Soils of the Municipality of Ritchot
Report No. D89 2011

Canada

Growing Forward

Manitoba

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURE

LIST OF MAPS

Additional Poster-Sized Maps Included with Report:

1:20,000 soil series maps for each township and partial adjacent township

- Map 1
- Map 2
- Map 3

The Following Maps use the original 1:20,000 data, but are printed at 1:50,000:

- Dryland Agricultural Capability Map
- Soil Drainage Map

Part 1 General Description of the Study Area

1.1 Location and Extent

The Rural Municipality of Ritchot covers an area of approximately 3.7 townships (34,451 hectares or 85,128 acres) extending south from the City of Winnipeg (Map 1) along both sides of the Red River. The Municipality comprises land in Township 7, 8 and 9, Range 2, 3 and 4E. St. Adolphe, Ste. Agathe, Ile des Chenes and Grande Pointe are situated in the study area. The study area also includes Sections 25 and 36 of Township 7 Range 3E which is part of the Town of Niverville.

This report contains soil resource information and maps at a scale of 1:20,000 for an area formerly covered in the reconnaissance survey (1:126,720) of the Winnipeg and Morris Map Sheet Areas, Report No. 5, 1953.

1.2 Soils

Soil materials are dominantly deep, lacustrine clay sediments with some areas of clay soils underlain by silty sediments.

The clayey soils are classified as dominantly imperfectly drained Black Chernozems (Red River, Scanterbury and Morris soil series) in combination with poorly drained Rego Humic Gleysols (Osborne soil series). Well drained clay soils (St. Norbert soil series) are usually developed under wooded areas along river channels and are classified as Dark Gray Chernozems. Clayey soils underlain by silty deposits are classified as well drained Black Chernozems (Fort Garry series), imperfectly drained Gleyed Chernozems (Hoddinott and Dencross soils series) and poorly drained Gleysols (Glenmoor soil series). Regosolic soils occur on the terrace and floodplain deposits along rivers and streams.

Part 2 Methodology

2.1 Mapping and Map Scale

Detailed soil mapping at a 1:20,000 scale (approx. 5 cm equals one km) was completed for the Municipality of Ritchot. Soil profiles were examined to a depth of one metre at sites approximately 150 metres apart along traverses that were spaced approximately 0.8 km apart. The initial inspection point in each section was located 50 to 100 metres from a road allowance and approximately 0.4 km from a selected corner of the section. Additional sites along road allowances were also examined to assist in locating soil boundaries. This method of sampling provided approximately 25 to 30 inspection sites per section of land or a soil inspection density of 1 site per 8 to 10 hectares (1 site per 20 to 25 acres). Occasionally, additional soil inspection traverses or checks were made in complex soil areas.

2.2 Map Units

The information from soil inspection sites form the basis for delineating soil boundaries on a map. Each geographic area enclosed by these soil boundaries is referred to as a soil polygon. Each soil polygon is named according to the soil series that are present in the polygon.

A soil series is defined as a naturally occurring soil body so that any profile within that body has a similar number and arrangement of horizons whose colour, texture, structure, consistency, reaction and composition are within a narrowly defined range. If a soil has properties that vary slightly from the prescribed range of the series, a soil series variant is established.

A soil polygon can contain up to three named soil series. The collective name or label of a soil polygon is referred to as a map unit.

A map unit represents portions of the soil landscape that have characteristics and properties varying within narrow limits that are determined by the intensity of the survey.

A map unit contains one or more than one soil or non-soil plus a certain proportion of unnamed inclusions. Map units are delineated on the basis of the types and relative proportions of their soils or non-soils, as well as on the basis of external criteria such as slope, stoniness or erosion.

2.3 Simple and Compound Map Units

There are two major types of map units: simple and compound. The difference between a simple and a compound map unit is the proportion and contrast of their components.

A **Simple Map Unit** contains predominantly one soil or non-soil. Its components vary as follows: the predominant component comprises at least 65 percent with up to 35 percent of non-limiting, similar components (components that are alike in most properties and behaviour), or up to 25 percent of non-limiting dissimilar components (components that do not affect management of the map unit but have a significant number of properties that vary from the predominant component), or up to 15 percent of limiting, dissimilar components (components which have many contrasting properties and usually affect management differently).

A **Compound Map Unit** contains predominantly more than one soil or non-soil (or a combination of both). The proportions of the two major components may vary from one considerably exceeding the other to both being approximately equal. Complementary to the definition of a single map unit, the proportions of components vary according to their areal extent and contrasting characteristics as they may affect soil management or use. Major components vary as follows: if other components are similar and non-limiting no single component represents more than 65 percent; or if other components are dissimilar and non-limiting no single component represents 75 percent or more; or if other components are dissimilar and limiting no single component represents 85 percent or more.

For the purpose of describing compound map units, components are considered dominant if they occupy over 40 percent of the unit. They are considered significant from 15-40 percent and minor if they occupy less than 15 percent. Minor components are described only if they are highly contrasting.

2.4 Phases

It is often desirable to indicate by a condition or quality of soil property or landscape feature that deviates significantly from the normal definition of map units by using a map unit symbol. These variations or phases of soil properties and landscape features, varying from delineation to delineation, significantly affect soil behaviour and land management or use.

Soil properties that are commonly used as phase criteria include texture, depth, surface peat, salinity and physical disruption. Properties of land that are used include slope, wind and water erosion, stoniness, rockiness, and altered drainage.

The four properties are erosion, slope class, degree of stoniness, and salinity. The degree or magnitude of each is designated in Table 1.

The convention employed to indicate these features in the map symbol is as follows:

If none of the above properties are observed to be significant, the map symbol representing the normal or unaffected soil series is used alone without modifiers (example in Table 1).

If one or more phase features are recognized, the appropriate letter or number is placed below the soil series symbol in one of four designated locations in the map unit symbol. The designated order is erosion, slope class, stoniness, and salinity. If a particular feature is not observed to be significant, a x is used in its appropriate designated location in the map symbol (Table 1).

An example of a compound unit is as follows: 70 percent consists of Fairland (FND^{7}) series having no erosion (x), very gently sloping topography (c), no stones at the surface (x), and no salinity (x), and 30 percent Glenboro (GBO^{3}) series having no erosion (x), very gently sloping topography (c), no stones (x), and no (x) salinity (Table 1).

2.5 Sampling

Selected surface and subsurface soil samples were analyzed for texture, pH, organic matter, salinity, and calcium carbonate content.

