Soils Report No. D33 1980

SOILS OF THE CRANBERRY PORTAGE MAP AREA

by

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SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA
JANUARY, 1980

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
Detailed Studies and Surveys								
D1	Pasquia (No. 11)	Pub.	57,200	a,b,d	3	1:63,360	Color	A
D2	Glenlea Research Station	Int.	541	a,b	1	1:7,920	Photo	A
D3	Morden Experimental Farm	Int.	256	a,b	1	1:12,000	Photo	A
D4	Onanole	Int.	768	a,b	1	1:7,920	Photo	U
D5	York Factory Area	Int.	768	a	3	1:63,360	B&W	
D6	McCreary Tile Drain Project	Int.	64	a,b	1	1:5,000	B&W	A
D7	Brandon Experimental Farm	Pre.	768	a,b	1	1:7,920	Photo	A
D8	Portage Potato Farm	Int.	480	a,b	1	1:4,800	Photo	A
D9	Portage la Prairie (No. 17)	Pub.	113,200	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D10	Morden-Winkler (No. 18)	Pub.	71,424	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D11	Deep Lake	Int.	1,400	a,b	1	1:6,000	B&W	R
D12	Thompson Environmental Study	Int.	32	a,b	1	1:1,000	B&W	
D13	Organic Soil Study of Alexander L.G.D.	Int.	29,456	a,b	3	1:63,360	B&W	A
D14	Winnipeg Region	Pub.	280,000	a,b,c	2	1:20,000	Photo	A,E,U,R
D15	Brandon Region	Pub.	59,600	a,b,c	2	1:20,000	Photo	A,E,U,R
D16	Boissevain-Melita (No. 20)	Pub.	262,912	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D17	Carman	Data continuing	35,840	a,b	2	1:20,000	B&W	A,E,R
D18	Orr Lake	Int.	20	a,b	1	1:1,000	B&W	
D19	Pelican-Rock Lake	Data	14,080	a.b	2	1:20,000	Photo	A,E,R
D20	West Portage	Pre. continuing	55,600	a,b	2	1:20,000	Photo	A,I,E,U,R
D21	Minnewasta	Int.	2,560	a,b	2	1:20,000	Photo	A,E,R,I
D22	Killarney	Int.	4,600	a,b	2	1:20,000	Photo	A,E,R,I
D23	Matlock-Gimli-Riverton	Int.	18,400	a,b	2	1:20,000	Photo	A,E,R,I
D24	Glenboro	Int.	5,960	a,b	2	1:20,000	Photo	A,E,R,I
D25	Sandy Lake	Int.	1,720	a,b	2	1:20,000	Photo	A,E,R,I
D26	Beausejour	Int.	10,813	a,b	2	1:20,000	Photo	A,E,R,I,U
D27	Rockwood	Int.	12,928	a,b	2	1:20,000	Photo	A,E,R,I,U
D28	Oak Lake	Int.	1,293	a,b	2	1:20,000	Photo	A,I
D29	Bird River	Pre.	2,560	a,b	2	1:20,000	Photo	A,E,R
D30	North Shore Lac du Bonnet	Pre.	2,400	a,b	2	1:20,000	Photo	A,E,R
D31	Grindstone Point	Int.	8,040	a,b	2	1:20,000	Photo	A,E,R

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1980

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
D32	Paint Lake	Pre.	2,880	a,b	2	1:20,000	Photo	A,E,R
D33	Cranberry Portage	Pre.	80	a,b	1	1:5,000	Photo	A,E,R
D34	Dauphin	Pre.	6,400	a,b	2	1:20,000	Photo	A,E,U,R,I
D35	South Riding Mtn.	Pre. continuing	17,095	a,b	2	1:20,000	Photo	A,E,U,R
D36	West Interlake	Pre.	10,036	a,b	2	1:20,000	Photo	A,E,U,R,I
D37	Swan R. Townsite	Pre. continuing	9,324	a,b	2	1:20,000	Photo	A,E,U,R
D38	Hadashville-organic	Pre.	6,475	a,b	3	1:40,000	Photo	A,E,U,R
D39	Rat River	Pre. continuing	27,972	a,b	3	1:40,000	Photo	A,E,U,R
D40	Whiteshell	Pre. continuing	25,900	a,b	2	1:20,000	Photo	A,E,U,R

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1980

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
Reconnaissance Surveys								
R1	South Western (No. 3)	Pub.	709,600	d	3	1:125,000	B&W	A
R2	South Central (No. 4)	Pub.	967,600	d	3	1:125,000	B&W	A
R3	Winnipeg and Morris (No. 5)	Pub.	1,419,200	d	3	1:125,000	Color	A
R4	Rossburn and Virden (No. 6)	Pub.	1,372,400	d	3	1:125,000	Color	A
R5	Carberry (No. 7)	Pub.	967,600	d	3	1:125,000	Color	A
R6	West-Lake (No. 8)	Pub.	592,800	d	3	1:125,000	Color	A
R7	Grandview (No. 9)	Pub.	689,200	d	3	1:125,000	Color	A
R8	Nelson River Basin (No. 10)	Pub.	224,000	b	3	1:100,000	Color	A
R9	Fisher and Teulon (No. 12)	Pub.	949,200	a,c	3	1:100,000	Color	A
R10	Swan River (No. 13)	Pub.	316,000	a,c	3	1:125,000	Color	A
R11	South Eastern (No. 14)	Pub.	749,200	a,c	3	1:125,000	Color	A,F
R12	Lac du Bonnet (No. 15)	Pub.	764,800	a,c	3	1:125,000	Color	A,F,R
R13	Grahamdale (No. 16)	Pub.	764,800	a,b	3	1:125,000	Color	A,F,U,R,E
R14	Red Rose-Washow Bay (No. 19)	Pub.	704,400	a,b	3	1:125,000	Color	A,F
R15	Boissevain-Melita (No. 20)	Pub.	299,520	a,b	2	1:40,000	Photo	A,I,E
R16	Ste.Rose	Pre.	658,800	a,b	3	1:125,000	Color	A
R17	Waterhen	Pre.	949,600	a,b	4	1:125,000	B&W	A
R18	Swan Lake	Data	599,200	a,b	3,4	1:125,000	B&W	A
R19	The Pas	Pre.	814,400	a,b	4	1:125,000	B&W	A
R20	Grand Rapids	Pre.	800,000	a,b	4	1:125,000	B&W	A
R21	Cormorant	Int.	920,000	a,b	4	1:125,000	B&W	A
R22	Wekusko	Pre.	1,400,000	a,b	4	1:125,000	B&W	A
R23	Pointe du Bois	Data	740,000	a,b				
R24	Roseau River	Pub.	45,200	a,b	3	1:63,360	B&W	A
R25	Red Deer Lake	Pub.	34,860	a,b	2	1:31,680	Photo	A
R26	Cross Lake and Norway House	Pre.	615,200	a,b	4	1:125,000	B&W	A

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1980

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
Biophysical and Exploratory Surveys								
B1	Lake Winnipeg, Churchill & Nelson Rivers	Pub.	3,600,000	e	4	1:250,000 1:50,000	B&W	
B2	Churchill Transportation Corridor	Data	179,000	f	4	1:125,000	B&W	
	N.R.I.P. (Northern Resource Information Project)		11,389,600	f	4	1:125,000	B&W	
B3	54C Hayes River	Int.	1,370,300	f	4	1:125,000	B&W	
B4	54D Kettle Rapids	Int.	1,370,300	f	4	1:125,000	B&W	
B5	52M Carrol Lake	Int.	634,000	f	4	1:125,000	B&W	
B5	62P Hecla	Int.	466,200	f	4	1:125,000	B&W	
B6	53D Deer Lake	Int.	629,700	f	4	1:125,000	B&W	
B6	63A Berens River	Int.	848,500	f	4	1:125,000	B&W	
B7	53M Knee Lake	Int.	1,405,900	f	4	1:125,000	B&W	
B8	53L Oxford House	Int.	1,441,100	f	4	1:125,000	B&W	
B8	63H Norway House	Data	540,800	f	4	1:125,000	B&W	
B9	SE 1/4 64A Split Lake	Int.	342,400	f	4	1:125,000	B&W	
B9	63P Sipiwesk	Int.	1,405,900	f	4	1:125,000	B&W	
B10	53E Island Lake	Pre.	1,286,900	f	4	1:125,000	B&W	
E1	Surface Deposits & Soils of Northern Manitoba	Int.		g	5	1:1,267,000	B&W	
E2	Exploratory Terrain Study of Northern Manitoba and Southern Keewatin, N.W.T.	Int.		g	5	1:1,000,000	B&W	

1. Report Status
   - Pub.-Published Report and Map
   - Int.-Interim Report and Map
   - Pre.-Preliminary Map and Legend
   - Data-Field Data Only

2. Map Unit Descriptions Code
   - a-single series and phases
   - b-series complexes defined as to proportion
   - c-series complexes undefined as to proportion
   - d-associations
   - e-biophysical units (materials and physiography)
   - f-biophysical units (associations & complexes of associations)
   - g-regional and local physiographic units

3. Survey Intensity Levels

Code	Name	Scale	Minimum Size Delineation(ha)	Inspection Density (Approx. range)
1	Very detailed	>1:12,000	<1.5	>1 per 3 ha
2	Detailed	1:12,000 to 1:40,000	1.5-16	1 per 3 to 50 ha
3	Semi-detailed	1:40,000 to 1:125,000	16 to 256	1 per 10 to 1000 ha
4	Reconnaissance	1:125,000 to 1:250,000	256 to 625	1 per 100 to 110,000 ha
5	Exploratory	1:250,000 to 1:1,000,000	625 to 10,000	1 per 300 to 500,000 ha

4. Published Map Base Code

Photo-Photomosaic
B&W -Black and white line
Color-Colored line

5. Interpretations Code

A-Agriculture Capability
E-Engineering
F-Forestry
I-Irrigation Suitability
U-Urban Planning and Community Development
R-Recreation

TOTAL HECTARAGE COVERED

	1979	To Date
Initial Reconnaissance	---	18,747,200
Initial Detailed	2,960	2,960
Reconnaissance	---	269,000
Detailed Resurvey	77,354	1,336,960
Biophysical Survey	---	11,389,600

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ACKNOWLEDGEMENTS

Grateful acknowledgement is made to the following persons:

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SUMMARY

The map area encompasses around 73.5 hectares on the shore of First Cranberry Lake, approximately 1.5 km east of Cranberry Portage. The area is rather complex in respect to surficial deposits and underlying bedrock. The surficial deposits consist of glacio-lacustrine, lacustrine, mixed till and colluvium. Precambrian bedrock, greenstone and dolostone occur within short distances of each other. Drainage is generally moderately well in the central and western portions of the area, but is largely poor to imperfect in the remainder. Slopes are generally very gentle with some moderate ones. The strongest relief in places is caused by a 100 to 150 cm high dolostone escarpment. The soils are generally thin and vary considerably in profile development. The whole of the area is forested except for a small area in the extreme northwest that has been cleared. Trembling aspen and spruce form the dominant tree cover.

HOW TO USE THIS REPORT

This report of the soils of the Cranberry Portage Map Area contains considerable information in addition to that shown on the soil map. This additional information is organized into various sections to help users of the report obtain a better understanding of the development, classification and interpretation for use of the soils in the area.

Information dealing with the development and classification of soils is of a general nature and is useful in providing an overview of the environment and soil landscapes of the map area.

The soil map of the study area is compiled on an uncontrolled photomosaic base found in the pocket of the report folder. The map shows the distribution of soils and landscape features that are significant for use as field management units. It provides a link between such units and accumulated information regarding soil conditions and behaviour under certain systems of management.

Information about use and suitability ratings of the units for various uses are presented in Section D.

INTRODUCTION

The nature and complexity of the surficial deposits in the Cranberry Portage Map Area resulted in the development of a number of soils different from the ones reported on in a former survey[1]. Because of the limited extent of this inventory, it is not known whether the soils occur only in this area or whether they occupy extensive areas in the immediate surrounding area. For that reason, map units are labelled in a numerical-alphabetical manner removing the need for establishing various new soil series.

Thus, descriptions of materials, textures and drainage and suitability ratings for various uses are applied to map units rather than to specific soil series.

[1] Tarnocai, C. 1975. Interim Soil Survey Report of the Cormorant Lake Area. Canada Soil Survey, Winnipeg.

A. GENERAL DESCRIPTION OF MAP AREA

1. Location and Extent

The area is located on the west shore of First Cranberry Lake, approximately 1.6 km (1 mile) east of the Town of Cranberry Portage (see Figure 1).

The area mapped covers approximately 73.5 ha (181.5 acres) and includes about 2.7 km (1.7 miles) of shoreline.

2. Present Land Use

No commercial operations are presently using any portion of the area. A small area in the northwest corner has been cleared and fenced and is periodically used for pasturing horses. Most of this parcel of land is covered with debris derived from either burnt down or collapsed buildings of some kind. Just outside the southwest boundary of the project area, a poorly covered shaft and tailings from an abandoned gold mine are present.

A single cottage type building is situated on the north shore of the project area. A number of paths and trails traverse the area and are presently used for hiking and horseback riding by residents of Cranberry Portage.

Access to the area is by some trails and one very muddy and poorly constructed road which is hardly passable by car in wet weather.

Most of the area is covered by forest consisting of various mixtures of Trembling Aspen, White Spruce, Black Spruce and Birch. Some localized cutting has taken place in the past, but the area does not seem to have been commercially logged at any time.

3. Physiography

The Cranberry Portage Map Area is located near the southern edge of the Snow Lake Plain subsection of the Kazan Upland Division, Kazan Region, which is part of the Precambrian Shield (Figure 2). Locally, the area consists of gently sloping mixed till uplands bordered by very gently to moderately sloping glacio-lacustrine areas of which some areas are covered by thin to moderately deep organic deposits.

A low dolostone escarpment runs across the map area separating in places the till areas from the glacio-lacustrine dominated ones.

i) Bedrock Geology[1]

The bedrock geology of the area is very complex (see Figure 3). Within the limits of the project area, exposures of dolostone, sandstone, Precambrian greenstone and granite are found.

The Precambrian granite is exposed in places along the east shore of the project area, and is close to the surface along the western boundary and especially in the southwest corner where an abandoned gold mine is located. Along the north shore, the Precambrian granite is overlain by greenstone (schist). Part of the greenstone has weathered into a green clay containing a high percentage of kaolinitic clay. This clay is protected by a Paleozoic cap composed of a layer of Ordovician sandstone of variable thickness and above that, a layer of thinly bedded dolostone.

Much of the sandstone which probably belongs to the Winnipeg formation, is severely eroded or buried under the slumping dolostone deposits. The sandstone is mostly encountered

[1] Baillie, A.D. 1952. Ordovician Geology of Lake Winnipeg and adjacent areas, Manitoba. Dept. Mines & Nat. Res., Mines Br., Prov. Man., Publ. 51-6.

