cm thick
Sandy - Sandy surface texture
Slip - Slippery or sticky when wet
Slope - Excessive slope
Solz - Solonetzic soil
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

TABLE 9. SOIL LIMITATIONS FOR BUILDINGS WITH BASEMENTS

MAP SYMBOL[1]	DEGREE OF LIMITATION[2]	MAP SYMBOL	DEGREE OF LIMITATION	MAP SYMBOL	DEGREE OF LIMITATION
1/b4 1/c4 1/d4	S - Stony, otherwise SL				
1/f4	S - Slope, Stony				
1/g4	VS - Slope, Stony				
2/bo	M - Frost				
3/b5	S - Wet VS - Stony				
TH/ao TH/co	VS - Org, Wet, Sh-Sw				
M/ao	VS - Org, Wet, Sh-Sw				

1. For explanation, see Soil Map
2. SL-None to slight, M-Moderate, S-Severe, VS-Very severe

Abbreviations

BR - Shallow depth to bedrock
Clay - High clay content
Flood - Flooding hazard (overflow)
Frost - Susceptibility to frost heave
M Sh-Sw - Moderate shrink - swell potential
Org - Organic soil
Sh-Sw - High shrink - swell potential
Slope - Excessive slope
Stony - Surface stoniness
Sulfate - Possible concrete corrosion hazard (soluble sulfate)
Wet - Seasonally high groundwater table or surface ponding

TABLE 10. SOIL LIMITATIONS FOR BUILDING WITHOUT BASEMENTS

MAP SYMBOL[1]	DEGREE OF LIMITATION[2]	MAP SYMBOL	DEGREE OF LIMITATION	MAP SYMBOL	DEGREE OF LIMITATION
1/b4 1/c4 1/d4	S - Stony, otherwise SL				
1/f4	S - Slope, Stony				
1/g4	VS - Slope, Stony				
2/bo	SL				
3/b5	S - Wet VS - Stony				
TH/ao TH/co	VS - Org, Wet				
M/ao	VS - Org, Wet				

1. For explanation, see Soil Map
2. SL-None to slight, M-Moderate, S-Severe, VS-Very severe

Abbreviations

BR - Shallow depth to bedrock
Flood - Flooding hazard (overflow)
Org - Organic soil
Slope - Excessive slope
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

TABLE 11. SOIL LIMITATIONS FOR SEPTIC TANK ABSORPTION FIELDS

MAP SYMBOL[1]	DEGREE OF LIMITATION[2]	MAP SYMBOL	DEGREE OF LIMITATION	MAP SYMBOL	DEGREE OF LIMITATION
1/b4 1/c4 1/d4	S - R Perm, GW				
1/f4	S - Slope, R Perm, GW				
1/g4	VS - Slope, R Perm, GW				
2/bo	SL				
3/a5	VS - Wet, GW, R Perm				
TH/ao TH/co	VS - Org, Wet, GW				
M/ao	VS - Org, Wet, GW				

1. For explanation, see Soil Map
2. SL-None to slight, M-Moderate, S-Severe, VS-Very severe

Abbreviations

BR - Shallow depth to bedrock
Clay - High clay content
Flood - Flooding hazard (overflow)
GW - Groundwater contamination hazard
Org - Organic soil
R Perm - Rapid permeability
Slope - Excessive slope
Sl Perm - Slow permeability
Wet - Seasonally high groundwater table or surface ponding

TABLE 12. SOIL LIMITATIONS FOR ROAD LOCATION

MAP SYMBOL[1]	DEGREE OF LIMITATION[2]	MAP SYMBOL	DEGREE OF LIMITATION	MAP SYMBOL	DEGREE OF LIMITATION
1/b4 1/c4 1/d4	SL				
1/f4	S - Slope				
1/g4	VS - Slope				
2/bo	M - M Sh-Sw, Frost				
3/b5	S - Wet				
TH/ao TH/co	VS - Org, Wet, Sh-Sw				
M/ao	VS - Org, Wet, Sh-Sw				