Map 1. Location of Study Area

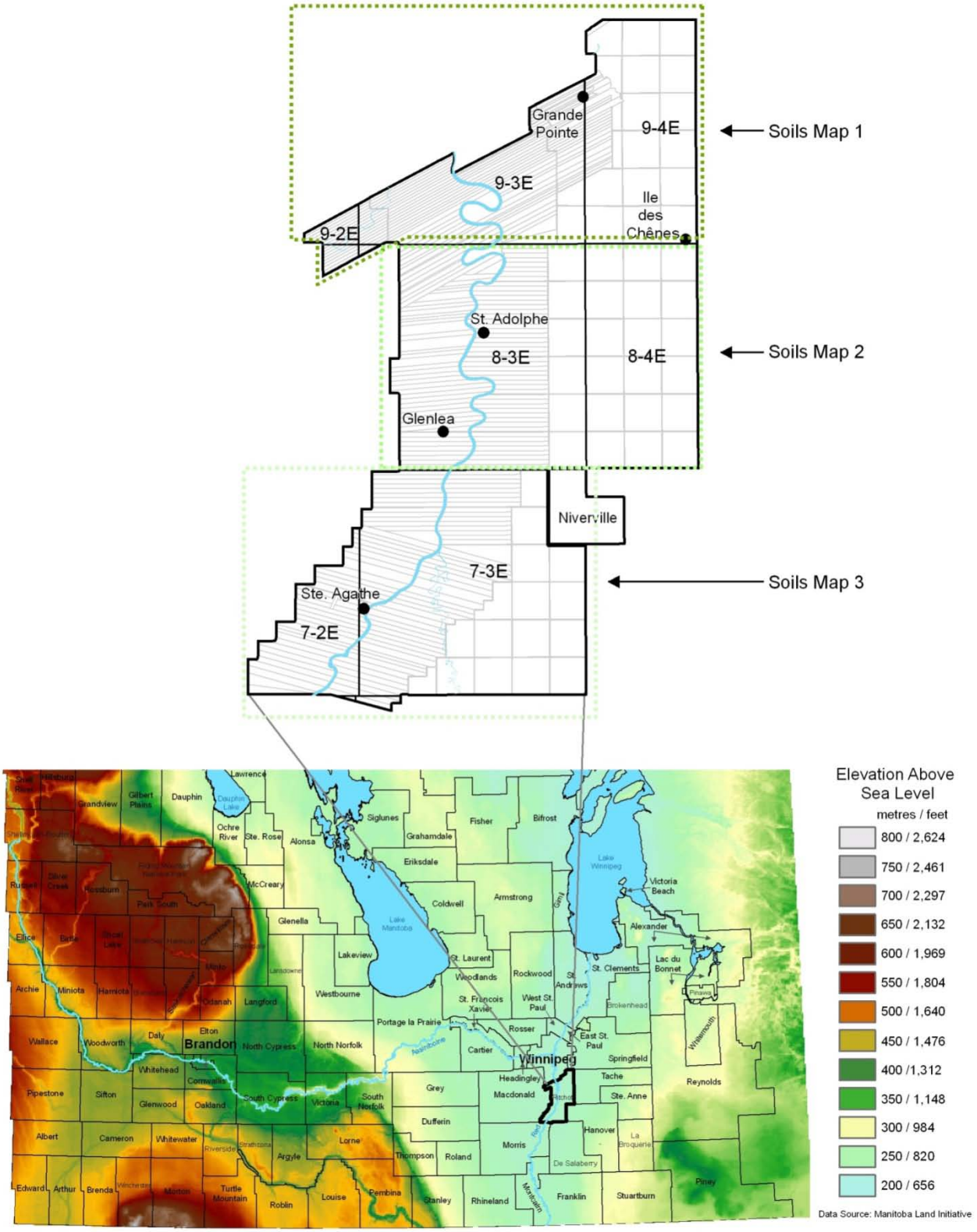
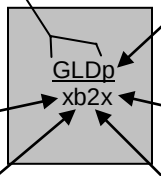


Table 1. Map Unit Symbol

Soil series maps contain labels similar to those shown in the grey boxes below. A description of each kind of label is indicated below.

Simple Map Units

(contain predominantly 1 soil or non-soil)



Soil Series Code

Variant Symbol(s)*

d = drained
p = peaty
v = very poorly drained
1 = texture variant

*Variants only apply to certain soil series

Degree of Erosion
x = non-eroded or minimal
1 = slightly eroded
2 = moderately eroded
3 = severely eroded
o = overblown/overwash

Topography (Slope Class)
x = level to nearly level: 0 - .5%
b = nearly level: >.5 – 2%
c = very gently sloping: >2 – 5%
d = gently sloping: >5 – 9%
e = moderately sloping: >9 – 15%
f = strongly sloping: >15 – 30%
g = very strongly sloping: >30 – 45%
h = extremely sloping: >45 -70%

Degree of Stoniness (Surface Covered)
x = non-stony: <.01%
1 = slightly stony: >.01 - .1%
2 = moderately stony : >.1 – 3%
3 = very stony: >3 – 15%
4 = exceedingly stony: >15 -50%
5 = excessively stony: >50%

Degree of Salinity Condition (mS/cm)
x = non-saline: 0 – 4
s = weakly saline: >4 – 8
t = moderately saline: >8 – 16
u = strongly saline: >16

WWD ← Soil Code with a phase of xxxx (The denominator shown in the above example is referred to as the 'phase')

Compound Map Units

(Contain up to 3 soils or non-soils)

$\frac{NDL^4}{xc2x} - \frac{VRC^3}{xc2x} - \frac{DRO^3}{xb3s}$

Percent of soil series found in map polygon to be multiplied by 10 (40+30+30=100%)

$\frac{FND^7\text{-}GBO^3}{xcxx}$ ← 2 Soil Series with the same phase

$FND^7\text{-}GBO^3$ ← 2 soil series, both with a phase of xxxx

Part 3 Development and Classification

3.1 Introduction

This section of the report describes the main characteristics of the soils and their relationship to the factors of soil development.

3.2 Classification

Soils in the study area are classified according to the System of Soil Classification for Canada. This system is hierarchical employing 5 levels of generalization or categories of classification. Beginning with the most generalized, these categories are the order, great group, subgroup, family and series. The classification is based on measurable soil properties that can be observed in the field, or can be inferred from other properties observable in the field. The properties selected as criteria for the higher categories are the result of soil genesis or of factors that affect soil genesis. Properties utilized to differentiate soils at the lower levels of family and series affect management. The five levels of generalization are defined as follows:

Order - Soil orders are defined on the basis of soil properties that reflect the soil environment and the kind and degree of dominant soil forming process. An example is a Chernozem in which soils with dark coloured surface horizons develop under sub-humid climate and dominantly grassland environments.

Great Group - Each order is subdivided into great groups based on differences in the strength of dominant processes or a major contribution of a process in addition to a dominant one. Such processes result in particular kinds, arrangements and degrees of expressions of pedogenic horizons. An example is a Luvic Gleysol in which the dominant process is considered to be gleying but clay accumulation in the B-horizon is also a major process.