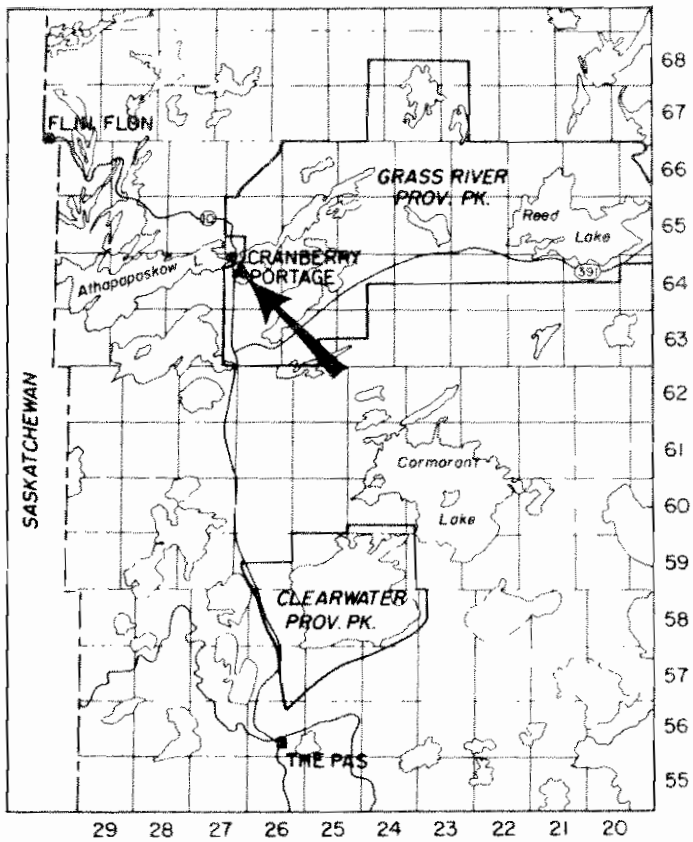
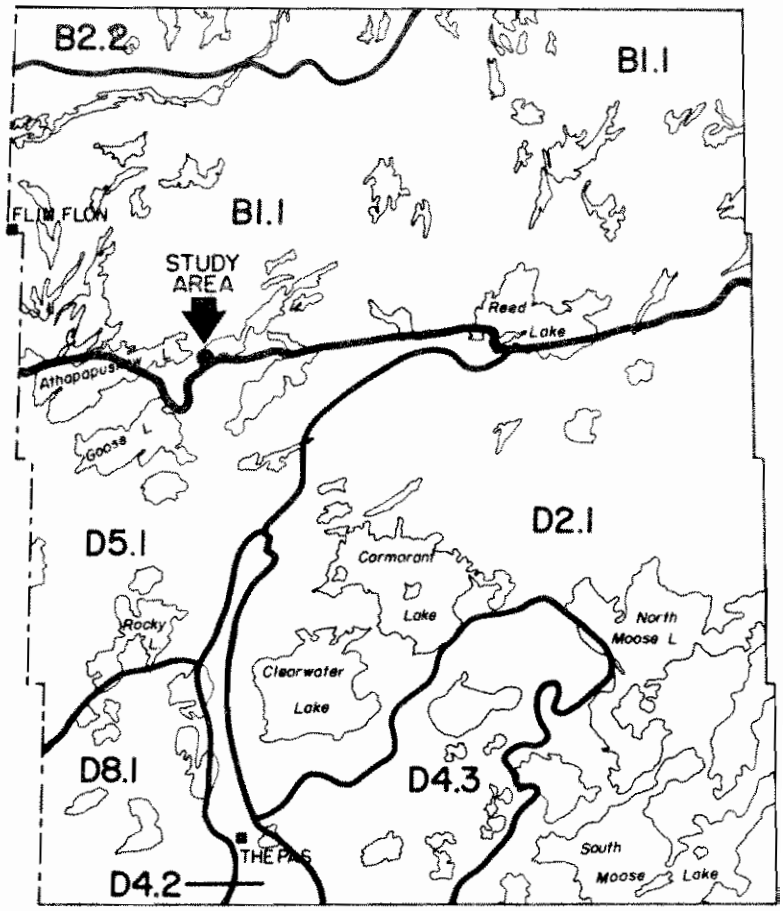


Figure1 Location of Cranberry Portage Area.



B1.1 Snow Lake Plain
B2.2 Southern Indian Lake Plain

[1] Canada-Manitoba Soil Survey, Unpublished data

D2.1 Westlake Till Plain
D4.2 The Pas Moraine
D4.3 Summerberry Lowland
D5.1 Namew Lake Plain
D8.1 Saskatchewan Delta

Figure 2 Physiographic Setting of the Cranberry Portage Study Area.[1]

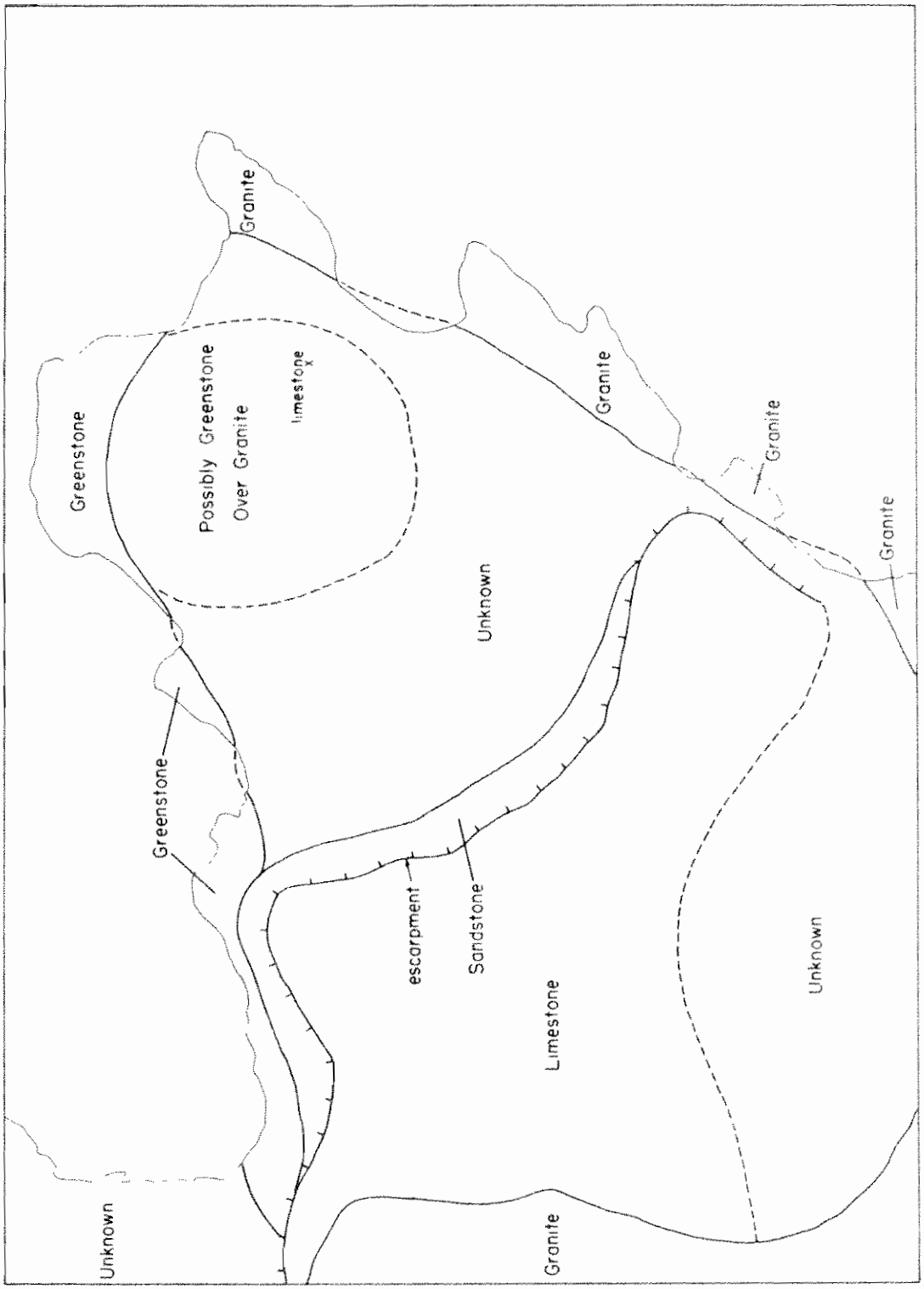


Figure 3 Bedrock Geology of Cranberry Portage Area.

in the form of poorly developed terraces and narrow beaches or old shores littered with rapidly decomposing sandstone fragments. The presence of large amounts of iron oxides results in strongly reddish-brown stained sands.

The dolostone forms a more resistant bed to weathering than the underlying sandstone and forms an escarpment along most of its eastern margin. This escarpment is about 1 to 1.5 m high. Although not visible on aerial photographs of a scale of 4 inches = 1 mile, this escarpment can easily be traced on the ground. The dolostone is thinly bedded and seems high in quartz content. The exposed flags along the edge are very loose and easily removed.

Figure 3 shows the distribution of the various bedrock components.

ii) Surficial Deposits

The complexity of the bedrock formations, geological erosion and deposition of materials firstly by glaciers and later by lakes has resulted in great variation in the surficial materials within the project area (see Figure 4).

Two genetically dominant deposits are recognized; glacial tills on the upland areas and lacustrine sediments in the lower lying areas.

The till is quite variable in texture and composition. Within a few meters, great changes in carbonate level, texture, coarse fragment content and nature of the fragments have been observed. Very thin to thin veneers of coarse loamy materials with a large amount of cherty and flaggy dolostone fragments mixed with some Precambrian cobbles are found along the upper edge of the small escarpment traversing the area. Thin till or probably residual loamy-skeletal materials are also found in the southwestern portion of the large No. 4 till unit. Deeper tills are, for the most part, encountered in the southern portion of this central till deposit and in the till area occurring as an outlier from the main deposit in the northeast corner of the project area. In some areas, the till is quite clayey; in other areas silt and sand are dominant. Also, carbonate levels vary widely over short distances. The till overlying Precambrian bedrock (Unit 5) is usually neutral in reaction and loamy in texture and contains a relatively higher amount of Precambrian material.

In general, glacio-lacustrine sediments are widespread in the project area. Units 1 and 3 have dominantly clay textured, calcareous sediments. The sediments have very little slope and are consequently poorly drained. This has resulted in peat development, especially in Unit 3, where most of the lacustrine sediments are overlain by 40 cm to 120 cm of mesic and humic forest peat. The remainder of the study area is dominantly covered by glacio-lacustrine deposits. However, mixed with these sediments are varying amounts of reworked till, colluvial materials (especially close to the escarpment) and lacustrine materials in the form of beaches and shorelines, resulting in a complex, very heterogenous surface deposit. Drainage varies widely in the area because of differences in slope and impediments by beaches.

The lacustrine sediments in Unit 6 are much like those of Unit 2, except that they may be more recent.

iii) Drainage

No running or standing bodies of water larger than pools were noted in the map area. Pools occur in map unit 3a and to some extent in map unit 1b.

Drainage in most of the area is imperfect to poor. The only extensive moderately

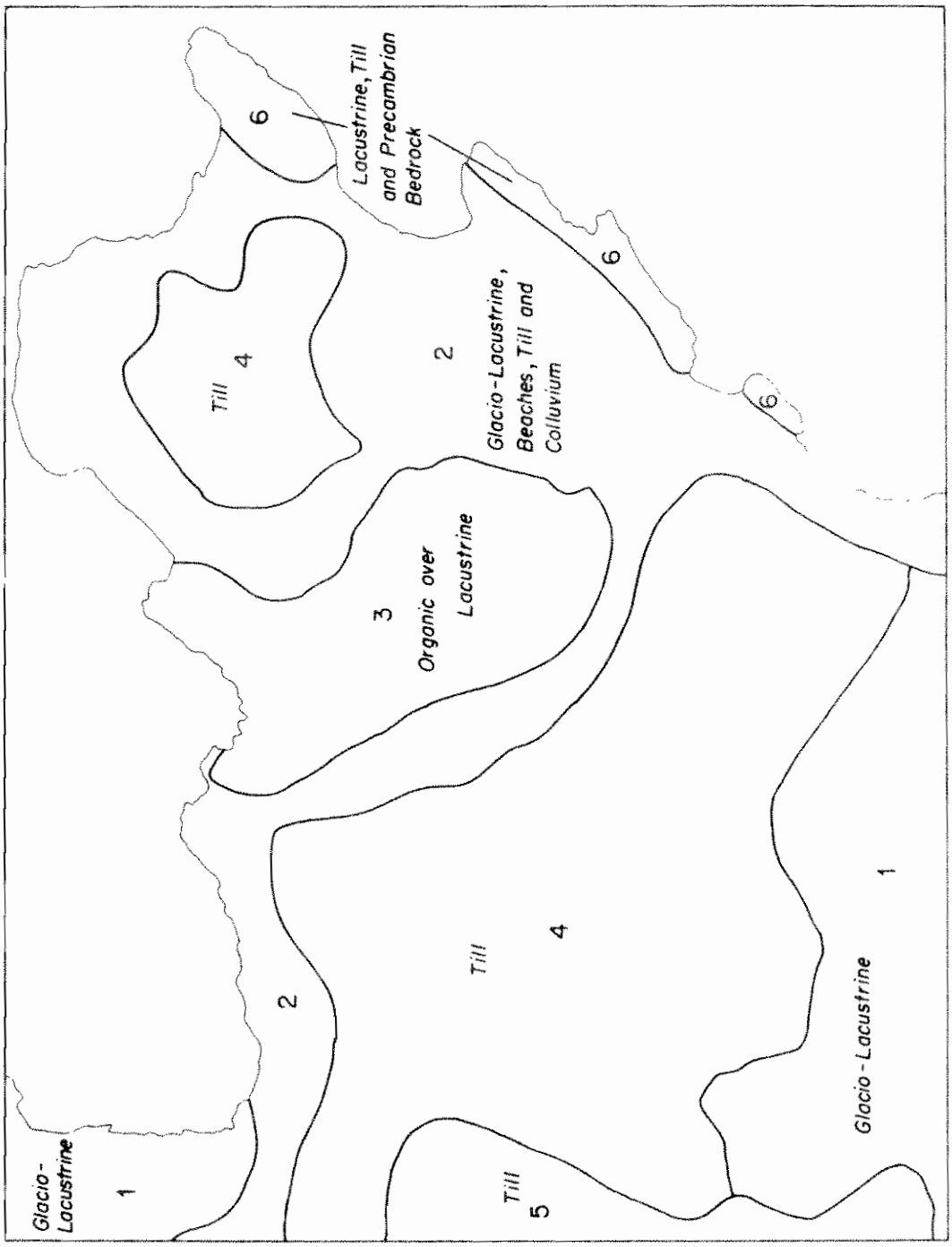


Figure 4 Surficial Deposits in the Cranberry Portage Study Area.

Figure 4. Surficial Deposits.

1. Level to very gently sloping, imperfectly to poorly drained, calcareous, dominantly clay textured glacio-lacustrine sediments overlain in part by shallow (<40 cm) mesic forest peat.

2. Gently to strongly sloping, well to imperfectly drained, weakly to moderately calcareous, loam to clay loam textured glacio-lacustrine sediments mixed with water-worked till materials and colluvium. Also loam to sandy textured former beaches and shorelines are found within this unit.

3. Level to gently sloping, poorly drained, shallow (40 to 160 cm) mesic and humic forest peats overlying calcareous, clay textured glacio-lacustrine sediments.

4. Gently to moderately sloping, moderately well to imperfectly drained, neutral and calcareous, loam to clay loam textured, mixed till overlying carbonatic bedrock. Bedrock is close to or at the surface in several areas.