1. For explanation, see Soil Map
2. SL-None to slight, M-Moderate, S-Severe, VS-Very severe

Abbreviations

BR - Shallow depth to bedrock
Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
Frost - Susceptibility to frost heave
M Sh-Sw-Moderate shrink-swell potential
Org - Organic soil
Sh-Sw-High shrink-swell potential
Slope - Excessive slope
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

TABLE 13. SOIL SUITABILITY FOR SOURCE OF ROADFILL

MAP SYMBOL[1]	DEGREE OF SUITABILITY[2]	MAP SYMBOL	DEGREE OF SUITABILITY	MAP SYMBOL	DEGREE OF SUITABILITY
1/b4 1/c4 1/d4	G				
1/f4	F - Slope				
1/g4	P - Slope				
2/bo	F - M Sh-Sw, Frost				
3/a5	P - Wet				
TH/ao TH/co	VP - Wet, Org, Sh-Sw				
M/ao	VP - Org, Wet, Sh-Sw				

1. For explanation, see Soil Map
2. G-Good, F-Fair, P-Poor, VP-Very poor

Abbreviations

BR - Shallow depth to bedrock
Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
Frost - Susceptibility to frost heave
M Sh-Sw - Moderate shrink - swell potential
Org - Organic soil
Sh-Sw - High shrink - swell potential
Slope - Excessive slope
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

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Scale 1:8000 (approx.)

666 0 666 1332 Feet

160 0 160 320 Metres

SOIL CLASSIFICATION			
MAP UNIT	SOIL ORDER	SOIL SUBGROUP	SOIL PARENT MATERIAL
1	Luvisolic	Orthic Gray Luvisol-60% Orthic Gray Luvisol, peaty phase-40%	very coarse textured glaciofluvial sediments (gravel)
2	Brunisolic	Orthic Eutric Brunisol	medium to moderately coarse textured fluvial sediments
3	Gleysolic	Orthic Gleysol and Orthic Gleysol, peaty phase	very coarse textured glaciofluvial sediments (gravel)
TH	Organic	Terric Humisol	predominantly humic peat, overlying medium to very coarse textured fluvial sediments
M	Organic	undifferentiated Mesisol	predominantly mesic peat

LEGEND: Map Symbol

1 ← map unit
f 4 ← surface stoniness rating
topographic class

- soil line
- boundary of mapped area
- escarpment
- direction of slope
- water-filled depression

N

Soil Map, Blue Lake Centre

Tp 52, R 26, W5M

G.M. Greenlee

Published 1985
Fieldwork conducted in 1976

Cartography by Alberta Research Council, Graphics Services.