Subgroup - Subgroups are subdivisions of great groups and are defined according to the kind and arrangement of horizons that indicate the central concept of the great group ex. Orthic, intergrades toward soils in other orders, ex. Gleyed or special features such as lime carbonate accumulation in B-horizons.

Family - Families are established within a subgroup based on the similarity of physical and chemical properties that affect management. The properties that are considered important for recognizing families are particle size distribution, mineralogy, soil climate, soil reaction, and thickness of solum.

Series - The series consists of soils that formed in a particular kind of material and have horizons with colour, texture, structure, consistence, thickness, reaction, and chemical composition that are similar in differentiating characteristics and in their arrangement in the soil profile.

The classification of soils in the study area in relation to parent material, texture and drainage is shown in Tables 2 and 3.

Table 2. Soils of the Study Area

Soil Symbol	Soil Name	Soil Drainage	Surface Texture	Textural Group of Soil Profile*	Total ac	Total ha	% of RM
BCK	Black Lake	Well	Clay	Fine	1,442	583	1.70
DCS	Dencross	Imperfect	Clay	Fine to Very Fine over Medium	9,101	3,683	10.72
DFS	Dufresne	Poor	Clay	Fine	168	68	0.20
FIH	Fisher	Imperfect	Silt loam	Medium to Moderately Fine	196	80	0.23
FTY	Fort Garry	Well	Clay	Fine to Very Fine over Medium	208	84	0.24
GOO	Glenmoor	Poor	Clay	Fine to Very Fine over Medium	3,374	1,366	3.97
HDG	Hodgson	Well	Silt loam	Medium to Moderately Fine	488	197	0.57
HDN	Hoddinott	Imperfect	Clay	Fine to Very Fine over Medium	512	207	0.60
LKD	Lakeland	Imperfect	Clay loam	Moderately Fine	468	189	0.55
MRS	Morris	Imperfect	Clay	Fine to Very Fine	98	40	0.12
MYT	Myrtle	Well	Clay	Fine to Very Fine	1,155	467	1.36
OBO	Osborne	Poor	Clay	Fine to Very Fine	21,566	8,727	25.40
RIV	Red River	Imperfect	Clay	Fine to Very Fine	16,106	6,518	18.97
SCY	Scanterbury	Imperfect	Clay	Fine to Very Fine	21,830	8,834	25.71
SOR	St. Norbert	Well	Clay	Fine to Very Fine	4,533	1,835	5.34
SRE	Seine River	Imperfect	Clay	Fine	923	373	1.09
$UL	Unclassified				1,215	492	1.43
$UR	Urban				343	139	0.40
$ZZ	Water				1,183	479	1.39

* Descriptions of Textural Groups, Table 29 of Appendix 3.

Table 3. Relationship between Soil Series, Soil Drainage, Mode of Origin, Parent Material and Soil Classification

Mode of Origin	Lacustrine			Alluvium	
Soil Material	**(SCL, CL, SiCL)**	**(SiC, C, HC)**	**(SiC, C, HC) over (SiL, SiCL)**	**(VFSL, L, SiL, CL, SiCL)**	**(SC, SiC,C, HC)**
Soil Classification / Drainage					
Well drained					
Cumulic Regosol				Hodgson (HDG)	Black Lake (BCK)
Orthic Dark Gray Chernozem		St. Norbert (SOR)			
Orthic Black Chernozem		Myrtle (MYT)	Fort Garry (FTY)		
Imperfectly drained					
Gleyed Cumulic Regosol				Fisher (FIH)	Seine River (SRE)
Gleyed Black Chernozem		Scanterbury (SCY)	Hoddinott (HDN)		
Gleyed Rego Black Chernozem	Lakeland (LKD)	Red River (RIV)	Dencross (DCS)		
Gleyed Solonetzic Black Chernozem		Morris (MRS)			
Poorly drained					
Rego Humic Gleysol		Osborne (OBO)	Glenmoor (GOO)		Dufresne (DFS)

Part 4 Agricultural Use and Management Interpretations of Soils

4.1 Introduction

These sections provide predictions for the performance or soil suitability ratings for various land uses based on soil and landscape characteristics, laboratory data and on soil behaviour under specified conditions of land use and management. Suitability ratings or interpretations for various land use applications are intended to serve as guides for planners and managers.

The management of soil and landscape data using Geographic Information System (GIS) technology enables rapid and more quantitative analysis of natural soil variability than is possible using manual techniques. The areal distribution of various soil components and properties that occur in complex landscapes can be highlighted in a mapped form and can thereby assist in planning and managing the soil resource. Such single factor maps and interpretative maps illustrate the distribution of individual soil properties and indicate the degree of soil limitation or potential for agricultural use and environmental applications.

A series of derived and interpretive maps are included in this section to assist in the interpretation of the soil resource information for the study area.

The maps portray a selection of individual soil properties or landscape conditions for map unit delineations. Combinations of soil properties or landscape features affecting land use and management are derived as specific interpretations. Derived maps portray specific interpretations based on the dominant condition in each map polygon.

Soil properties determine to a great extent the potential and limitations for both dryland and irrigation agriculture. In this section, interpretive soil information is provided for agricultural land use evaluations such as:

a) soil capability for agriculture
b) irrigation suitability

A summary of the soil series indicating their interpretive classification for agricultural capability and irrigation suitability is provided in Table 4.