5. Gently to moderately sloping, moderately well to imperfectly drained, neutral and calcareous, loam to clay loam textured mixed till overlying Precambrian granitic bedrock. Bedrock is close to or at the surface in part of the area.

6. Very gently to steeply sloping, moderately well to poorly drained, calcareous, dominantly loam to clay textured lacustrine sediments. The sediments are shallow over granitic bedrock outcrops along the shore of First Cranberry Lake and often are associated with reworked mixed till.

well to well drained areas are map units 2a, c, 4a, b and d. Drainage in these areas is good because of elevation above surrounding terrain (4a, b and d) or as a result of slope (2a) or materials (2c). Water drains from these units via the groundwater, either directly into the lake or into units 1b and 3a, b. Surplus moisture from the latter drains slowly through the organic material into First Cranberry Lake. Surplus moisture from 1b drains away to the south and eventually enters the lake. Some units like 2f, 5, 6c and d have impeded drainage because of bedrock, relief and/or texture. Most map units will have a moisture problem after spring melt and heavy summer rains and will stay wet at least for a few days.

4. Climate

In relation to world-wide climatic conditions, northern Manitoba is within the region designated by Koppen[1] as Dfc. This is a subarctic climate of humid microthermal type with a short warm summer and a cold, snowy winter. Some climatic data from weather stations in the surrounding region are presented in Table 1.

A well drained mineral soil in this region has a Mean Annual Soil Temperature (MAST)[2] of approximately 2 to <5.5°C and a Mean Summer Soil Temperature (MSST) of 4 to <8°C at 50 cm depth. Degree days above 5°C number between 55 and 400[2].

Soils which are saturated for significant periods of the growing season may remain frozen for portions of that season. Organic soils have discontinuous or localized permafrost. Precipitation is generally sufficient to meet requirements during the growing season, although slight deficiencies may occur from year to year.

5. Vegetation

The area lies within the Northern Coniferous Section of the Boreal Forest Region[3].

> "Black spruce is the predominant tree, forming stands on the thin soils of the uplands as well as on the poorly drained lowlands, and associated on these two positions with jack pine and tamarack, respectively".
>
> ".... around some of the lakes and on south-facing slopes, where more favourable conditions of soil and local climate obtain, white spruce, balsam fir, trembling aspen and balsam poplar form mixed stands of good growth".

Because of fire, most of unit 5 and 4c, all of unit 4b and the southern half of unit 4a have a cover of trembling aspen. Along the shore, spruce or mixtures of spruce and trembling aspen dominate. On sandier material and in areas along the escarpment, white birch occasionally forms an important component of the stand. White spruce and balsam poplar are encountered throughout the area. Black spruce predominates in poorly drained areas, especially in units 3b and 1b.

Tree growth is generally rather good for the region as a result of climatic modification by the lake. The stands are, however, not extensive and in places definitely patchy.

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[1] Koppen, W. and Geiger. Handbuch der Klimatologie, Bond 1, Teil C, Gebruder Borntraeger, Berlin, 1936.

[2] Mills, G.F., C. Tarnocai and C.F. Shaykewich. 1977. Characteristics and Distribution of Soil Temperature Regimes in Manitoba, Canada. Proc. Man. Soil Sci. Meeting, Winnipeg.

[3] Rowe, J.S. 1972. Forest Regions of Canada. Can. Dept. Env., Can. For. Serv. Pub. No. 1300.

Table 1. Mean Temperature[1] and Precipitation Data[2] and Average Frost-Free Period[3] for Flin Flon, Flin Flon CFB, Wanless, The Pas and The Pas Airport.

	Mean Daily Temp. (°C)			Precipitation (mm)		Frost-Free Period (Av.)
	Year	Jan.	July	Year	May 1 - Sept. 30	
Flin Flon (Lat. 54°46' N, Long. 101°51' W; 335 masl)	-0.4	-21.8	18.3	458.3	297.2	118
Flin Flon CFB (Lat. 54°41'N, Long. 101°58' W; 305 masl)	-0.7	-22.4	17.9	419.9	259.6	-
Wanless (Lat. 54°11'N, Long. 101°22'W; 261 masl)	-1.3	-23.6	16.7	454.5	278.1	65
The Pas (Lat. 53°49' N, Long. 101°15' W; 271 masl)	-0.3	-22.0	18.3	491.7	304.5	113
The Pas Airport (Lat. 53°58' N, Long. 101°06' W; 273 masl)	-0.6	-22.4	17.9	449.6	286.0	114

[1] Canadian Normals, Temperature 1941-1970. Atmospheric Environment, Environment Canada, Vol. I - SI (1975).

[2] Canadian Normals, Precipitation 1941-1970. Atmospheric Environment, Environment Canada, Vol. II - SI (1975).

[3] Hemmerich, G.M. and G.R. Kendall. 1971. Frost Data 1941-1970. Atmospheric Environment, Environment Canada.

B. METHODS

1. Field Operations

The area was surveyed in early October, 1978. Aerial photo coverage (scale 4" = 1 mile) proved to be inadequate for the level of detail the project demanded. Forty-six sites and soils were examined and described. The descriptions include notes on material, drainage, profile development, carbonates, slope, etc. Also, short notes were made on vegetation, bedrock and coarse fragments.

2. Reliability

The reliability of the map can be estimated to some extent on the basis of the number of inspections per unit area. The reliability of the map is not as great as could be wished for as a result of complexity of terrain and surficial materials. Some units have sufficient investigations per unit area, while others have hardly been examined. Even though some units should have received more attention the ratings for various uses can generally be relied upon. However, these ratings do not preclude further on site investigation prior to any work being carried out.

Location and distribution of the sites can be obtained from the map unit map.

3. Map Unit Definition

The units on the map are based on type of surficial material, drainage, soils, slope, underlying bedrock and/or bedrock outcrops. Because of the complexity of the bedrock geology and surficial deposits, soils vary considerably in texture, development, drainage, etc. over relatively short distances.

As the area mapped is rather small, it was decided that rather than establish a number of new soil series and to map the area as such, to delineate units based on similarity of materials, drainage, slope, soil type development and to label them in numerical-alphabetical fashion. This enabled us to describe the unit as we perceived it and to rate it for various uses.

4. Sampling

Two soils were sampled. The location is marked on the map as D_1 and D_2. Chemical, physical and morphological data are presented in Appendix A. Less detailed information collected at other sites can be obtained from the senior author.

C. MAP UNIT DESCRIPTIONS

1. Soil Development

The soils in the map area are generally thin. This is partially the result of climatic conditions which do not favour high chemical and biological activity. The growing season is short, consequently bio-mass production is fairly low as is the rate of decomposition. Precipitation is sufficient in most years to meet the needs of the natural vegetation during the growing season, but is not sufficient to cause significant leaching of the soil.

2. Map Units

Map Unit 1a (2.4 ha)

This unit consists of poorly to imperfectly drained, deep, moderately calcareous lacustrine clay. The area slopes very gently towards the lake. The steepest slopes of the unit are found along its contact with unit 2a. Runoff in the unit is slow to moderate, but internal soil permeability is slow because of the fine textured materials and the high groundwater level that persists for a greater part of the year.

Soils in the unit consist of poorly drained, peaty Rego Gleysols (50%) and imperfectly drained Gleyed Gray Luvisols (50%).

This unit has been partly cleared and has been used for pasture but now is littered with debris from burnt down buildings and other sources.

Map Unit 1b (5.4 ha)

This unit consists of poorly drained, moderately deep, moderately calcareous, fine textured lacustrine sediments. The area is level to nearly level. Runoff is slow and internal soil permeability is low because of the fine textured materials. The high groundwater level persists for a greater part of the year.

The dominant soil is a poorly drained peaty Orthic Gleysol (>80%). Some peaty Rego Gleysols and Gleyed Gray Luvisols occur as minor associates.

The vegetation is dominated by black spruce, Labrador tea and Sphagnum mosses.

Map Units 1c (1.8 ha) and 1d (1.7 ha)

These units consist of imperfectly drained, moderately deep, moderately calcareous, fine textured lacustrine sediments. Topography is level to gently sloping with overall slope being to the south. Runoff is slow to moderate and the groundwater level is high within the profile during spring and early summer.

The dominant soil is an imperfectly drained Gleyed Gray Luvisol. Minor inclusions of poorly drained, peaty Rego and Orthic Gleysols form part of the unit.

Vegetation consists of black spruce, trembling aspen, Labrador tea and mosses.

Map Unit 2a (2.8 ha)

This unit consists of moderately well and, to some extent, imperfectly drained, moderately calcareous, fine textured lacustrine sediments of varying depths overlying medium textured, stony or cobbly colluvial or till materials. The lacustrine sediments are often very heavy textured and light olive to olive in color. Layers or blobs of green heavy clay (color 5G 4/1) with similar colored fragments occur at variable depths, especially along the shore. The boundaries between horizons and layers are distinct but distorted as a result of soil creep. Stones and cobbles are more frequent close to the escarpment than along the shoreline. Carbonates occur at various depths but are frequently close to the surface. Topography is moderately to gently sloping. Runoff is rapid because of slope but impeded where a thick LFH layer occurs.

The dominant soil is a well drained Orthic Eutric Brunisol. Minor inclusions of Regosols and Gleyed Gray Luvisols form part of the unit.

Vegetation is predominantly black spruce with some white spruce, trembling aspen and feathermosses.

Map Unit 2b (1.2 ha)

This unit consists of imperfectly to poorly drained, moderately calcareous, stratified fine to medium textured glacio-lacustrine sediments. Topography is very gently sloping to nearly level. Runoff is slow to very slow and groundwater level is fairly high in the profile during spring and early summer. Materials are much like the ones described under map unit 2a but are poorer drained and are less disturbed as a result of soil creep.

The dominant soils in the unit are a poorly drained peaty Orthic Gleysol and imperfectly drained Gleyed Eluviated Eutric Brunisols. Minor areas of Orthic Eutric Brunisols and Gleyed Gray Luvisols are associated with the dominant soils.

Vegetation consists of black spruce, trembling aspen, Labrador tea and feathermosses.

Map Unit 2c (5.4 ha)

This unit consists of dominantly well to moderately well drained, moderately calcareous, medium to coarse textured glacio-lacustrine sediments. In some areas, these sediments overlie till deposits; in other areas, they are in the form of beaches or former shorelines. The sediments are derived from the erosion products of greenstone, dolostone and sandstone. The materials derived from sandstone and dolostone are yellow and gray in color with bands and layers of reddish brown iron-oxide stained materials. Textures range from loamy sand to sandy loam with some silty inclusions. Fragments in the form of cherts and flagstones are frequently close to the escarpment. Topography is generally steepest close to the escarpment and on the beaches and ranges within the unit from moderately to very gently sloping. Runoff is generally moderate and groundwater level low for most of the year.

The dominant soil is a moderately well to well drained Eluviated Eutric Brunisol. Imperfectly drained Gleyed Eutric Brunisols form minor associated areas in this unit.

Dominant vegetation is black spruce, white spruce, trembling aspen, white birch, bunchberry and alder.

Map Unit 2d (5.2 ha)

This unit consists of imperfectly to moderately well drained, moderately calcareous, stratified fine to medium textured glacio-lacustrine sediments. Topography is gently sloping to very gently sloping. Materials are similar to those described under map unit 2a, but the lacustrine sediments are deeper and contain less coarse fragments. Runoff is slow to moderate and is affected by a continuous feathermoss type LFH layer.

Dominant soils are imperfectly drained Gleyed Gray Luvisols and moderately well drained Orthic Gray Luvisols.

Vegetation is dominantly black spruce, white spruce and feathermosses.

Map Unit 2e (2.7 ha)

This unit consists of dominantly imperfectly drained, moderately calcareous, medium textured glacio-lacustrine sediments. Part of this unit is occupied by deposits in the form of former beaches. These deposits tend to be coarser in texture. Topography is very gently sloping with the strongest relief to be found associated with the beaches. Runoff is slow and in places impeded because of the beaches.

Dominant soils in the unit are imperfectly drained Gleyed Eutric Brunisols. Associated

soils are Gleyed Gray Luvisols and Rego Gleysols.

Vegetation is dominantly trembling aspen, balsam poplar, white spruce, white birch, willow, red-osier dogwood.

Map Unit 2f (4.6 ha)

This unit consists of dominantly imperfectly to poorly drained, moderately calcareous, fine to medium textured glacio-lacustrine sediments. Topography is very gently sloping to nearly level. Runoff is slow and groundwater levels are high, especially in spring and early summer.

Dominant soils are an imperfectly drained Gleyed Gray Luvisol and a poorly drained peaty Rego Gleysol. Minor areas of associated soils are included.

Dominant vegetation is black spruce, trembling aspen, willow, Labrador tea and mosses.

Map Unit 2g (1.6 ha)

This unit consists of dominantly poorly drained, moderately calcareous, fine textured glacio-lacustrine sediments. Surface textures range from clay to heavy clay grading into silty clay to silty loam textures in the subsurface horizons. Topography is level to nearly level. Runoff is very slow to non-existent, resulting in high groundwater levels.

The dominant soil is a poorly drained Orthic Gleysol. The dominant associated soil is an imperfectly drained Gleyed Gray Luvisol.

Vegetation is dominantly white spruce, black spruce, willow and feathermosses.

Map Unit 3a (4.4 ha)

This unit consists of poorly drained, shallow to very shallow, well to very well decomposed forest peat overlying moderately calcareous, fine textured glacio-lacustrine sediments. Topography is level to nearly level with the overall slope towards the lake. Small pools occur throughout the unit giving it a swamp-like appearance.

The dominant soil type is a poorly drained Terric Humic Mesisol (40 to 80 cm deep), associated with poorly drained Terric Mesisols and peaty Rego Gleysols.

Vegetation consists of alder, willow, Labrador tea, feathermosses, white spruce and some white birch.

Map Unit 3b (3.3 ha)

This unit consists of poorly drained, shallow, well decomposed forest peat overlying moderately calcareous, fine textured glacio-lacustrine sediments. Slopes are very gentle with some micro-hummocky relief as a result of local Sphagnum peat build-ups.

The soil types are dominantly Terric Fibric Mesisols and Terric Mesic Fibrisols developed on 40 to 120 cm of poorly drained forest peat. Minor areas of peaty Gleysols are found within the unit and are usually found along the contact with units 2b, 2c and 2f.

This area is more bog-like in appearance and supports a vegetation consisting of white spruce (in edge), black spruce, willow, alder, Sphagnum and feathermosses.

Map Unit 4a (15.3 ha)

This unit, by far the largest in the project area, consists of dominantly shallow (<1 m), moderately well to imperfectly drained, moderately calcareous, medium textured mixed till overlying dolostone bedrock. Topography is very gently to gently sloping. Depth to bedrock varies from about 10 cm in some spots to more than 1 m in others. Coarse fragments in the form of cobbles and cherts are found throughout the unit but are only plentiful where the bedrock is close to the surface and along the escarpment. Runoff is slow to moderate.

The dominant soils are a moderately well drained Orthic Eutric Brunisol, lithic phase (40%), on very shallow loam, Eluviated Eutric Brunisols, lithic phase (30%), on deeper material, and imperfectly drained Gleyed Eluviated Eutric Brunisols, lithic phase (30%). Associated soils are nonlithic phases of the above soil types.

The vegetation consists largely of trembling aspen as a result of a burn. Non-burnt areas have a more heterogenous vegetation of trembling aspen, white spruce, alder, and feathermosses.