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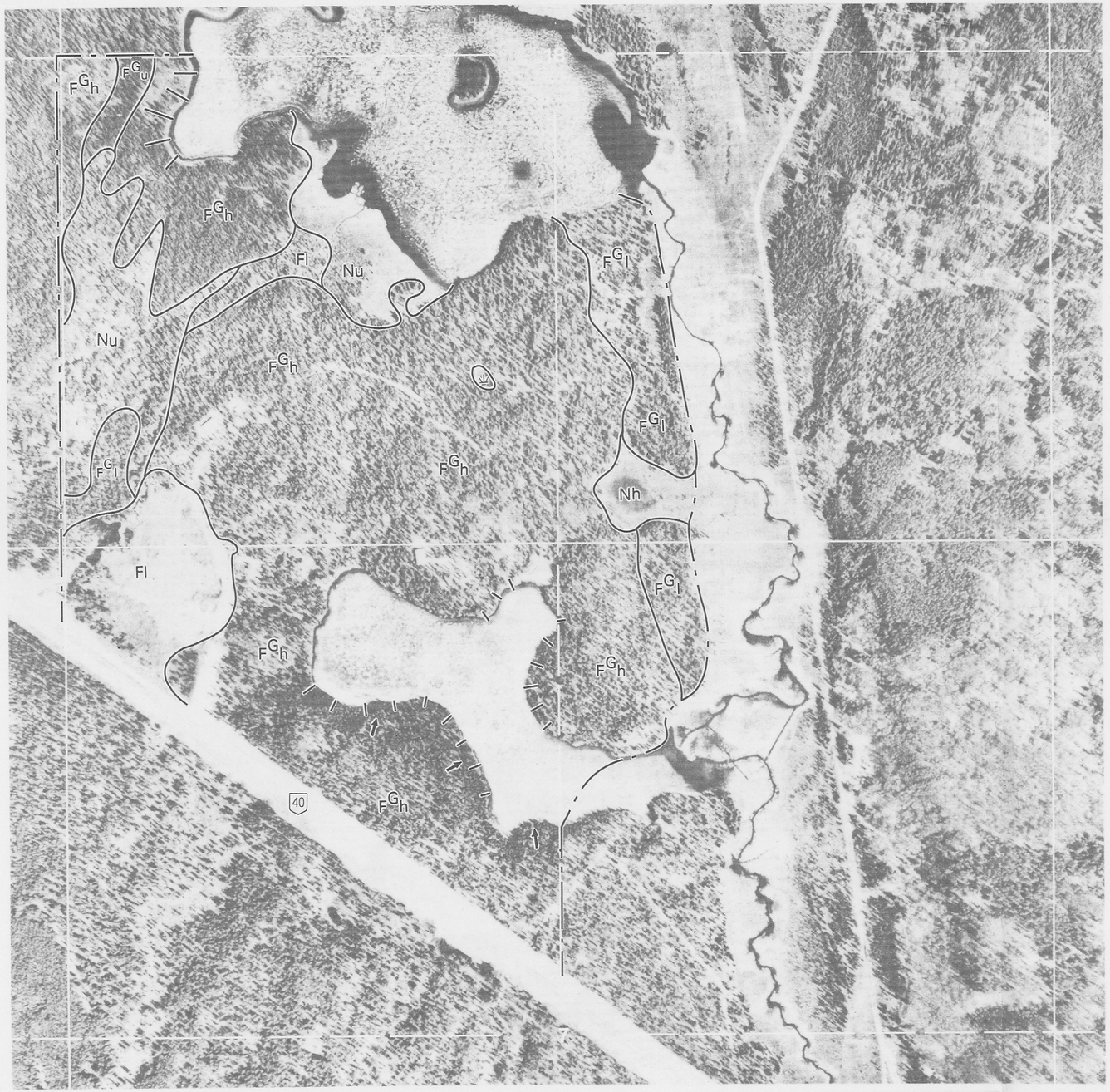

LEGEND:

F - Fluvial

Fl	- level fluvial
F^{G}_{h}	- hummocky glaciofluvial
F^{G}_{l}	- level glaciofluvial
F^{G}_{u}	- undulating glaciofluvial

N - Fen

Nh	- horizontal fen
Nu	- undulating fen

- landform line
- boundary of mapped area
- escarpment
- direction of slope
- water-filled depression

N

Scale 1:8000 (approx.)

666 0 666 1332 Feet

160 0 160 320 Metres

Landform Map, Blue Lake Centre

Tp 52, R 26, W5M

G.M. Greenlee

Published 1985
Fieldwork conducted in 1976

Cartography by Alberta Research Council, Graphics Services.