Table 4. Agricultural Capability and Irrigation Suitability Ratings of Soils

Soil Code	Phase	Soil Name	Total ac	Total ha	% of RM	Drainage Class	Surface Texture	Agricultural Capability Class	Irrigation Suitability		
									Class	General Rating	Rating for Potatoes
$UL	xxxx	Unclassified Land	1,215	492	1.43	-	-	-	-	-	-
$UR	xxxx	Urban Land	343	139	0.40	-	-	-	-	-	-
$ZZ	xxxx	Water	1,183	479	1.39	-	-	-	-	-	-
BCK	xxxx	Black Lake	1,442	583	1.70	Well	Clay	2I	3kxA	Fair	5
DCS	xxxx	Dencross	7,063	2,858	8.32	Imperfect	Clay	2W	4k A	Poor	5
DCS	xbxx	Dencross	1,443	584	1.70	Imperfect	Clay	2W	4k A	Poor	5
DCS	xcxx	Dencross	595	241	0.70	Imperfect	Clay	2TW	4k Bt2	Poor	5
DFS	xxxx	Dufresne	168	68	0.20	Poor	Clay	5W	4kwCi	Poor	5
FIH	xxxx	Fisher	196	80	0.23	Imperfect	Silty clay loam	3I	3w Bi	Fair	3
FTY	xxxx	Fort Garry	208	84	0.24	Well	Clay	1	4k A	Poor	5
GOOd	xxxx	Glenmoor, drained	3,361	1,360	3.96	Poor	Clay	3W	4kwA	Poor	5
GOOd	xbxx	Glenmoor, drained	6	2	0.01	Poor	Clay	3W	4kwA	Poor	5
GOO	xxxx	Glenmoor	7	3	0.01	Poor	Clay	5W	4kwA	Poor	5
HDG	xxxx	Hodgson	488	197	0.57	Well	Silt loam	2I	2k A	Good	2
HDN	xxxx	Hoddinott	512	207	0.60	Imperfect	Clay	2W	4k A	Poor	5
LKD	xxxx	Lakeland	468	189	0.55	Imperfect	Clay loam	2W	3w A	Fair	3
MRS	xxxx	Morris	98	40	0.12	Imperfect	Clay	2DW	4kxA	Poor	5
MYT	xxxx	Myrtle	1,155	467	1.36	Well	Clay	1	4kxA	Poor	5
OBOd	xxxx	Osborne, drained	20,443	8,273	24.08	Poor	Clay	3W	4kwA	Poor	5
OBOv	xxxx	Osborne, very poorly drained	1,123	454	1.32	Very Poor	Clay	6W	4kwA	Poor	5
RIV	xxxx	Red River	15,481	6,265	18.23	Imperfect	Clay	2W	4kxA	Poor	5
RIV	xbxx	Red River	625	253	0.74	Imperfect	Clay	2W	4kxA	Poor	5
SCY	xxxx	Scanterbury	21,802	8,823	25.68	Imperfect	Clay	2W	4kxA	Poor	5
SCY	xbxx	Scanterbury	27	11	0.03	Imperfect	Clay	2W	4kxA	Poor	5
SOR	xxxx	St Norbert	4,533	1,835	5.34	Well	Clay	2D	4kxA	Poor	5
SRE	xxxx	Seine River	923	373	1.09	Imperfect	Clay	3I	3kwBi	Fair	5

4.2 Soil Capability for Agriculture

The soil capability rating for agriculture is based on an evaluation of both the soil characteristics and landscape conditions that influence the soil suitability and limitations for agricultural use (Anon, 1965) (Table 8 of Appendix 1).

The class indicates the general suitability of the soils for agriculture. The first three classes are considered capable of sustained production of common field crops, the fourth is marginal for sustained arable agriculture, the fifth is suitable only for improved permanent pasture, the sixth is capable of use only for native pasture while the seventh class is for soils and land types considered incapable of use for arable agriculture or permanent pasture. A description of the capability classes is provided in Table 9 of Appendix 1.

Soil capability subclasses identify the soil properties or landscape conditions that may limit use or be a hazard. The various kinds of limitations recognized at the subclass level are defined in Table 10 of Appendix 1.

Class 1 soils in the map area have level to very gently sloping topography, are deep and well to moderately well drained with no major limitations for crop use.

Class 2 soils include the imperfectly drained soils with a wetness limitation (2W) and the well-drained and imperfectly drained soils having a topographic limitation (2T). The 2-5% slopes associated with the 2T soils may increase cultivation costs over that of a smooth landscape and increase the risk of water erosion.

Class 3 soils have a moderately severe limitation associated with gently sloping topography (5-9%) resulting in a moderate risk of water erosion.

Class 4 soils are poorly drained with a severe restriction to the growth of crops or choice of crops. The timing of cultivation or choice of crops is severely limited because of the wetness limitation.

Class 5 soils have very severe limitations as a result of excess water (5W). This Class includes the lower, depressional areas of the poorly drained soils.

Class 6 soils have an extremely severe limitation due to excess wetness and/or steep slopes, which restricts cropping to production of perennial forages.

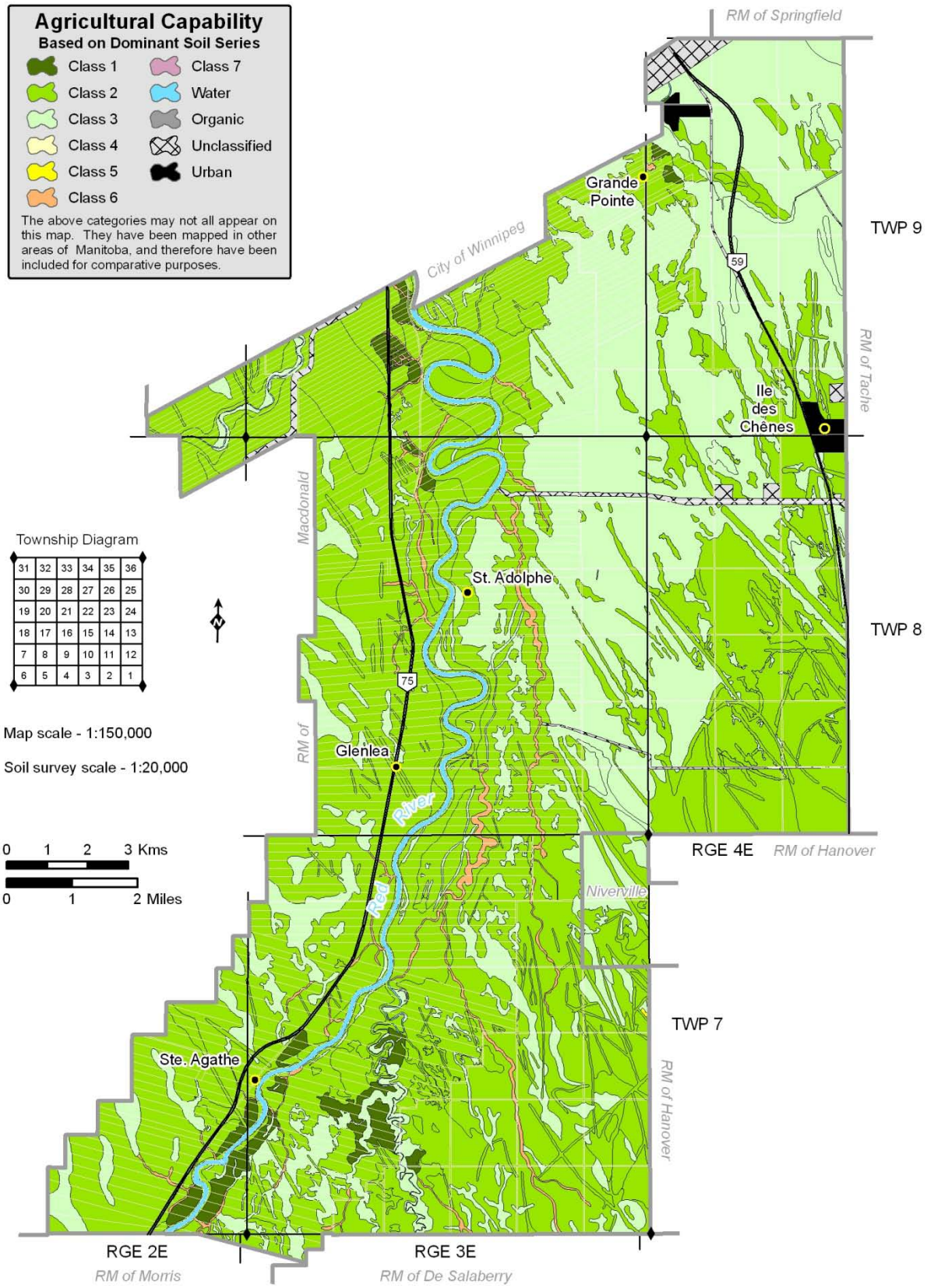
Class 7 soils have no capability for arable culture. However, these soils may have high capability for native vegetation species and habitat for waterfowl and wildlife.