Map Unit 4b (1.5 ha)

This unit consists of very shallow (<25 cm), moderately well drained, moderately calcareous, loamy till or rubble over dolostone bedrock. Topography is very gently sloping and runoff is moderate. Coarse fragments largely in the form of cherts are plentiful.

The dominant soil type is a moderately well drained Orthic Eutric Brunisol, very shallow lithic phase.

The vegetation consists dominantly of trembling aspen, balsam poplar and alder.

Map Unit 4c (7.5 ha)

This unit consists of deep (>1 m), moderately well to imperfectly drained, moderately calcareous, medium textured mixed till. The upper part of the soil may be of lacustrine origin, is heavier in texture and overlies loamy till. Topography is gently to very gently sloping. Runoff is slow to moderate.

Dominant soils are imperfectly drained Gleyed Gray Luvisols (60%) and moderately well drained Orthic Gray Luvisols (40%).

Vegetation is dominantly trembling aspen, white spruce, balsam poplar, alder and willow.

Map Unit 4d (4.1 ha)

This unit consists of shallow to deep, moderately well to imperfectly drained, moderately calcareous, medium textured till of mixed origin. A thin lacustrine overlay is present in some parts of the area. Topography is gently to very gently sloping. Runoff is moderate.

The dominant soil types are a moderately well drained Eluviated Eutric Brunisol (70%) and an imperfectly drained Gleyed Gray Luvisol, lithic phase (30%).

The vegetation is characterized by black spruce, trembling aspen, bunchberry and feathermosses.

Map Unit 5 (3.3 ha)

This map unit consists of moderately well to imperfectly drained, neutral to weakly calcareous, medium textured mixed till. This till overlies Precambrian bedrock; this bedrock occurs in most of the unit at between 1 m and 1.5 m from the surface. Bedrock is found at the surface just outside the southwest corner of the map area where a former gold mine is located. Topography is very gently sloping. Runoff is slow.

Dominant soils are imperfectly drained Gleyed Gray Luvisols (60%) and moderately well drained Eluviated Eutric Brunisols (40%).

The vegetation consists of trembling aspen and alder.

Map Unit 6a (0.2 ha)

This unit consists of a Precambrian granite bedrock outcrop with steep slopes towards the lake. Thin mixed till deposits occur in depressions and on the southwesterly (landward) slope.

Vegetation consists of some trembling aspen and shrubbery.

Map Unit 6b (.9 ha)

This unit consists of a moderately well drained, loamy, mixed till overlying a greenish clay which probably is derived from greenstone. Some imperfectly drained areas of fine textured lacustrine sediments are found on the lower slopes. Topography is gently sloping with a few short, steep slopes. Runoff is slow to moderate.

Dominant soils in the unit are moderately well drained Eluviated Eutric Brunisols (80%), developed on till and imperfectly drained Gleyed Gray Luvisols (20%) developed on lacustrine sediments.

Vegetation consists of trembling aspen, white birch, white spruce, and red-osier dogwood.

Map Units 6c (.9 ha) and 6d (.2 ha)

These units consist of a combination of fine textured lacustrine sediments, remnants of mixed till and granitic bedrock outcrops along the lake shore. Drainage is dominantly poor as runoff is impeded by the bedrock. Topography is level to nearly level.

The dominant soil is a poorly drained Rego Gleysol, which may have a bedrock contact within 1 m from the surface.

Vegetation is dominantly black spruce, white spruce, trembling aspen with willow.

D. USE AND MANAGEMENT

1. Introduction

The interpretive data presented in this chapter is based on evaluations of internal and external soil characteristics and on research of soil behavior under specified conditions of land use. These interpretations are intended only as a guide to optimize use of land.

2. Soil Suitability for Selected Recreation and Engineering Uses

The criteria used to evaluate soil suitability for selected recreation and engineering uses are adopted from guides found in Coen et al.[1], and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture[2], and the Canada Soil Survey Committee[3].

i) Definition of Soil Suitability Classes

Evaluation of soil suitability for engineering and recreation uses is based on both internal and external soil characteristics. Four soil suitability classes are used to evaluate both mineral and organic soils and hence, mapping units for selected uses. These ratings express relative degrees of suitability or limitation for potential uses of natural or essentially undisturbed soils. The long-term effects of the potential use on the behaviour of the soil are considered in the rating.

The four suitability class ratings are defined as follows:

Good- Soils in their present state have few or minor limitations that would affect the proposed use. The limitations would easily be overcome with minimal cost.

Fair- Soils in their present state have one or more moderate limitations that would affect the proposed use. These moderate limitations would be overcome with special construction, design, planning or maintenance.

Poor- Soils in their present state have one or more severe limitations that would severely affect the proposed use. To overcome these severe limitations would require the removal of the limitation or difficult and costly alteration of the soil or of special design or intensive maintenance.

Very Poor- Soils have one or more features so unfavourable for the proposed use that the limitation is very difficult and expensive to overcome or the soil would require such extreme alteration that the proposed use is economically impractical.

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[1] Coen, et al. 1977. Soil survey of Yoho National Park, Canada. Alberta Soil Survey Report No. 37, 208 pp. Alberta Institute of Pedology, University of Alberta, Edmonton, Alberta.

[2] USDA. 1971. Guide for Interpreting Engineering Uses of Soils. Soil Conservation Service, USDA. SCS-45, 87 pp.

[3] CSSC. 1973. Proceedings of the Ninth Meeting of the Canada Soil Survey Committee, University of Saskatchewan, Saskatoon. 357 pp.

ii) Soil Suitability Subclasses

The basic soil properties that singly or in combination with others commonly affect soil suitability for selected engineering properties and recreation uses are provided in Table 2. These subclass designations serve to identify the kind of limitation or hazard for a particular use.

iii) Guides for Assessing Soil Suitability

Guides for assessing soil suitability for eight engineering related uses are given in Appendix E (Tables 1 through 8). These tables provide as specifically as possible, definitions of the soil properties which result in the specific suitability or degree of limitation. In assessing soil suitability for various engineering uses, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed soil properties. For example, if the suitability is "Good" for all but one soil property and it is estimated to be "Very poor", then the overall rating of the soil for that selected use is "Very poor". Suitability of individual soil properties, if estimated to be "Fair" or "Poor", can be accumulative in their effect for a particular use. Judgement is required to determine whether the severity of the combined effects of several soil properties on suitability for a particular use will result in downgrading an evaluation. This is left to the discretion of the interpreter. It is incorrect to assume that each of the major soil properties influencing a particular use has an equal effect. Class limits established for rating the suitability of individual soil properties take this into account. For a selected use, therefore, only those soil properties which most severely limit that use are specified.

When using these interpretations, consideration must be given to the following assumptions:

1. Interpretations are based on predictions of soil behavior under defined conditions of use and management as specified in the preamble to each of Tables 1 through 8 (Appendix E). When conditions of use and management are not the same as those defined here, new guides should be established and appropriate revisions made in Table 3.
2. Soil ratings do not include site factors such as nearness to towns and highways, water supply, aesthetic values, etc.
3. Soil ratings are based on natural, undisturbed soil.
4. Soil suitability ratings are usually given for the entire soil, but for some uses, they may be based on the limitations of an individual soil horizon or other earthy layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1 to 2 meters, but in some kinds of soils, reasonable estimates can be given for soil material at greater depths. It should be noted here that the term "soil" has been used throughout the report in the pedologic sense and differs in concept from that commonly used by engineers.
5. Poor and very poor soil ratings do not imply that a site cannot be changed to remove, correct or modify the soil limitations. The use of soils rated as poor depends on the nature of the limitations, whether or not the soil limitation can be altered successfully and economically, and on the scarcity of good sites.

6. Interpretations of map units do not eliminate the need for on-site evaluation by qualified professionals. Due to the variable nature of soils, and the scale of mapping, small, unmappable inclusions of soils with different properties may be present in an area where a development is planned. The need for or importance of on-site studies depends on the use to be made of the soil and the kinds of soil and soil problems involved.

Table 2. Codes Utilized to Identify Soil Suitability Limitations in Evaluating Soils for Selected Uses (Table 3).

a	subgrade properties
b	thickness of topsoil
c	coarse fragments on surface
d	depth to bedrock
e	erosion or erodibility
f	susceptibility to frost hazard
g	contamination hazard of groundwater
h	depth to seasonal water table
i	flooding or inundation
j	thickness of slowly permeable material
k	permeability or hydraulic conductivity
l	shrink-swell properties
m	moisture limitations or deficit
n	salinity or sulphate hazard
o	organic matter
p	stoniness
q	depth to sand or gravel
r	rockiness
s	surface texture
t	topographic slope class
u	moist consistence
w	wetness or soil drainage class
z	permafrost

Table 3. Suitability Ratings for Map Units in the Cranberry Portage Map Area for Selected Uses. Suitability is designated as G - Good, F - Fair, P - Poor, and V - Very Poor. The nature of the most severe limitations is indicated by subclass symbols defined in Table 2 and applied according to use and management conditions specified in the appropriate guide tables (Tables 1-8, Appendix E).

Map Unit Symbol	Suitability for							Suitability as Source of Roadfill
	Camp Areas	Picnic Areas	Play-grounds	Paths & Trails	Permanent Buildings (without basements)	Septic Fields	Local Roads and Streets	
1a	Pws-Vws	Pws-Vws	Pws-Vws	Ps	Pwa-Vwa	Vkh	Paf-Vwa	Paw
1b	Vws	Vws	Vws	Vsw	Vwa	Vkh	Vwa	Paw
1c	Pws	Pws	Pws	Ps	Pwa	Vkh	Paf	Pa
1d	Pws	Pws	Pws	Ps	Pwa	Vkh	Paf	Pa
2a	Fst	Fst	Pst	Fs	Pta	Pkt	Ptaf	Paf
2b	Pws	Pws	Pws	Psw	Pwa	VPh	Pwaf	Paiw
2c	Fws	Fws	Ptc	Fsw	Fwd	Pd	Fd	Fd
2d	Fwst	Fwst	Pst	Fsw	Pta	Pkt	Ptaf	Paf
2e	Fws	Fws	Fwts	Fsw	Fwa	Fwh	Fwa	Faw
2f	Pws	Pws	Pws	Psw	Pwf	Pkh	Pwa	Pwa
2g	Pws	Pws	Pws	Psw	Pwf	Pkh	Pwa	Pwa
3a	Vws	Vws	Vws	Vsw	Vwha	Vh	Vwa	Vaw
3b	Vws	Vws	Vws	Vsw	Vwha	Vh	Vwa	Vaw
4a	Fws	Fws	Fwds	Fws	Fad	Vd	Fa	Fad
4b	Pc	Pc	Pdc	G	Fd	Vd	Fd	Vd
4c	Pws	Fws	Fws	Fsw	Fwa	Fh	Fwa	Fwa
4d	Fws	Fws	Fws	Fsw	Fwa	Fh	Fwa	Fwa
5	Fwk	Fw	Fwk	Fw	Fwad	Phd	Fwd	Fwdh
6a	Vr	Vr	Vr	Vr	Pd	Vd	Vr	Vr
6b	Fst	Fst	Vt	Fst	Fa	Pkt	Fta	Fa
6c	Pws	Pws	Pws	Psw	Pwa	Vkh	Pwa	Pawh
6d	Pws	Pws	Pws	Psw	Pwa	Vkh	Pwa	Pawh

A P P E N D I C E S

Platy - Having thin, plate-like aggregates with faces mostly horizontal

Blocky - Having block-like aggregates with sharp, angular corners

Subangular blocky - Having block-like aggregates with rounded and flattened faces and rounded corners By convention an aggregate is described in the order of grade, class and type, e.g. strong, medium, blocky and moderate, coarse, granular. In the parent material of soils the material with structural shapes may be designated as pseudo-blocky, pseudo-platy, etc. In stratified materials, a bed is a unit layer distinctly separable from other layers and is one or more cm thick but a lamina is a similar layer less than 1 cm thick.

Soil Survey - The systematic examination, description, classification, and mapping of soil in an area.

Swamp - See Appendix C

Texture, soil - The relative proportions of the fine earth (less than 2 mm.) fraction of a soil. Textural classes are usually assigned to specific horizons whereas family particle size classes indicate a composite particle size of a portion of the control section that may include several horizons.

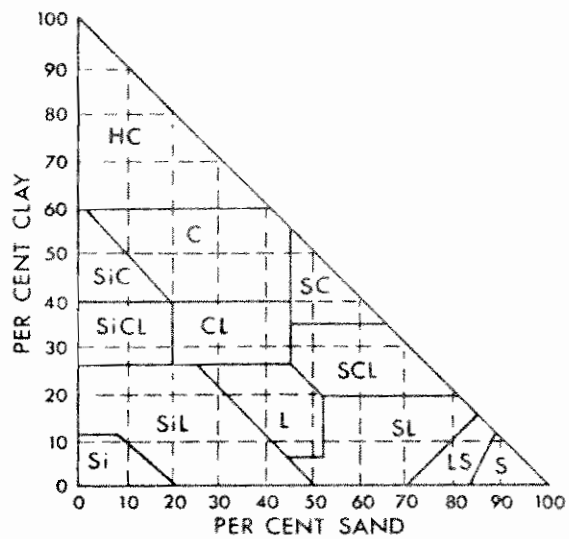
The size range of the constituent primary particles are as follows:

	Diameter (mm)
Very coarse sand	2.0-1.0
Coarse sand	1.0-0.5
Medium sand	0.5-0.25
Fine sand	0.25-0.10
Very fine sand	0.10-0.05
Silt	0.05-0.002
Clay	< 0.002
Fine clay	< 0.0002

Till, glacial - Unstratified glacial deposites consisting of clay, sand, gravel, and boulders intermingled in any proportion.

Tilth - The physical condition of soil as related to its ease of tillage, fitness as a seedbed, and its impedance to seedling emergency and root penetration.

Topography - Refers to the percent slope and the pattern or



Texture / Group / Class		
Coarse	S	Sand
	LS	Loamy Sand
	SL	Sandy Loam
Medium	Si	Silt
	SiL	Silt Loam
	SiCL	Silty Clay Loam
	L	Loam
	CL	Clay Loam
	SCL	Sandy Clay Loam
	VFSL	Very Fine Sandy Clay
Fine	SiC	Silty Clay
	SC	Sand Clay
	C	Clay
	HC	Heavy Clay

Figure 2: Soil Textural Classes

Shrinkage ratio - This is the ratio between the volume change and a corresponding change in moisture content. It equals the apparent specific gravity of the dried soil.

Silt - (a) Individual mineral particles of soil that range in diameter between 0.05 to .002 mm. (b) Soil of the textural class silt contains greater than 80 percent silt and less than 12 percent clay.

Slickenside - Smoothed surfaces along planes of weakness resulting from the movement of one mass of soil against another in soils dominated by swelling clays.

Sodium-Adsorption Ratio (S.A.R.) - A ratio for soil extracts and irrigation waters used to express the relative activity of sodium ions in exhange reactions with soil. Where the ionic concentrations are expressed as milliequivalents per litre.

Soil - The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effects), macro- and micro-organisms, and topography, all acting over a period of time.

Solum - The upper horizons of a soil above the parent material and in which the processes of soil formation are active. It usually comprises the A and B horizons.

Stones - Rock fragments greater than 25 cm in diameter.