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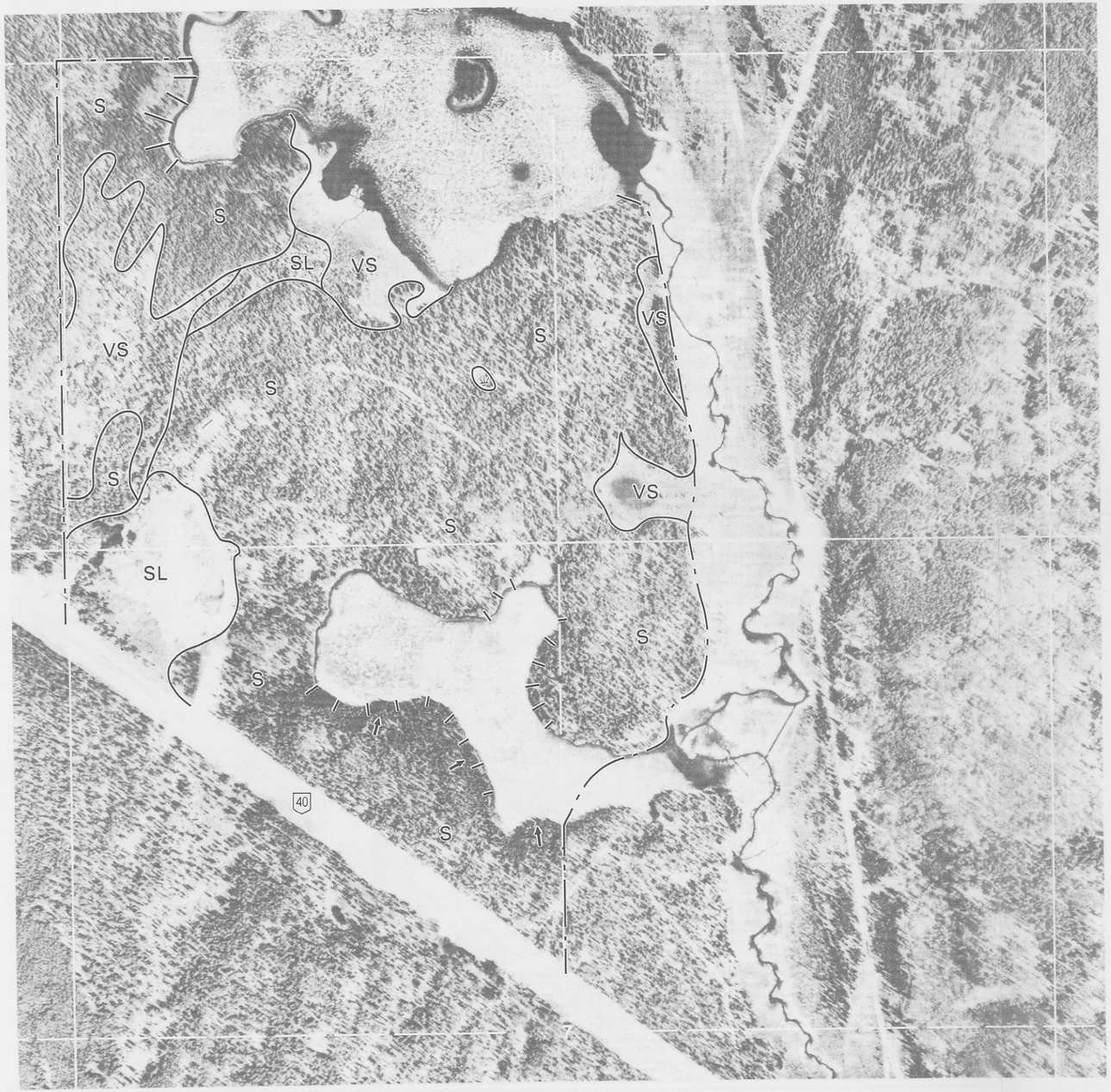

LEGEND:

SL - none to slight soil limitations

M - moderate soil limitations

S - severe soil limitations

VS - very severe soil limitations

N

- soil limitation line
- boundary of mapped area
- escarpment
- direction of slope
- water-filled depression

Scale 1:8000 (approx.)

666 0 666 1332 Feet

160 0 160 320 Metres

Soil Limitations for Recreation, Blue Lake Centre

Tp 52, R 26, W5M

G.M. Greenlee

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