An interpretative map (Map 2) illustrates the rating of the dominant soil series and landscape features for each polygon. The nature of the subclass limitations and the rating of subdominant soil and landscape components are not shown at the scale of this map. Subdominant soil components and the nature of the subclass limitations are indicated in the report (Table 4).

A larger, poster-sized agricultural capability map is also included with this report. It contains the original 1:20,000 data, but is printed at a scale of 1:50,000 in order to fit on one map sheet.

Agricultural Capability Class	Total ac	Total ha	% of RM
Class 1	1,363	552	1.60
Class 2	54,578	22,087	64.28
Class 3	24,930	10,089	29.36
Class 4	0	0	0.00
Class 5	175	71	0.21
Class 6	1,123	454	1.32
Organic	0	0	0.00
Water	1,183	479	1.39
Unclassified	1,215	492	1.43
Urban	343	139	0.40

Map 2. Agriculture Capability Map



4.3 Irrigation Suitability

The rating guidelines in this section are derived from "An Irrigation Suitability Classification System for the Canadian Prairies" (ISC, 1987). The irrigation suitability rating of the soils is based on soil and landscape characteristics. It does not consider factors such as method of water application, water availability, water quality, or economics of this type of land use.

Soil properties considered important for evaluating irrigation suitability are: texture, soil drainage, depth to water table, salinity and geological uniformity.

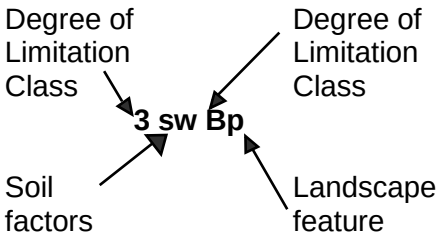
Landscape features considered important for rating irrigation suitability are topography and stoniness.

The irrigation suitability of the soil and landscape characteristics in the study area assists in making initial irrigation plans. The next step involves on site field investigation to examine the depth to water table, salinity and geological uniformity to a depth of 3 m. Drainability, drainage outlet requirement, organic matter status and potential for surface crusting are other factors to consider. This assessment also considers potential impact of irrigation on non-irrigated areas as well as on the irrigated area.

The most limiting soil property or landscape feature is combined to determine the placement of a land area in one of 16 classes of irrigation suitability which are grouped and described by 4 ratings: **Excellent, Good, Fair** and **Poor** (Table 11 of Appendix 1).

The guidelines are listed in Appendix 1, Tables 12 and 13, respectively.

An example of an irrigation suitability class rating with subclass limitations is shown:

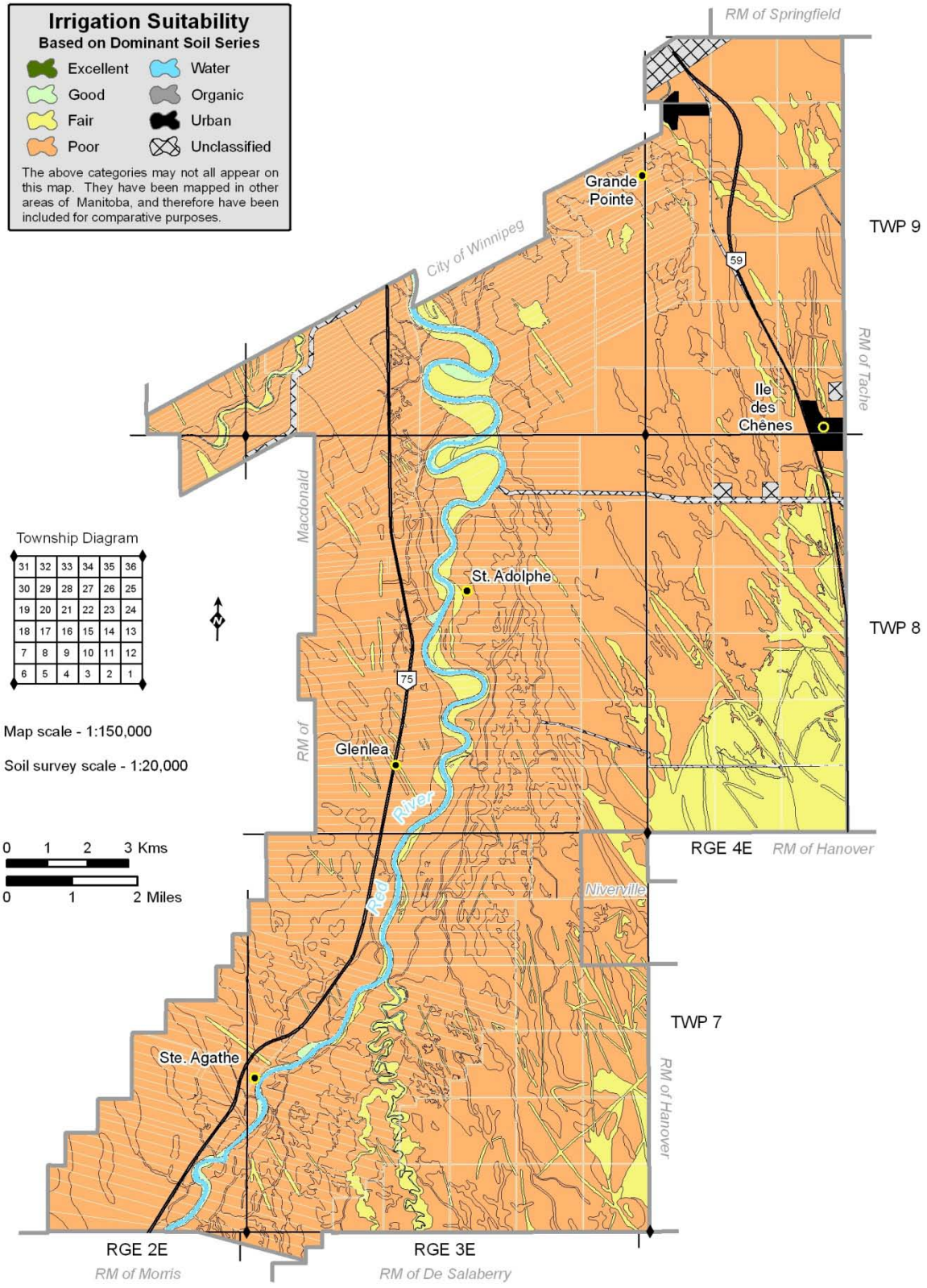


A maximum of 3 codes is used to identify the subclass rating. Salinity (s) and drainage class (w) are soil factors that contribute to the soil rating of 3 or Moderate. The landscape limitation due to stones (p) is Slight or (B). As the soil factor (3 or Moderate) is more limiting than the landscape feature (B or Slight), the general rating for this land area (3B) is Fair (Table 11 of Appendix 1).