Stoniness - The relative proportion of stones in or on the soil. The classes of stoniness are defined as follows:

Stones 0. Nonstony -- Land having less than 0.01% of surface occupied by stones.

Stones 1. Slightly stony -- Land having 0.01-0.1% of surface occupied by stones. Stones 15-30 cm in diameter, 10-30 m apart. The stones offer only slight to no hindrance to cultivation.

Stones 2. Moderately stony -- Land having 0.1-3% of surface occupied by stones. Stones 15-30 cm in diameter, 2-10 m apart. Stones cause some interference with cultivation.

Stones 3. Very stony -- Land having 3-15% of surface occupied by stones. Stones 15-30 cm in diameter, 1-2 m apart. There are sufficient stones to constitute a serious handicap to cultivation.

Stones 4. Exceedingly stony -- Land having 15-50% of surface occupied by stones. Stones 15-30 cm in diameter, 0.7-1.5 m apart. There are sufficient stones to prevent cultivation until considerable clearing has been done.

Stones 5. Excessively stony -- Land having more than 50% of surface occupied by stones. Stones 15-30 cm in diameter, less than 0.7 m apart. The land is too stony to permit cultivation.

Storage Capacity - Refers to the maximum amount of readily available water that can be stored within the rooting zone of a crop in a given soil. For practical irrigation purposes, 50 percent of the total soil water between field capacity and wilting point may be considered as readily available.

Stratified materials - Unconsolidated sand, silt and clay arranged in strata or layers.

Structure - The combination or arrangement of primary soil particles into secondary soil particles, units or peds, which are separated from adjoining aggregates by surfaces of weakness. Aggregates differ in grade (distinctness) of development. Grade is described as structureless (no observable aggregation or no definite orderly arrangement amorphous if coherent, single-grained if noncoherent), weak, moderate, and strong. The aggregates vary in class (size) and are described as fine, medium, coarse, and very coarse. The size classes vary according to the type (shape) of structure. The types of structure are:

Granular - Having more or less rounded aggregates without smooth faces and edges

Phase, soil - A soil phase is a unit of soil outside the system of soil taxonomy. It is a functional unit and is used at any categorical level from Order to Series. It is used to characterize soil and landscape properties that are not used as criteria in soil taxonomy. The major phase differentiae are: slope, erosion, deposition, stoniness, texture, salinity, and calcareousness.

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

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

Potential evapotranspiration (PE) - The maximum quantity of water capable of being lost as water vapor, in a given climate, by a continuous stretch of vegetation covering the whole ground and well supplied with water.

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

Reaction, soil - The acidity or alkalinity of a soil. Soil reaction classes are characterized as follows:

extremely acid. . . .	pH < 4.5
very strongly acid.	4.5 to 5.0
strongly acid . . .	5.1 to 5.5
medium acid	5.6 to 6.0
slightly acid . . .	6.1 to 6.5
mildly alkaline . .	7.4 to 7.8
mod. alkaline . . .	7.9 to 8.4
strongly alkaline .	8.5 to 9.0
very strongly alkaline. .	> 9.0

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

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

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

Saline Soil - A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 millsiemens/cm (ms/cm), the exchangeable-sodium percentage is less than 15, and the pH is usually less than 8.5. Approximate limits of salinity classes are:

non-saline. . . .	0 to 4 ms/cm
slightly saline .	5 to 8 ms/cm
mod. saline . . .	9 to 15 ms/cm
strongly saline . .	> 15 ms/cm

Salinization - The process of accumulation of salts in the soil.

Salt-Affected Soil - Soil that has been adversely modified for the growth of most crop plants by the presence of certain types of exchangeable ions or of soluble salts. It includes soils having an excess of salts, or an excess of exchangeable sodium or both.

Sand - A soil particle between 0.05 and 2.0 mm in diameter. The textural class name for any soil containing 85 percent or more of sand and not more than 10 percent of clay.

Saturation Percentage - The moisture percentage of a saturated soil paste, expressed on an oven dry weight basis.

Seepage -

1. The escape of water downward through the soil.

2. The emergence of water from the soil along an extensive line of surface in contrast to a spring where water emerges from a local spot.

Series, soil - A category in the Canadian System of Soil Classification. It consists of soils that have soil horizons similar in their differentiating characteristics and arrangement in the profile, except for surface texture and are formed from a particular type of parent material.

Shrinkage limit - This is the moisture content at which an equilibrium condition of volume change is reached and further reduction in moisture content will not cause a decrease in the volume of the soil mass.

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

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

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

Fine-clayey. A clayey particle size that has 35-60% clay in the fine earth fraction.

Very-fine-clayey. A clayey particle size that has 60% or more clay in the fine earth fraction.

Ped - An individual soil aggregate such as granule, prism or block formed by natural processes (in contrast with a clod which is formed artificially).

Pedology - Those aspects of soil science involving constitution, distribution, genesis and classification of soils.

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

Permafrost -

1. Perennially frozen material underlying the solum.

2. A perennially frozen soil horizon.

Permafrost table - The upper boundary of permafrost, usually coincident with the lower limit of seasonal thaw (active layer).

Permeability - The ease with which water and air pass through the soil to all parts of the profile. It is described as rapid, moderate or slow.

pH - The intensity of acidity and alkalinity, expressed as the logarithm of the reciprocal of the H + concentration. pH 7 is neutral, lower values indicate acidity and higher values alkalinity.

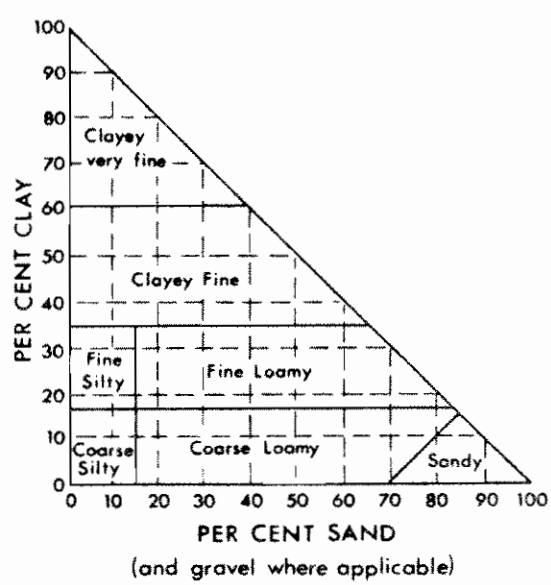


Figure 1: Family particle-size classes

field moisture equivalent) to the shrinkage limit.

Mapping Unit - Any delineated area shown on a soil map that is identified by a symbol. A mapping unit may be a soil unit, a miscellaneous land type, or a soil complex.

Marsh - Periodically flooded or continually wet areas having the surface not deeply submerged. It is covered dominently with sedges, cattails, rushes or other hydrophytic plants.

Mature soil - A soil having well-developed soil horizons produced by the natural processes of soil formation.

Mesophyte - Plants requiring intermediate moisture conditions and are not very resistant to drought.

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

Milliequivalent (me) - One-thousandth of an equivalent. An equivalent is the weight in grams of an ion or compound that combines with or replaces one gram of hydrogen. The atomic or formula weight divided by valence.

Mottles - Irregularly marked spots or streaks, usually yellow or orange but sometimes blue. They are described in order of abundance (few, common, many), size (fine, medium, coarse) and contrast (faint, distinct, prominent). Mottles in soils indicate poor aeration and lack of good drainage.

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

Ovendry soil - Soil that has been dried at 105 degrees C until it has reached constant weight.

Parent material - The unaltered or essentially unaltered mineral or organic material from which the soil profile develops by pedogenic processes.

Particle size, soil - The grain size distribution of the whole soil including the coarse fraction. It differs from texture, which refers to the fine earth (less than 2mm) fraction only. In addition, textural classes are usually assigned to specific horizons whereas soil family particle-size classes indicate a composite particle size of a part of the control section that may include several horizons.

The particle-size classes for family groupings are as follows:

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

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

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

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

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

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

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

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

Groundwater - Water beneath the soil surface, usually under conditions where the voids are completely filled with water (saturation).

Halophytic vegetation - vegetation that grows naturally in soils having a high content of various patts. It usually has fleshy leaves or thorns and resembles desert vegetation.

Horizon (soil) - 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.

Horizon boundary - The lower boundary of each horizon is described by indicating its distinctness and form. The distinctness depends on the abruptness of vertical change (thickness). The Form refers to the variation of the boundary plane.

Distinctness -
abrupt - less than 2 cm
clear - 2 to 5 cm
gradual - 5 to 15 cm
diffuse - more than 15 cm

Form -
smooth - nearly plain
wavy - pockets are wider than deep
irregular - pockets are deeper than wide
broken - parts of the horizon are unconnected with other parts

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

Hydraulic Conductivity - Refers to the effective flow velocity or discharge velocity in soil at unit hydraulic gradient. It is an approximation of the permeability of the soil and is expressed in cm. per hour.

Hydrologic cycle - The conditions through which water naturally passes from the time of precipitation until it is returned to the atmosphere by evaporation and is again ready to be precipitated.

Hydrophyte - Plants growing in water or dependent upon wet or saturated soil conditions for growth.

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

Immature soil - A soil having indistinct or only slightly developed horizons. Also called juvenile soil.

Impeded drainage - A condition that hinders the movement of water by gravity through the soils.

Inclusion - Soil type found within a mapping unit that is not extensive enough to be mapped separately or as part of a complex.

Infiltration - The downward entry of water into the soil

Irrigation - The artificial application of water to the soil for the benefit of growing crops.

Irrigation requirement (IR) - Refers to the amount of water exclusive of effective precipitation that is required for crop production.

Lacustrine deposits - Material deposited by or settled out of lake waters and exposed by lowering of the water levels or elevation of the land. These sediments range in texture from sand to clay and are usually varved (layered annual deposits).

Landforms - See Appendix C.

Landscape - All the natural features such as fields, hills, forest, water, etc., which distinquish one part of the earth's surface from another part.

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

Liquid limit (upper plastic limit) - The water content corresponding to an arbitrary limit between the liquid and plastic states of consistency of a soil. The water content at this boundary is defined as that at which a pat of soil cut by a groove of standard dimensions will flow together for a distance of 1.25 cm under the impact of 25 blows in a standard liquid limit apparatus.

Lineal shrinkage - This is the decrease in one dimension expressed as a percentage of the original dimension of the soil mass when the moisture content is reduced from a stipulated percentage (usually

Dryland farming - The practice of crop production in low rainfall areas without irrigation.

Eluvial horizon - A horizon from which material has been removed in solution or in water suspension.

Eolian - Soil material accumulated through wind action.

Erosion - The wearing away of the land surface by detachment and transport of soil and rock material through the action of moving water, wind or other geological processes. The ratings of erosion are:

Erosion 1 slightly eroded - soil with a sufficient amount of the A horizon removed that ordinary tillage will bring up and mix the B horizon or other lower lying horizons with surface soil in the plow layer.

Erosion 2 moderately eroded - soil with all of the A horizon and a part of the B or other lower lying horizons removed. The plow layer consists mainly of the original horizons below the A or below the original plow layer.

Erosion 3 severely eroded - soils have practically all of the original surface soil removed. The plow layer consists mainly of C horizon material, especially on knolls and steep upper slope positions.

Evapotranspiration - The combined loss of water from a given area, and during a specific period of time, by evaporation from the soil surface and transpiration from plants.

Field Moisture Equivalent - The minimum moisture content at which a drop of water placed on a smoothed surface of the soil will not be absorbed immediately by the soil, but will spread out over the surface and give it a shiny appearance.

Flood plain - The land bordering a stream, built up of sediments from overflow of the stream and subject to innundation when the stream is at flood stage.

Fluvial deposits - All sediments past and present, deposited by flowing water, including glaciofluvial deposits.

Frost heave - The raising of the surface caused by ice in the subsoil.

Friable - Soil aggregates that are soft and easily crushed between thumb and forefinger.

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

Gleyed soil - An imperfectly or poorly drained soil in which the material has been modified by reduction or alternating reduction and oxidation. These soils have lower chromas or more prominent mottling or both in some horizons than the associated well-drained soil.

Gleysolic - An order of soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas or prominent mottling or both, in some horizons.

Granular Structure - Soil structure in which the individual grains are gouped into small block-like aggregates with indistinct or round edges (spheriodal).

Gravel - Rock fragments 2 mm to 7.5 cm in diameter.

Ground Moraine - An unsorted mixture of rocks, boulders, sand, silt and clay deposited by glacial ice. The predominant material is till, most of till is thought to have accumulated under the ice by lodgment, but some till has been let down from the upper surface of the ice by oblation. Resorting and modification may have taken place to some extent by wave-action of glacial melt waters. The topography is most commonly in the form of undulating plains with gently sloping sells and enclosed depressions.

allowed to drain) and length of the saturation period within the plant root zone. The terms are as follows:

Very rapidly drained - Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervioous. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse in texture, or shallow, or both. Water source is precipitation.

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

Well drained - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are equaled by losses. These soils are usually free of mottles within 100 cm of the surface but may be mottled below this depth. Soil horizons are usually bright colored.

Moderately well drained - Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6cm) within the control section and are usually medium to fine in texture. Soils are commonly mottled in the 50 to 100 cm depth. Colors are dull brown in the subsoil with stains and mottles.

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

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

Very poorly drained - Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration. Soils have a wide range in available water storage capacity, Texture, and depth, and are either Gleysolic or Organic.

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

Cobbles - Rock fragments 8 to 25 cm in diameter.

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

Complex (soil) - A mapping unit used in detailed and reconnaissance soil surveys where two or more soil series that are so intimately intermixed in an area that it is impractical to separate them at the scale of mapping used.

Concretions - Hard grains, pellets or nodules from concentration of compounds in the soil that cement soil grains together.

Conductivity electrical - A physical quantity that measures the readiness with which a medium transmits electricity. It is expressed as the reciprocal of the electric resistance (ohms) or millisiemens per cm at 25 degrees C of a conductor which is one cm long with a cross sectional area of one square cm. It is used to express the concentration of salt in irrigation water or soil extracts.

Consistence (soil) - The mutual attraction of the particles in a soil mass, or their resistence to separation or deformation. It is described in terms such as loose, soft, friable, firm, hard, sticky, plastic or cemented.

Consumptive use factor (CU) - The ratio of consumptive use of water by a crop to potential evapotranspiration. and transpiration. An actively growing crop that completely covers the soil over a large area and that has an ample supply of readily available soil water has a consumptive use factor of 1.0.

Consumptive use of water - The sum of the depths of water transpired by the plants and evaporated from the soil surface and from intercepted precipitation. It may be less or greater than potential evapotranspiration.

Contour - An imaginary line connecting points of equal elevation on the surface of the soil.

Cover - This term generally has one of the following meanings:

1. Vegetation or other material providing protection

2. In forestry, low growing shrubs and herbaceons plants under trees (i.e., ground cover vrs. tree cover)

3. Any vegetation producing a protective mat on or just above the soil surface.

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

Decile portion - A one-tenth portion. As used in this map symbol A7 B3 means that the A soils cover seven tenths and the B soils cover three tenths of the map unit.

Delta - An alluvial or glaciofluvial fan shaped deposit at the mouth of a river that empties into a lake or sea.

Deflocculate - To separate or to break up soil aggregates into individual particles by chemical or physical means or both.

Degradation (of soils) - The changing of a soil to a more highly leached and more highly weathered condition, usually accompanied by morphological changes such as the development of an eluviated light colored (Ae) horizon.

Drainage (soil) - (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (2) As a condition of the soil, it refers to the frequency and duration of periods when the soil is free of saturation.

Drainage in soil reports is described on the basis of actual moisture content in excess of field capacity (that moisture retained after soil is

Appendix B

GLOSSARY

AASHO classification (soil engineering) - The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

Acid soil - A soil having a pH less than 7.0.

Acidity - (Alkalinity) - The degree of acidity of the soil expressed in pH values. See Reaction, soil.

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

Arable soil - Soil suitable for plowing and cultivation.

Association - A sequence of soils of about the same age, derived from similar parent material, and occuring under similar climatic conditions but showing different characteristics due to variations in relief and in drainage.

1/3 Atmosphere Moisture - The moisture percentage on dry weight basis of a soil sample that has been air dried, screened, saturated and subjected to a soil moisture tension of 345 cm of water through a permeable membrane for a period of 48 hours. It approximates the soil moisture retention capacity.

Available nutrient - That portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

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

Bearing capacity - Capacity of soil (in moist to wet conditions) to support loads such as buildings, people, vehicles, and animals.

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

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

Bulk density - The weight of oven dry soil (105 degrees C) divided by its volume at field moisture conditions, expressed in grams per cubic centimeter.

Buried soil - Soil covered by an alluvial, loessial, or other deposit, usually to a depth greater than the thickness of the solum.

Calcareous soil - Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with hydrochloric acid.

Calcium Carbonate Equivalent - Refers to the percent of carbonates in the soil expressed on the basis of calcium carbonate. Terms used to express the carbonate contents of soils are:

noncalcareous	<1%
weakly calcareous	1-5%
moderately calcareous . .	6-15%
strongly calcareous . .	16-25%
v. strongly calcareous.	26-40%
extremely calcareous. . .	>40%

Capillary fringe - A zone of essentially saturated soil just above the water table. The size distribution of the pores determines the extent and degree of the capillary fringe.

Carbon-nitrogen ratio (C/N ratio) - The ratio of the weight of organic carbon to the weight of total nitrogen in a soil or in an organic material.

Cation Exchange Capacity (CEC) - A measure of the total amount of exchangeable cations that can be held by a soil. Expressed in milliequivalents per 100g of soil.

Table 2. Analysis of Soil from Site D2.

Horizon	Depth cm	Text. Class	Sand %	Silt %	Clay %	pH $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 g soil	Exchangeable Cations m.e./100 g					Ash %
															Ca	Mg	Na	K	H	
Of	21-8	-	-	-	-	4.2	-	-	-	-	48.5	1.49	-	102.6	29.5	9.3	1.9	0.5	64.0	-
Om	8-0	-	-	-	-	6.7	-	-	-	-	48.4	1.65	-	221.1	120.8	46.2	0.9	0.2	29.2	-
Ahe	0-3	SICL	4	60	36	7.4	0.5	-	-	-	2.6	0.16	-	42.0	25.6	14.4	0.6	0.2	1.7	-
Bmgj	3-27	SIC	14	43	43	7.4	0.4	-	-	-	0.8	0.08	-	29.7	15.0	10.4	0.6	0.2	2.6	-
BC	27-44	C	18	39	43	7.6	0.4	6.1	3.7	2.2	-	-	-	23.5	-	-	-	-	-	-
Ckg	44-120	SICL	8	64	28	7.6	0.3	3.4	1.8	1.5	-	-	-	17.4	-	-	-	-	-	-

Soil from Site D2.

Classification:	Gleyed Eluviated Eutric Brunisol
Parent Material:	Loamy, weakly weathered, weakly to moderately calcareous, very gently sloping glacio-lacustrine.
Moisture and Drainage:	Humid, imperfectly drained, moderately pervious; surface runoff none to very slow.

Horizon	Depth (cm)	Profile Description
Of	21-8	Dark reddish brown (5YR 3/2.5, m) to dark brown (10YR 3/3, d) slightly decomposed needles, feathermoss, herbaceous fragments and woody material; strong, medium fibered; abundant, fine, oblique roots; highly porous; extremely acid; abrupt, smooth boundary.
Om	8-0	Reddish black (10R 2.5/1, m) to dark reddish brown (5YR 3/3, d) moderately decomposed needles, feathermoss, herbaceous fragments and woody material; strong, fine to medium fibered; abundant, fine, oblique roots; highly porous; neutral; abrupt, smooth boundary.
Ahe	0-3	Very dark grayish brown (10YR 3/2, m) to grayish brown (10YR 5/2, d) silty clay loam; mottled; moderate, fine, granular; very sticky and plastic when wet, very friable when moist, hard when dry; abundant, fine oblique roots; moderately porous; mildly alkaline; clear, smooth boundary.
Bmgj	3-27	Dark brown (10YR 3/3, m) to light brownish gray (10YR 6/2, d) silty clay; mottled; weak to moderate, fine to medium granular; very sticky and plastic when wet, very friable when moist, hard when dry; plentiful, fine, vertical roots; moderately porous; mildly alkaline; clear, wavy boundary.
BC	27-44	Grayish brown (2.5Y 5/2, m) to light brownish gray (2.5Y 6/2, d) clay; mottled; weak, very fine to fine, pseudo granular; sticky and plastic when wet, firm when moist, very hard when dry; few, very fine, random roots; moderately porous; mildly alkaline and moderately calcareous; gradual, wavy boundary.
Ckg	44-120	Grayish brown (2.5Y 5/2, m) to light gray (2.5Y 7/2, d) silty clay loam; mottled; massive; sticky and plastic when wet, firm when moist, very hard when dry; very few, very fine, random roots; slightly porous; mildly alkaline and weakly calcareous.

Table 1. Analysis of Soil from Site D1.

Horizon	Depth cm	Text. Class	Sand %	Silt %	Clay %	pH $CaCl_2$	Cond. mmhos/cm	$CaCO_3$ Equiv. %	Calcite %	Dolomite %	Org. C %	Total N %	C/N Ratio	Exch. Cap. m.e./100 g soil	Exchangeable Cations m.e./100 g					Ash %
															Ca	Mg	Na	K	H	
L-F	12-1	-	-	-	-	3.7	-	-	-	-	51.5	1.08	-	94.0	14.3	2.5	0.9	1.8	52.0	-
H	1-0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bm	0-7	SL	74	19	7	4.4	0.3	-	-	-	0.4	0.05	-	9.7	1.5	0.8	0.1	0.1	6.2	-
Aegj	7-18	L	46	40	14	5.0	0.3	-	-	-	0.1	0.04	-	10.5	3.6	2.5	0.1	0.2	4.1	-
AB	18-23	L	36	40	24	5.2	0.2	-	-	-	0.6	0.04	-	16.2	6.0	5.0	0.1	0.3	5.4	-
Btgj	23-38	C	16	34	50	5.1	0.2	-	-	-	0.6	0.05	-	27.9	11.8	10.6	0.7	0.6	8.2	-
BC	38-50	CL	25	44	31	5.3	0.2	-	-	-	-	-	-	22.0	9.7	8.8	0.3	0.3	5.9	-
Cgj	50-63	L	31	44	25	6.5	0.3	-	-	-	-	-	-	19.3	9.3	8.0	0.3	0.3	3.2	-

Appendix A. Morphological Description and Chemical and Physical Data of Two Soils in the Cranberry Portage Map Area.

Soil from Site D1.

Classification:	Gleyed Brunisolic Gray Luvisol
Parent Material:	Loamy, weakly weathered, non-calcareous, nearly level to very gently sloping, moderately stony till.
Moisture and Drainage:	Humid, imperfectly drained, moderately pervious; surface runoff very slow.

Horizon	Depth (cm)	Profile Description
L-F	12-1	Dark reddish brown (5YR 3/2, m) to dark brown (7.5YR 3/2, d), weakly decomposed needles, herbaceous and woody fragments; strong, medium fibered; abundant, medium, horizontal roots; highly porous; extremely acid; abrupt, smooth boundary.
H	1-0	Black, well decomposed plant remains; weak, fine fibered; abundant, medium, horizontal roots; highly porous; extremely acid; abrupt, smooth boundary.
Bm	0-7	Dark grayish brown (10YR 4/2, m) to light brownish gray (2.5Y 6/2, d) sandy loam; very weak, fine granular; nonsticky and nonplastic when wet, loose when moist, soft when dry; plentiful, fine, horizontal roots; highly porous; very strongly acid; clear, wavy boundary.
Aegj	7-18	Grayish brown (2.5Y 5/2, m) to light gray (2.5Y 7/1, d) loam; mottled; strong, medium platy; slightly sticky and slightly plastic when wet, friable when moist, very hard when dry; plentiful, fine, horizontal roots; highly porous; strongly acid; clear, wavy boundary.
AB	18-23	Light brownish gray (2.5Y 6/2, m) to light gray (2.5Y 7/2, d) loam; mottled; weak, coarse platy; slightly sticky and plastic when wet, friable when moist, very hard when dry; plentiful, fine, horizontal roots; highly porous; strongly acid; clear, smooth boundary.
Bt	23-38	Dark brown (10YR 3/3, m) to pale brown (10YR 6/3, d) clay; mottled; weak to moderate, medium, subangular blocky breaking to weak, fine, angular blocky; slightly sticky and very plastic when wet, firm when moist, very hard when dry; few, fine, random roots; moderately porous; strongly acid; gradual, wavy boundary.
BC	38-50	Brown (10YR 5/3, m) to pale brown (10YR 6/3, d) clay loam; mottled; very weak, fine, pseudo granular; slightly sticky and plastic when wet, firm when moist, hard when dry; few, fine, random roots; moderately porous; strongly acid; clear, wavy boundary.
C	50-63	Grayish brown (2.5Y 5/2, m) to light brownish gray (2.5Y 6/2, d) loam; mottled; very weak, fine pseudo granular; sticky and slightly plastic when wet, very friable when moist, hard when dry; few, very fine, random roots; moderately porous; slightly acid.
cR	63+	Carbonitic bedrock (dolostone).

frequency of slopes in different directions. A set of 10 slope classes are used to denote the dominant but not necessarily most abundant slopes within a mapping unit. Letters are used for multiple slopes (irregular surface).

Slope Class	Slope Name	Percent slope	Approx. degrees
1	level	0-0.5	0
2	nearly level	.5-2.5	.3-1.5
3	very gentle	2-5	1-3
4	gentle	6-9	3.5-5
5	moderate	10-15	6-8.5
6	strong	16-30	9-17
7	very strong	31-45	17-24
8	extreme	46-70	25-35
9	steep	71-100	35-45
10	very steep	>100	>45

Underground runoff - (or seepage)-Water flowing towards stream channels after infiltration into the ground.

Unified Soil Classification System (engineering) - A classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

Urban Land - Areas so altered or obstructed by urban works or structures that identification of soils is not feasible.

Variant, soil - A soil whose properties are believed to be sufficiently different from other known soils to justify a new series name, but comprising such a limited geographic area that creation of a new series is not justified.

Varve - A distinct band representing the annual deposit in sedimentary materials regardless of origin and usually consisting of two layers, one thick light colored layer of silt and fine sand laid down in the spring and summer, and the other a thin, dark colored layer of clay laid down in the fall and winter.

Water balance, soil - Is the daily amount of readily available water retained by the soil. The daily soil-water balance is decreased by the amount that the daily consumptive use exceeds the daily rainfall. When daily rainfall exceeds the consumptive use, the daily balance increases by the amount of the difference unless the soil-water balance is at storage capacity, in which case the excess is assumed to be lost by runoff or deep percolation.

Water table - (groundwater surface; free water surface; groundwater elevation) Elevation at which the pressure in the water is zero with respect to the atmospheric pressure.

Water-holding capacity - The ability of a soil to hold water. The water-holding capacity of sandy soils is usually considered to be low, while that of clayey soils is high. It is often expressed in cm of water per 30 cm depth of soil.

Weathering - The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

Xerophyte - Plants capable of surviving extended periods of soil drought.

Appendix C

SOIL HORIZON DESIGNATIONS

ORGANIC HORIZONS

Organic horizons are found in Organic soils, and commonly at the surface of mineral soils. They may occur at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon (approximately 30% organic matter) by weight. Two groups of these horizons are recognized, O horizons and the L, F, and H horizons.

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

- Of The fibric horizon is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fiber that are readily identifiable as to botanical origin. A fibric horizon has 40% or more of rubbed fiber by volume and a pyrophosphate index of 5 or more. If the rubbed fiber volume is 75% or more, the pyrophosphate criterion does not apply.
- Om The mesic horizon is the intermediate stage of decompostion with intermediate amounts of fiber, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic horizon is one that fails to meet the requirements of fibric or of humic.
- Oh The humic horizon is the most highly decomposed of the organic soil materials. It has the least amount of fiber, 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. The humic horizon has less than 10% rubbed fiber by volume and a phrophosphate index of 3 or less.

LFH These organic horizons developed primarily from leaves, twigs, woody materials and a minor component of mosses under imperfectly to well drained forest conditions.

- L This is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible.
- F This is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor.
- H This is an organic horizon characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral, grains, especially near the junction with the mineral horizon.

MASTER MINERAL HORIZONS

Mineral horizons are those that contain less than 30% organic matter by weight as specified for organic horizons.

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

1. horizons in which organic matter has accumulted as a result of biological activity (Ah);

2. horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of them (Ae);

3. horizons having characteristics of 1) and 2) above but transitional to underlying B or C (AB or A and B);

4. horizons markedly disturbed by cultivation or pasture (Ap).

B This is a mineral horizon or horizons characterized by one or more of the following:

1. an enrichment in silicate clay, iron, aluminum, or humus, alone or in combination (Bt,Bf,Bfh,Bhf, and Bh);

2. a prismatic or columnar structure that exhibits pronounced coatings or stainings and significant amount of exchangeable Na (Bn);

3. an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both, and does not meet the requirements of 1) and 2) above (Bm,Bg).

C This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (i) the process of gleying, and (ii) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca,Csa,Cg, and C). Marl and diatomaceous earth are considered to be C horizons.

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

W This is a layer of water in Gleysolic, Organic, or Cryosolic soils. It is called a hydric layer in Organic soils.

LOWER-CASE SUFFIXES

b Buried soil horizon.

c A cemented (irreversible) pedogenic horizon. The ortstein of a Podzol, and a layer cemented by calcium carbonate and a duripan are examples.

ca A horizon with secondary carbonate enrichment where the concentration of lime exceeds that present in the unenriched parent material. It is more than 10cm thick, and if it has a $CaCO_3$ equivalent of less than 15 percent it should have at least 5 percent more $CaCO_3$ equivalent than the parent material (IC). If it has more than 15 percent $CaCO_3$ equivalent it should have 1/3 more $CaCO_3$ equivalent than IC. If no IC is present, this horizon is more than 10 cm thick and contains more than 5 percent by volume of secondary carbonates in concretions or soft, powdery forms.

cc Cemented (irreversible) pedogenic concretions.