An interpretative map (Map 3) illustrates the rating of the dominant soil series and landscape features for each polygon.

Irrigation Class	Total ac	Total ha	% of RM
Excellent	0	0	0.00
Good	488	197	0.57
Fair	11,404	4,615	13.43
Poor	70,276	28,440	82.77
Water	1,183	479	1.39
Organic	0	0	0.00
Unclassified	1215	492	1.43
Urban	343	139	0.40

Map 3. Irrigation Suitability Map



4.4 Soil Suitability for Irrigated Potato Production

An evaluation of soil properties and landscape features was used to generate a 5 class rating of land for irrigated potato production. Soil properties considered are: texture, soil drainage, salinity and sodicity. Landscape features that were considered relate to the impact of slope and stoniness. Most suitable soil and landscape conditions occur in **Class 1** and least desirable conditions occur in **Class 5**. Details regarding the criteria applied in the suitability rating are described in the Tables 14a and 14b of Appendix 1.

Assumptions:

This evaluation examines soil and landscape factors that are important for irrigated production of potatoes for processing. Production of seed and table potatoes with irrigation may not be impacted to the same degree by soil conditions such as stoniness and texture.

Stoniness hinders soil preparation and interferes with harvesting and increases the chances of potato bruising during harvest.

Deep, well drained sandy loam to loam soils exhibit favorable properties for the production of high quality potatoes. Clay soils with impeded internal soil drainage have a severe limitation to potato production because of reduced oxygen supply and increased incidence of fungal diseases. An increased risk of delayed spring tillage and planting and crop harvesting due to wet conditions can occur on fine textured soils.

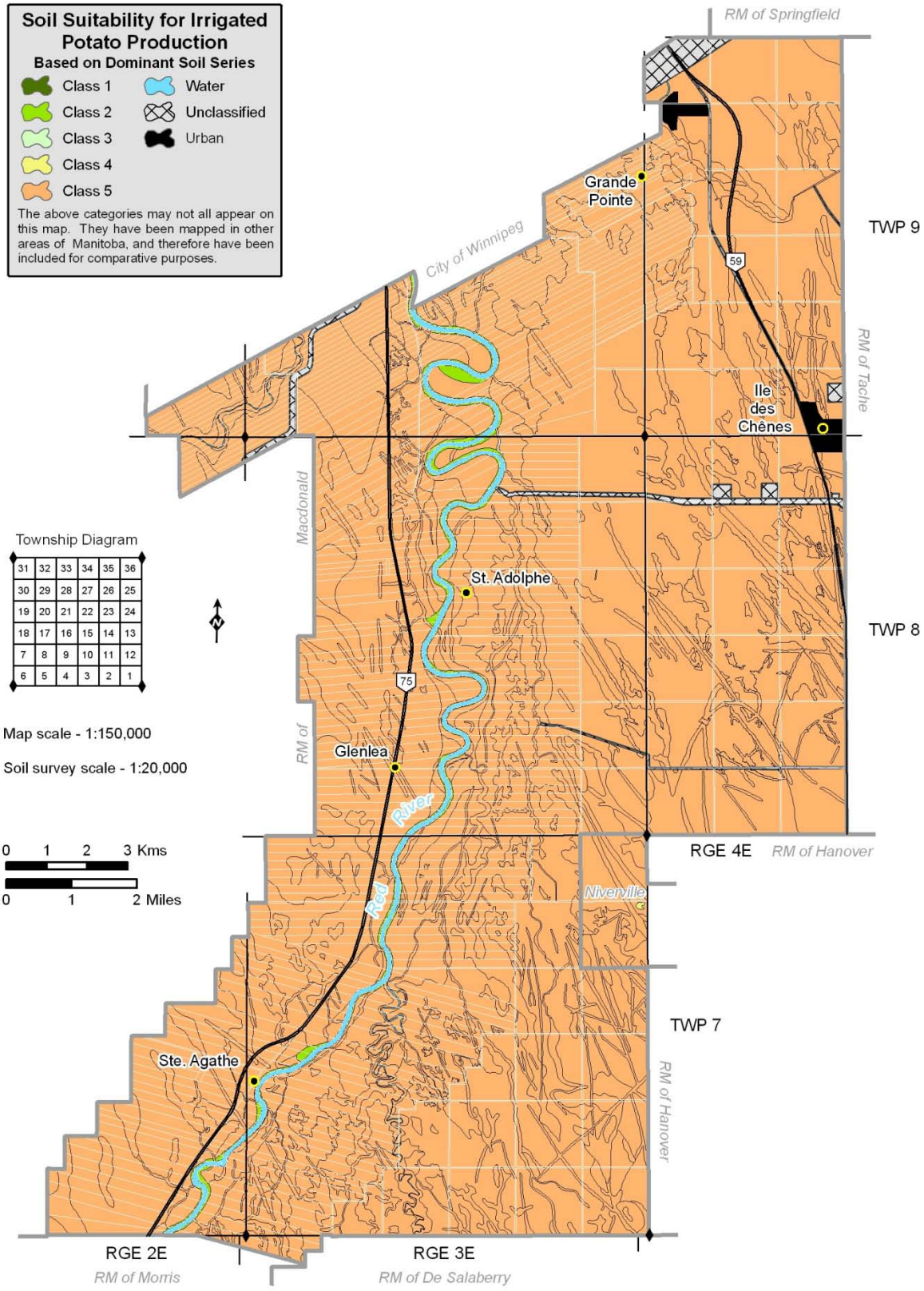
Slope or topography reduces uniform water infiltration and increases the potential for soil erosion and nutrient loss.

This evaluation of soil and landscape properties does not incorporate additional factors that must be assessed for sustainable irrigated production of potatoes. The environmental impact of intensive management practices on soil and water quality, the supply of good quality water, and the suitability of climatic conditions for optimum potato production must all be evaluated.

An interpretative map (Map 4) depicts the rating of the dominant soil series and landscape features for each polygon.