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

f A horizon enriched with amorphous material, principally Al and Fe combined with organic matter. It usually has a hue of 7.5YR or redder or its hue is 10YR near the upper boundary and becomes yellower with depth. When moist, the chroma is higher than 3 or the value is 3 or less. It contains 0.6% or more pyrophosphate-extractable Al+Fe in textures finer than sand and 0.4% or more in sands (coarse sand, sand, fine sand, and very fine sand). The ratio of pyrophosphate-extractable Al+Fe to clay (less than 0.0002mm) is more than 0.05 and organic C exceeds 0.5%. Pyrophosphate-extractable Fe is at least 0.3%, or the ratio of organic C to pyrophosphate-extractable Fe is less than 20, or both are true. It is used with B alone (Bf), with B and h (Bhf), with B and g (Bfg), and with other suffixes. The criteria for "f" do not apply to Bgf horizons. The following horizons are differentiated on the basis of organic carbon content: Bf - 0.5% to 5% organic carbon. Bhf- more than 5% organic carbon.

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. It is used with A and e (Aeg); with B alone (Bg); with B and f (Bfg); with B, h,

and f (Bhfg); with B and t (Btg); with C alone (Cg); with C and k (Ckg); and several others. In some reddish parent materials, matrix colors of reddish hues and high chromas may persist despite long periods of reduction. In these soils, horizons are designated as g if there is gray mottling or if there is marked bleaching on ped faces or along cracks.

Aeg This horizon must meet the definitions of A,e, and g.

Bg These horizons are analogous to Bm horizons but they have colors indicative of poor drainage and periodic reduction. They include horizons occurring between A and C horizons in which the main features are (i) colors of low chroma, that is: chromas of 1 or less, without mottles on ped surfaces or in the matrix if peds are lacking; or chromas of 2 or less in hues of 10YR or redder, on ped surfaces or in the matrix if peds are lacking, accompanied by more prominent mottles than those in the C horizon; or hues bluer than 10Y, with or without mottles on ped surfaces or in the matrix if peds are lacking. (ii) colors indicated in (i) and a change in structure from that of the C horizons. (iii) color indicated in (i) and illuviation of clay too slight to meet the requirements of Bt; or accumulation or iron oxide too slight to meet the limits of Bgf. (iv) colors indicated in (i) and removal of carbonates. Bg horizons occur in some Orthic Humic Gleysols and some Orthic Gleysols.

Bfg, Bhfg, Btg, and others When used in any of these combinations the limits set for f, hf, t, and others must be met.

Bgf The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more. Pyrophosphate-extractable Al + Fe is less than the minimum limit specified for 'f' horizons. This horizon occurs in Fera Gleysols and Fera Humic Gleysols, and possibly below the Bfg of gleyed Podzols. It is distinguished from the Bfg of gleyed Podzols on the basis of the extractability of the Fe and Al. The Fe in the Bgf horizon is thought to have accumulated as a result of the oxidation of ferrous iron. The iron oxide formed is not associated intimately with organic matter or with Al, and it is sometimes crystalline. The Bgf horizons are usually prominently mottled, with more than half of the soil material occurring as mottles of high chroma.

Cg, Ckg, Ccag, Csg, Csag When g is used with C alone, or with C and one of the lower-case suffixes k, ca, s, or sa, it must meet the definiton for C and for the particular suffix.

h A horizon enriched with organic matter. It is used with A alone (Ah); or with A and e (Ahe); or with B alone (Bh); or with B and f (Bhf).

Ah A horizon enriched with organic matter that either has a color value at least one unit lower than the underlying horizon or contains 0.5% more organic carbon than the IC, or both. It contains less than 17% organic carbon by weight.

Ahe An Ah horizon that has undergone eluviation as evidenced, under natural conditions, by streaks and splotches of differing shades of gray and often by platy structure. It may be overlain by a darker-colored Ah and underlain by a lighter-colored Ae.

Bh This horizon contains more than 1% organic carbon, less than 0.3% pyrophosphate-extractable Fe, and has a ratio of organic carbon to pyrophosphate-extractable Fe of 20 or more. Generally the color value and chroma are less than 3 when moist.

Bhf Defined under 'f'.

j Used as a modifier of the suffixes e, f, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be

placed to the right and adjacent to the suffix it modifies. For example Bfgj means a Bf horizon with weak expression of gleying; Bfjgj means a B horizon with weak expression of both 'f' and 'g' features.

Aej It denotes an eluvial horizon that is thin, discontinuous or slightly discernible.

Btj It is a horizon with some illuviation of clay, but not enough to meet the limits of Bt.

Btgj, Bmgj Horizons that are mottled but do not meet the criteria of Bg.

Bfj It is a horizon with some accumulation of pyrophosphate-extractable Al and Fe but not enough to meet the limits of Bf.

Bntj or Bnj Horizons in which development of solonetzic B properties is evident but insufficient to meet the limits for Bn or Bnt.

k Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added. Most often it is used with B and m (Bmk) or C (Ck), and occasionally with Ah or Ap (Ahk, Apk), or organic horizons (Ofk, Omk).

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

1. Evidence of alteration in one of the following forms:

   a) Higher chromas and redder hues than the underlying horizons.

   b) Removal of carbonates, either partially (Bmk) or completely (Bm).

2. Illuviation, if evident, too slight to meet the requirements of a Bt or a podzolic B.

3. Some weatherable minerals.

4. No cementation or induration and lacks a brittle consistence when moist. This suffix can be used as Bm, Bmgj, Bmk, and Bms.

n A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. It must also have kthe following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistence when dry. It is used with B, as Bn or Bnt.

p A horizon disturbed by man's activities, such as cultivation, logging, habitation, etc. It is used with A and O.

s A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by depressed crop growth, or by the presence of salt-tolerant plants. It is commonly used with C and k (Csk), but can be used with any horizon or combination of horizon and lowercase suffix.

sa A horizon with secondary enrichment of salts more soluble than calcium and magnesium carbonates, in which the concentration of salts exceeds that present in the unenriched parent material. The horizon is 10 cm or more thick. The conductivity of the saturation extract must be at least 4 ms/cm and must exceed that of the C horizon by at least one-third.

t An illuvial horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), with B and n (Bnt), etc.

Bt A Bt horizon is one that contains illuvial layer-lattice clays. It forms below an eluvial horizon, but may occur at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than IC. It has the following properties:

1. If any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizons, as follows:

   a) If any part of the eluvial horizon has less than 15% total clay in the fine earth fraction (2mm) the Bt horizon must contain at least 3%

more clay, e.g.,Ae 10% clay-Bt minimum 13% clay.

b) If the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of the clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more, e.g., 20% clay increase in the Bt over Ae.

c) If the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon, e.g. Ae 50% clay; Bt at least 58% clay.

2. A Bt horizon must be at least 5 cm thick. In some sandy soils where clay accumulation occurs in the lamellae, the total thickness of the lamellae should be more than 10 cm in the upper 150 cm of the profile.

3. In massive soils the Bt horizon should have oriented clays in some pores and also as bridges between the sand grains.

4. If peds are present, a Bt horizon shows clay skins on some of the vertical and horizontal ped surfaces and in the fine pores, or shows oriented clays in 1% or more of the cross section, as viewed in thin section.

5. If a soil shows a lithologic discontinuity between the eluvial horizon and the Bt horizon, or if only a plow layer overlies the Bt horizon, the Bt horizon need show only clay skins in some part, either in some fine pores or on some vertical and horizontal ped surfaces. Thin sections should show that some part of the horizon has about 1% or more of oriented clay bodies.

Btj Btj and Btg are defined under j and g.

u A horizon that is markedly disrupted by physical or faunal processes other than cryoturbation. Evidence of marked disruption such as the inclusion of material from other horizons, absence of the horizon, etc. must be evident in at least half of the cross section of the pedon. Such turbation can result from blowdown of trees, mass movement of soil on slopes, and burrowing animals. It can be used with any horizon or subhorizon with the exception of A or B alone; e.g. Aeu, Bfu, BCu.

x A horizon of fragipan character. A fragipan is a loamy subsurface horizon of high bulk density and very low organic matter content. When dry, it has a hard consistence and seems to be cemented. When moist, it has moderate to weak brittleness. It frequently has bleached fracture planes and is overlain by a friable B horizon. Air dry clods of fragic horizons slake in water.

y A horizon affected by cryoturbation as manifested by disrupted and broken horizons,, incorporation of materials from other horizons and mechanical sorting in at least half of the cross section of the pedon. It is used with A, B, and C alone or in combination with other subscripts, e.g. Ahy, Ahgy, Bmy, Cy, Cgy, Cygj, etc.

z A frozen layer. It may be used with any horizon or layer, e.g. Ohz, Bmz, Cz, Wz.

Appendix D

DESCRIPTION OF LANDFORMS

C.1 GENETIC MATERIALS

Unconsolidated mineral component

The unconsolidated mineral component consists of clastic sediments that may or may not be stratified, but whose particles are not cemented together. They are essentially of glacial or post-glacial origin but include poorly consolidated and weathered bedrock.

Anthropogenic - Man-made or man-modified materials, including those associated with mineral exploitation and waste disposal.

Colluvial - Massive to moderately well stratified, nonsorted to poorly sorted sediments with any range of particle sizes from clay to boulders and blocks that have reached their present position by direct, gravity-induced movement.

They are restricted to products of mass-wasting whereby the debris is not carried by wind, water, or ice (excepting snow avalanches).

Eolian - Sediment, generally consisting of medium to fine sand and coarse silt particle sizes, that is well sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive. Individual grains may be rounded and show signs of frosting.

These materials have been transported and deposited by wind action.

Fluvial - Sediment generally consisting of gravel and sand with a minor fraction of silt and clay. The gravels are typically rounded and contain interstitial sand. Fluvial sediments are commonly moderately to well sorted and display stratification, but massive, nonsorted fluvial gravels do occur. These materials have been transported and deposited by streams and rivers. Finer textured Fluvial deposits of modern rivers are termed Alluvium.

Lacustrine - Sediment generally consisting of either stratified fine snad, silt, and clay deposited on the lake bed; or moderately well sorted and stratified sand and coarser materials that are beach and other nearshore sediments transported and deposited by wave action.

These are materials that either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action.

Marine - Unconsolidated deposits of clay, silt, sand, or gravel that are well to moderately well sorted and well stratified to moderately stratified (in some places containing shells). They have settled from suspension in salt or brackish water bodies or have accumulated at their margins through shoreline processes such as wave action and longshore drift.

Morainal - Sediment generally consisting of well compacted material that is nonstratified and contains a heterogeneous mixture of particle sizes, often in a mixture of sand, silt, and clay that has been transported beneath, beside, on, within and in front of a glacier and not modified by any intermediate agent.

Saprolite - Rock containing a high proportion of residual silts and clays formed by alteration, chiefly by chemical weathering.

The rock remains in a coherent state, interstitial grain relationships are undisturbed and no downhill movement due to gravity has occurred.

Undifferentiated - A layered sequence of more than three typed of

genetic material outcropping on a steep erosional escarpment.

Volcanic - Unconsolidated pyroclastic sediments. These include volcanic dust, ash, cinders, and pumice.

Qualifying Descriptors

These have been introduced to qualify the genetic materials and to supply additional information about the mode of formation or depositional environment.

Glacial - Used to qualify nonglacial genetic materials or process modifiers where there is direct evidence that glacier ice exerted a strong but secondary or indirect control upon the mode of origin of the materials or mode of operation of the process. The use of this qualifying descriptor implies that glacier ice was close to the site of the deposition of a material or the site of operation of a process.

Glaciofluvial - Fluvial materials showing clear evidence of having been deposited either directly in front of or in contact with glacier ice.

Glaciolacustrine - Lacustrine materials deposited in contact with glacial ice.

Glaciomarine - Materials of glacial origin laid down in a marine environment, as a result of settling from melting, floating ice and ice shelves.

Organic component

The organic component consists of peat deposits containing >30% organic matter by weight that may be as thin as 10 cm if they overlie bedrock but are otherwise greater than 40 cm and generally greater than 60 cm thick. The classes and their definitions follow.

B	Bog
N	Fen
S	Swamp

Bog - A bog is a peat-covered or peat-filled area, generally with a high water table. Since the surface of the peatland is slightly elevated, bogs are either unaffected or partly affected by nutrient-rich groundwaters from the surrounding mineral soils. The groundwater is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat, underlain, at times, by fen peat.

Fen - A fen is a peat-covered or peat-filled area with a high water table, which is usually at the surface. The dominant materials are shallow to deep, well to moderately decomposed fen peat. The waters are mainly rich in nutrients (minerotrophic) and are derived from mineral soils. The peat materials are therefore higher in both nutrients and pH than the peats associated with bogs.

Swamp - A swamp is a peat-covered or peat-filled area. The peat surface is level or slightly concave in cross section. The water table is frequently at or above the peat surface. There is strong water movement from margins or other mineral sources. The microrelief is hummocky, with many pools present. The waters are neutral or slightly acid. The dominant peat materials are shallow to deep mesic to humic forest and fen peat.

C.2 GENETIC MATERIAL MODIFIERS

Material modifiers are used to qualify unconsolidated mineral and organic deposits. Particle-size classes serve to indicate the size, roundness, and sorting of unconsolidated mineral deposits. Fiber classes indicate the degree of decomposition and fiber size of organic materials.

Particle size classes for unconsolidated mineral materials

Blocky: An accumulation of angular particles greater than 256 mm in size.

Bouldery: An accumulation of rounded particles greater than 256 mm in size.

Clayey: An accumulation of particles where the fine earth fraction contains 35% or more clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Cobbly: An accumulation of rounded particles having a diameter of 64-256 mm.

Gravelly: An accumulation of rounded particles ranging in size from pebbles to boulders.

Loamy: An accumulation of particles of which fine earth fraction contains 35% or more clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Pebbly: An accumulation of rounded particles having a diameter of 2-64 mm.

Rubbly: An accumulation of angular fragments having a diameter of 2-256 mm.

Sandy: An accumulation of particles of which the fine earth fraction contains more than 70% by weight of fine snad or coarser particles. Particles greater than 2 mm occupy less than 35% by volume.

Silty: An accumulation ofparticles of which the fine earth fraction contains less than 15% of fine sand or coarser particles and has less than 35% clay. Particles greater than 2 mm occupy less than 35% by volume.

Fiber classes for organic materials

The amount of fiber and its durability are important characterizing features of organic deposits in that they reflect on the degree of decomposition of the material. The prevalence of woody materials in peats is also of prime importance.

Fibric: The least decomposed of all organic materials; there is a large amount of well-preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.

Mesic: Organic material in an intermediate stage of decompostion; intermediate amounts of fiber are present that can be identified as to their botanical origin.

Humic: Highly decomposed organic material; small amounts of fiber are present that can be identified as to their botanical origin. Fibers can be easily destroyed by rubbing.

Woody: Organic material containing more than 50% of woody fibers.

C.3 SURFACE EXPRESSION

The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials. When applied to consolidated materials, form refers to the product of their modification by geological processes. Surface expression also indicates the manner in which unconsolidated genetic materials relate to the underlying unit.

Consolidated and Unconsolidated mineral surface classes

Apron - A relatively gently slope at the foot of a steeper slope and formed by materials from the steeper, upper slope.

Blanket - A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but still conforming to the general underlying topography.

Fan - A fan-shaped form similar to the segment of a cone and having a perceptible gradient from the apex to the toe.

Hummocky - A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls or depressions. Slopes are generally 9-70% (5-35 degrees).

Inclined - A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities. Slopes are 2-70% (1-35 degrees). The form of inclined slopes is not related to the initial mode of origin of the underlying material.

Level - A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 2% (1 degree).