Potato Suitability Class	Total ac	Total ha	% of RM
Class 1	0	0	0
Class 2	488	197	0.57
Class 3	665	269	0.78
Class 4	0	0	0.00
Class 5	81,015	32,786	95.41
Water	1,183	479	1.39
Unclassified	1,215	492	1.43
Urban	343	139	0.40

Map 4. Soil Suitability Map for Irrigated Potato Production



4.5 Soil Texture

Mineral particles in soil are grouped according to size into sand (2 - 0.05 mm in diameter), silt (0.05 - 0.002 mm) and clay (less than 0.002 mm). The proportion of individual mineral particles present in a soil is referred to as texture. Soil texture is described by means of 13 textural classes defined according to the relative proportions of sand, silt and clay (Figure 1 of Appendix 3). The presence of larger particles (diameter is greater than 2 mm) in soil is recognized as:

gravelly - particles ranging from 0.2 to 7.5 cm in diameter

cobbly - rock fragments ranging from 7.5 to 25 cm in diameter

stony - rock fragments ranging from 25 to 60 cm in diameter or if flat 38 to 60 cm long

Soil texture strongly influences the soil's ability to retain moisture, soil fertility and ease or difficulty of cultivation. Water moves easily through coarse-textured (sandy) soils so little moisture is retained and they dry out more quickly than fine textured (clay) soils. As well, sandy soils do not retain plant nutrients as well as clay soils and are lower in natural fertility. Sandy soils often are characterized by loose or single grained structure, which is very susceptible to wind erosion. Clay soils have a high proportion of very small pore spaces which hold moisture tightly and are usually fertile because they are able to retain plant nutrients. Clay soils transmit water very slowly; therefore these soils are susceptible to excess soil moisture conditions.

Textural class names (Table 29 of Appendix 3) are grouped as follows:

Coarse - coarse sand, medium sand, fine sand, loamy coarse sand, loamy sand, loamy fine sand

Moderately Coarse - very fine sand, loamy very fine sand, coarse sandy loam, sandy loam, fine sandy loam

Medium - very fine sandy loam, loam, silt loam, silt

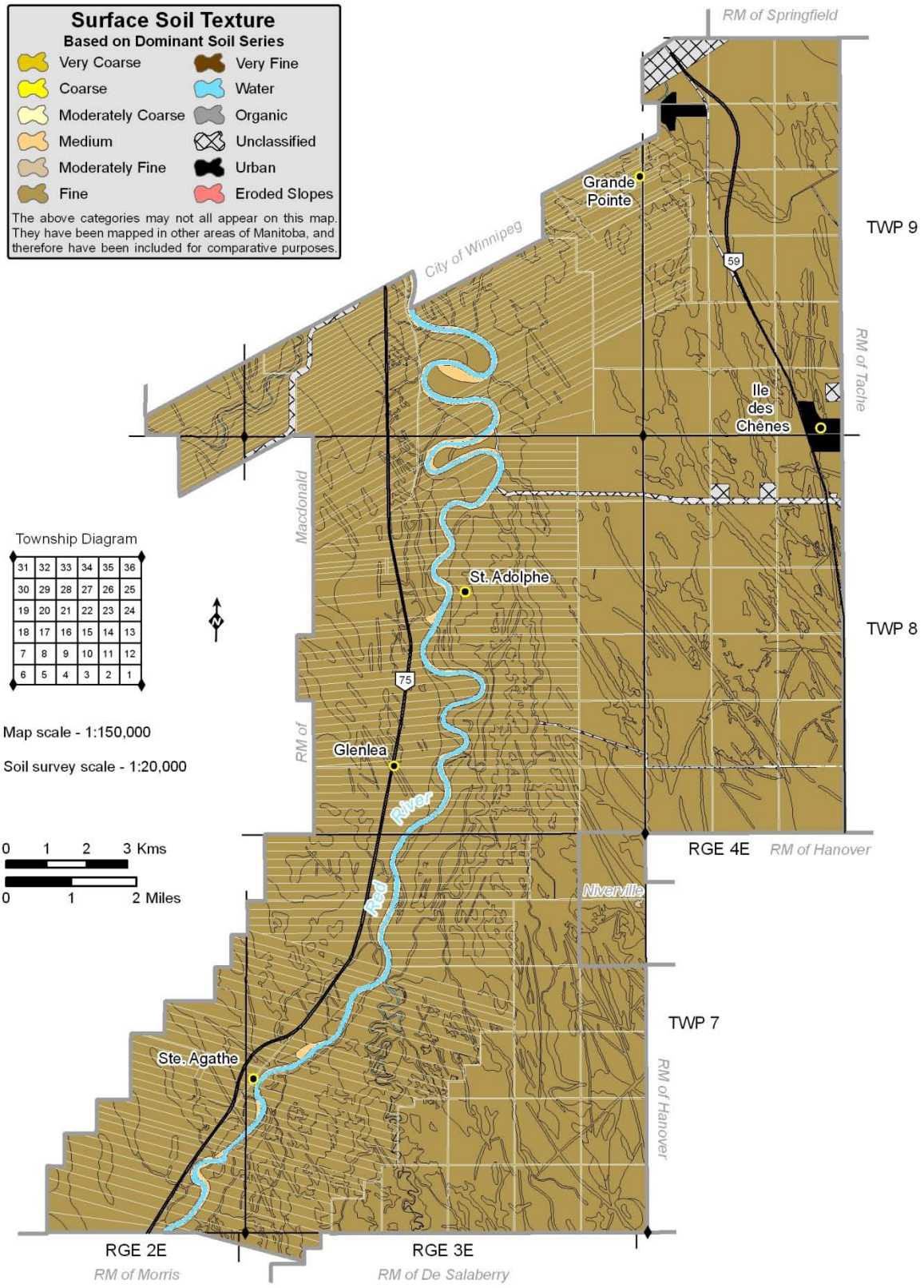
Moderately Fine - sandy clay loam, clay loam, silty clay loam

Fine - sandy clay, silty clay, clay, heavy clay (>60%)

Surface soil texture shown in Map 5 illustrates the textural group of the dominant soil for each polygon.

Texture Group	Total ac	Total ha	% of RM
Very Coarse	0	0	0.00
Coarse	0	0	0.00
Moderately Coarse	0	0	0.00
Medium	488	197	0.57
Moderately Fine	1,390	563	1.64
Fine	80,289	32,492	94.56
Very Fine	0	0	0.00
Organic	0	0	0.00
Unclassified	1,215	492	1.43
Water	1,183	479	1.39
Urban	343	139	0.40

Map 5. Soil Texture Map



4.6 Soil Drainage

Soil drainage refers to the frequency and duration of periods when the soil is free of saturation. Excessive water content in soil limits the free movement of oxygen and decreases the efficiency of nutrient uptake. Delays in spring tillage and planting are more frequent in depressional or imperfectly to poorly drained areas of a field. Improved surface drainage and underground tile drainage are management considerations that can reduce excessive moisture conditions in soils. The majority of poorly drained soils remain in the native state supporting vegetation associated with wetlands and marsh. Five soil drainage classes are indicated below.