Rolling - A very regular sequence of moderate slopes extending from rounded, sometines confined concave depressions to broad, rounded convexities producing a wavelake pattern of moderate relief. Slope length is often 1.6 km or greater and gradients are greater than 5% (3 degrees).

Ridged - A long, narrow elevation of the surface, usually sharp crested with steep sides. The ridges may be parallel, subparallel, or intersecting.

Steep - Erosional slopes, greater than 70% (35 degrees), on both consolidated and unconsolidated materials. The form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material.

Terraced - Scarp face and the horizontal or gently inclined surface (tread) above it.

Undulating - A very regular sequence of gentle slopes that extends from rounded, sometines confined concavities to broad rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is 2-5% (1-3 degrees).

Veneer - Unconsolidated materials too thin to mask the minor irrigularities of the underlying unit surface. A veneer will range from 10 cm to 1 m in thickness and will possess no form typical of the materials's genesis.

Organic surface classes

Blanket - A mantle of organic materials that is thick enough to mask minor irregularities in the under-lying unit but still conforms to the general underlying topography.

Bowl - A bog or fen occupying concave-shaped depressions.

Domed - A bog with an elevated, convex, central area much higher than the margin. Domes may be abrupt (with or without a frozen core) or gently sloping or have a stepped surface.

Floating - A level organic surface associated with a pond or lake and not anchored to the lake bottom.

Horizontal - A flat peat surface not broken by marked elevations and depressions.

Plateau - A bog with an elevated, flat, central area only slightly higher than the margin.

Ribbed - A pattern of parallel or reticulate low ridges associated with fens.

Sloping - A peat surface with a generally constant slope not broken by marked irregularities.

Veneer - A thin (40 to cm.) mantle of organic materials which generally conforms to the underlying topography. They may or may not be associated with discontinuous permafrost.

Table 1. Guide for assessing soil suitability for camp areas.

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

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

Symbol[1/]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2/]	Very rapidly, rapidly, well and moderately well drained soils with no seepage or ponding. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils with no seepage or ponding. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None	Very occasional flooding during season of use. Once in 5-10 years.	Occasional flooding during season of use. Once in 2-4 years.	Flooding during every season of use.
k	Permeability	Very rapid to moderate inclusive.	Moderately slow and slow.	Very slow.	
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2/,3/]	SL, FSL, VFSL, L	SiL, SCL, CL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4/]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2/,5/]	0-20%	20-50%	>50%	
p	Stoniness[2/,6/]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
r	Rockiness[2/,6/]	No rock exposures	Rock exposures >10 m apart and cover <25% of the area.	Rock exposures <10 m apart and cover >25% of the area.	Rock exposures too frequent to permit campground location.

1/ The symbols are used to indicate the nature of the limitation.

2/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

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

4/ Moderately well and well drained SC, SiC and C soils may be rated fair.

5/ Coarse fragments for the purpose of this table include gravels and cobbles. Some gravelly soils may be rated as having slight limitations if the content of gravel exceeds 20% by only a small margin, providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

6/ Very shallow soils are rated as having a limitation for rockiness and/or stoniness.

Table 2. Guide for assessing soil suitability for picnic areas.

This guide applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to the access roads. 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.

Symbol[1/]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2/]	Very rapidly, rapidly, well and moderately well drained soils not subject to seepage or ponding. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils not subject to ponding or seepage. Water Table above 50 cm for short periods during season of use.	Imperfectly drained soils subject to seepage or ponding. Poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	May flood 1 or 2 times per year for short periods during season of use.	Floods more than 2 times during season of use.	Prolonged flooding during season of use.
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2/,3/]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4/]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2/]	0-20%	20-50%	>50%	
p	Stoniness[2/]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[2/,5/,6/]	Rock exposures roughly 30-100 or more m apart and cover <10% of the surface.	Rock exposures roughly 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of picnic areas.
m	Useful Moisture[7/]	Water storage capacity[8/] >15 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8/] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8/] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

1/ The symbols are used to indicate the nature of the limitation.

2/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978). Coarse fragments for the purpose of this table, include gravels and cobbles. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

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

4/ Moderately well and well drained SC, SiC and C soils may be rated fair.

5/ Very shallow soils are rated as having severe or very severe limitations for stoniness or rockiness.

6/ The nature and topography of the bedrock exposures may significantly alter these ratings. As such, on-site investigations will be necessary in map units containing bedrock when these are considered as possible sites.

7/ This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

8/ Consult glossary for definitions of terms used.

Table 3. Guide for assessing soil suitability for playgrounds.

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

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

Symbol[1/]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2/]	Rapidly, well and moderately well drained soils with no ponding or seepage. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding of short duration and imperfectly drained soils. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding, and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	Occasional flooding. May flood once every 2-3 years during season of use.	Floods every year during season of use.	Prolonged flooding during season of use.
k	Permeability	Very rapid to moderate.	Moderately slow and slow.	Very slow.	
t	Slope	0-2%	2-5%	5-9%	>9%
d	Depth to Bedrock	>100 cm	50-100 cm[3/]	<50 cm[3/]	
c	Coarse fragments on surface[2/]	Relatively free of coarse fragments.	<20% coarse fragments.	>20% coarse fragments.	
p	Stoniness[2/]	Stones >10 m apart. (Class 0 to 1)	Stones 2-10 m apart. (Class 2)	Stones 0.1-2 m apart. (Class 3, 4)	Stones <0.1 m apart. (Class 5)
r	Rockiness[2/]	Rock exposures >100 m apart and cover <2% of the surface.	Rock exposures 30-100 m apart and cover about 2-10% of the surface.	Rock exposures <30 m apart and cover >10% of the surface.	Rock outcrops too frequent to permit playground location.
s	Surface Soil Texture[2/,4/]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS	SC, SiC, C[5/]; S, Si	Peaty soils; S and LS subject to blowing.
q	Depth to Sand or Gravel[6/]	>100 cm	50-100 cm	<50 cm	
m	Useful Moisture[7/]	Water storage capacity[8/] >15.0 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8/] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8/] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

1/ The symbols are used to indicate the nature of the limitation.

2/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).
Coarse fragments for the purpose of this table include gravels and cobbles.

3/ Downgrade to a very poor suitability rating if the slope is greater than 5%.

4/ Surface soil texture influences soil ratings as it affects foot trafficability, surface wetness, dust, and maintenance. Adverse soil textures may be partially or completely overcome with the addition of topsoil.

5/ Moderately well and well drained SC, SiC and C soils may be rated fair.

6/ Depth to sand or gravel is considered a limitation in that levelling operations may expose sand or gravel, thereby bringing about adverse surface textures and undesirable amounts of coarse fragments. The addition of topsoil after the levelling process would overcome this limitation.

7/ This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

8/ Consult glossary for definitions of terms used.

Table 4. Guide for assessing soil suitability for paths and trails.

It is assumed that the trails will be built at least 45 cm wide and that obstructions such as cobbles and stones will be removed during construction. It is also assumed that a dry, stable tread is desirable and that muddy, dusty, worn or eroded trail treads are undesirable. Hiking and riding trails are not treated separately, but as the design requirements for riding trails are more stringent, a given limitation will be more difficult to overcome. Poor or very poor suitability does not indicate that a trail cannot or should not be built. It does, however, suggest higher design requirements and maintenance to overcome the limitations.

Symbol[1/]	Items[2/] Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Texture[3/,4/]	SL, FSL, VFSL, LS, L	SiL, CL, SiCL, SCL	SC, SiC, C[5/]; Sand, Si	Peaty soils; loose sand subject to blowing
c	Coarse Fragment Content[4/,6/]	0-20%	20-50%	>50%	
p	Stoniness[4/]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
w	Wetness[4/]	Very rapidly, rapidly well, and moderately well drained soils. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage and ponding and imperfectly drained soils. Water table may be above 50 cm for short periods during season of use.	Poorly and very poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Permanently wet soils.
r	Rockiness[4/,7/]	Rock exposures >30 m apart and cover <10% of the surface.	Rock exposures 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of paths and trails.
t	Slope[8/]	0-15%	15-30%	30-60%	>60%
i	Flooding	Not subject to flooding during season of use.	Floods 1 or 2 times during season of use.	Floods more than 2 times during season of use.	Subject to prolonged flooding during season of use.

1/ The symbols are used to indicate the nature of the limitation.

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

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

4/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Moderately well and well drained SC, SiC and C soils may be rated fair.

6/ Coarse fragments for the purpose of this table, include gravels and cobbles. Gravels tend to cause unstable footing when present in high amounts, and are also associated with increased erosion. Cobbles (and stones) must be removed from the trail tread, increasing construction and maintenance difficulties. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix or (b) the fragments are less than 2 cm in size.

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

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

Table 5. Guide for assessing soil suitability for permanent buildings[1].

This guide applies to undisturbed soils to be evaluated for single-family dwellings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundation requirements; but soil slope, susceptibility to flooding and other hydrologic conditions, such as wetness, that have effects beyond those related exclusively to foundations are considered too. Also considered are soil properties, particularly depth to bedrock, which influence excavation and construction costs for the building itself and for the installation of utility lines. Excluded are limitations for soil corosivity, landscaping and septic tank absorption fields.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability[3]			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[4]	With Basements: Very rapidly, rapidly and well drained. Without Basements: Very rapidly, rapidly, well and moderately well drained.	With Basements: Moderately well drained. Without Basements: Imperfectly drained.	With Basements: Imperfectly, poorly, and very poorly drained. Without Basements: Poorly and very poorly drained.	With Basements: Permanently wet soils. Without Basements: Permanently wet soils.
h	Depth to Seasonal Water Table	With Basements: >150 cm Without Basements: >75 cm	With Basements: 75-150 cm Without Basements: 50-75 cm	With Basements: 25-75 cm Without Basements: 25-50 cm	With Basements: <25 cm Without Basements: <25 cm
i	Flooding	None	None	Occasional flooding (once in 5 years)	Frequent flooding (every year)
t	Slope[5]	0-9%	9-15%	15-30%	>30%
a	Subgrade[6]				
	a. AASHO group index[7]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM and GC and SC	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Potential Frost Action[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[4]	Stones >10 m apart (Class 0 to 1)	Stones 2-10 m apart (Class 2[10])	Stones 0.1-2 m apart (Class 3[10] to 4)	Stones <0.1 m apart (Class 5[10])
r	Rockiness[4,11]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to allow location of permanent buildings
d	Depth to Bedrock[11]	With Basements: >150 cm Without Basements: >100 cm	With Basements: 100-150 cm Without Basements: 50-100 cm	With Basements: 50-100 cm Without Basements: <50 cm	With Basements: <50 cm

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

2/ The symbols are used to indicate the nature of the limitation.

3/ Some soils assessed as fair or poor may be good sites from an aesthetic or use standpoint, but they will require more site preparation and/or maintenance.

4/ For an explanation of rockiness, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

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

6/ This item estimates the strength of the soil, that is, its ability to withstand applied loads. When available, AASHO Group Index values from laboratory tests were used; otherwise the estimated Unified classes were used.

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

8/ P.I. means plasticity index.

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

10/ Rate one class better for buildings without basements.

11/ Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment such as backhoes.

Table 6. Guide for assessing soil suitability for septic tank absorption fields.

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

Symbol[1/]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
k	Permeability[2/]	Rapid to moderately rapid	Moderate	Slow	Very slow
	Percolation Rate[3/] (Auger hole method)	About 8-18 min/cm[3/]	18-24 min/cm	Slower than 24 min/cm	
h	Depth to Seasonal Water Table[4/]	>150 cm[5/]	100-150 cm	50-100 cm	<50 cm
i	Flooding	Not subject to flooding	Not subject to flooding	Subject to occasional flooding (once in 5 years)	Floods every year
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Hard Rock, bedrock or other impervious materials	>150 cm	100-150 cm[6/]	50-100 cm	<50 cm

1/ The symbols are used to indicate the nature of the limitation.

2/ The suitability ratings should be related to the permeability of soil layers at and below depth of the tile line.

3/ Soils having a percolation rate less than about 8 min/cm are likely to present a pollution hazard to adjacent waters. This hazard must be noted, but the degree of hazard must, in each case, be assessed by examining the proximity of the proposed installation to water bodies, water table, and related features. The symbol g is used to indicate this condition. Refer to U.S. Dept. of Health, Education and Welfare (1969) for details of this procedure.

4/ Seasonal means for more than one month. It may, with caution, be possible to make some adjustment for the severity of a water table limitation in those cases where seasonal use of the facility does not coincide with the period of high water table.

5/ A seasonal water table should be at least 100 cm below the bottom of the trench at all times for soils rated Good (U.S. Dept. of Health, Education and Welfare, 1969). The depths used to water table are based on an assumed tile depth of 50 cm. Where relief permits, the effective depth above a water table or rock can be increased by adding appropriate amounts of fill.

6/ Where the slope is greater than 9%, a depth to bedrock of 100-150 cm is assessed as poor.

Table 7. Guide for assessing soil suitability for local roads and streets[1].

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

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth of hardrock, stoniness, rockiness, and wetness affect the ease of excavation and the amount of cut and fill to reach an even grade.

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

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

2/ Symbols are used to indicate the nature of the limitation.

3/ For an explanation of stoniness, rockiness and soil drainage classes, see the Canada Soil Information System (Canada Soil Survey Committee, 1978).

4/ Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery.

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

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

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

8/ P.I. means plasticity index.

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

Table 8. Guide for assessing soil suitability as source of roadfill.

Fill material for buildings or roads are included in this use. The performance of the material when removed from its original location and placed under load at the building site or road bed are to be considered. Since surface materials are generally removed during road or building construction their properties are disregarded. Aside from this layer, the whole soil to a depth of 150-200 cm should be evaluated. Soil materials which are suitable for fill can be considered equally suited for road subgrade construction.

Symbol[1/]	Items Affecting Use[2/]	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	Subgrade[3/]				
	a. AASHO group index[4/]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[5/] and SC[5/]	CL (with P.I.[6/] <15) and ML	CL (with P.I.[6/] of 15 or more), CH and MH[7/]	OL, OH and Pt
l	Shrink-swell potential	Low	Moderate	High	
f	Susceptibility to frost action[8/]	Low	Moderate	High	
t	Slope	0-15%	15-30%	30-45%	>45%
p	Stoniness[9/]	Stones >2 m apart (Class 0, 1 and 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[9/]	Rock exposures >35 m apart and cover <10% of the surface	Rock exposure 10-35 m apart and cover 10-25% of the surface	Rock exposure 3.5-10 m apart and cover 25-50% of the surface	Rock exposures <3.5 m apart and cover 50-90% of the surface
w	Wetness[9/]	Excessively drained to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
d	Depth to Bedrock	>100 cm	50-100 cm	20-50 cm	<20 cm
h	Depth to Seasonal Water Table	>150 cm	75-150 cm	50-75 cm	<50 cm

1/ The symbols are used to indicate the nature of the limitation.

2/ The first three items pertain to soil after it is placed in a fill; the last six items pertain to soil in its natural condition before excavation for road fill.

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

4/ Use AASHO group index only where laboratory data are available for the kind of soil being rated; otherwise, use Unified soil groups.

5/ Downgrade suitability rating to fair if content of fines is more than about 30 percent.

6/ P.I. means plasticity index.

7/ Upgrade suitability rating to fair if MH is largely kaolinitic, friable, and free of mica.

8/ Use this item only where frost penetrates below the paved or hardened surface layer and where moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front.

9/ For an explanation of stoniness, rockiness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).