Rapidly drained - water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow can occur on steep slopes during heavy rainfall. Soils have low water storage capacity and are usually coarse in texture.

Well-drained - excess water is removed from the soil, flowing downward readily into underlying pervious material or laterally as subsurface flow.

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. The source of moisture includes precipitation and/or groundwater.

Poorly drained - water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time when the soil is not frozen. The main water source is subsurface flow and/or groundwater in addition to precipitation.

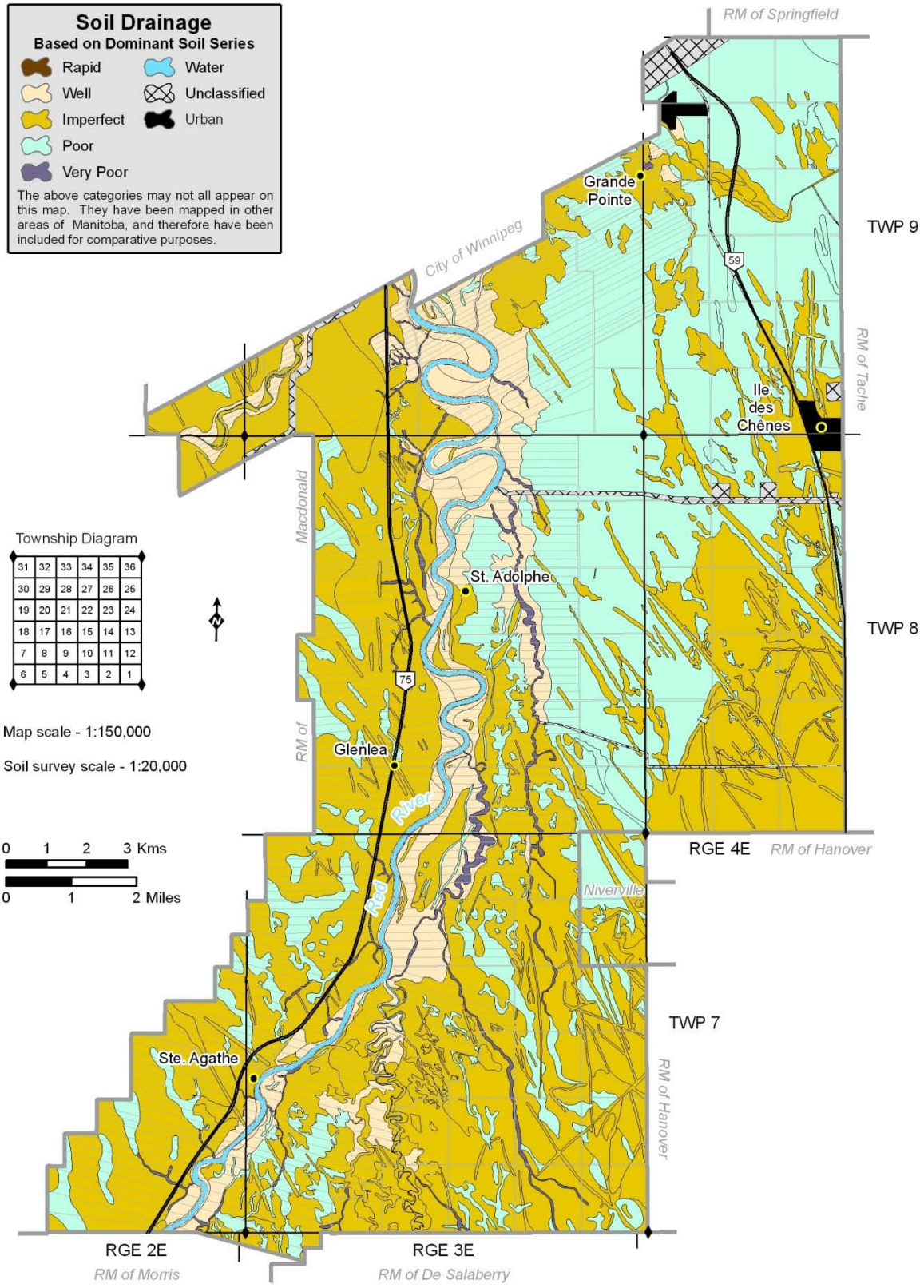
Very poorly drained - water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time that the soil is not frozen. Excess water is present in the soil throughout most of the year.

Soil drainage shown in Map 6 illustrates the textural group of the dominant soil for each polygon.

A larger, poster-sized soil drainage map is included with this report. It contains the original 1:20,000 data, but is printed at a scale of 1:50,000 in order to fit on 1 map sheet.

Drainage Class	Total ac	Total ha	% of RM
Rapid	0	0	0.00
Well	7,826	3,167	9.22
Imperfect	49,234	19,924	57.98
Poor	23,986	9,707	28.25
Very Poor	1,123	454	1.32
Water	1,183	479	1.39
Unclassified	1,215	492	1.43
Urban	343	139	0.40

Map 6. Soil Drainage Map



4.7 Soil Erosion

Erosion is defined as the detachment and movement of soil particles by water, wind, ice or gravity. Soil erosion by water is the main concern on undulating and hummocky soil landscapes in the agricultural region of Manitoba. Soil loss resulting from rainfall-runoff is usually due to combinations of raindrop splash, sheet, and rill, gully and channel bank erosion. Sheet and rill erosion is usually least apparent in the landscape but often the most damaging since it causes gradual thinning of the soil profile over the entire slope. Sheet erosion tends to occur on upper slopes and ridges whereas, the more visible rills form in the area of concentrated runoff on mid and lower slopes. The deposition of eroded soil at the base of slopes or in ditches constitutes additional losses and costs attributed to erosion.

Wind erosion has its largest influence on sandy (coarse) textured, cultivated soils on relatively level landscapes. However, all soils are subject to wind erosion if vegetation or crop residues do not cover the soil surface. Continuous cropping and minimum or zero tillage to maximize residue cover will reduce the risk of erosion. Row crops such as potatoes produce low amounts of residue, therefore, seeding annual crops like fall rye and winter wheat will help to protect the soil surface during the critical post harvest period until the establishment of groundcover the following spring.

The impact of soil erosion on soil loss and lowered productivity is not easily measured. In addition to nutrient loss from soil erosion there is physical deterioration of the soil resulting in lower water holding and infiltration capacity and poorer surface structure. Crops are thus susceptible to more frequent and severe water stress and lower crop yields occur.

The ratings of soil erosion are generally classified into three classes:

Slightly eroded - soil with a sufficient amount of the A horizon removed that ordinary tillage will bring up and mix the B-horizon or lower horizons.

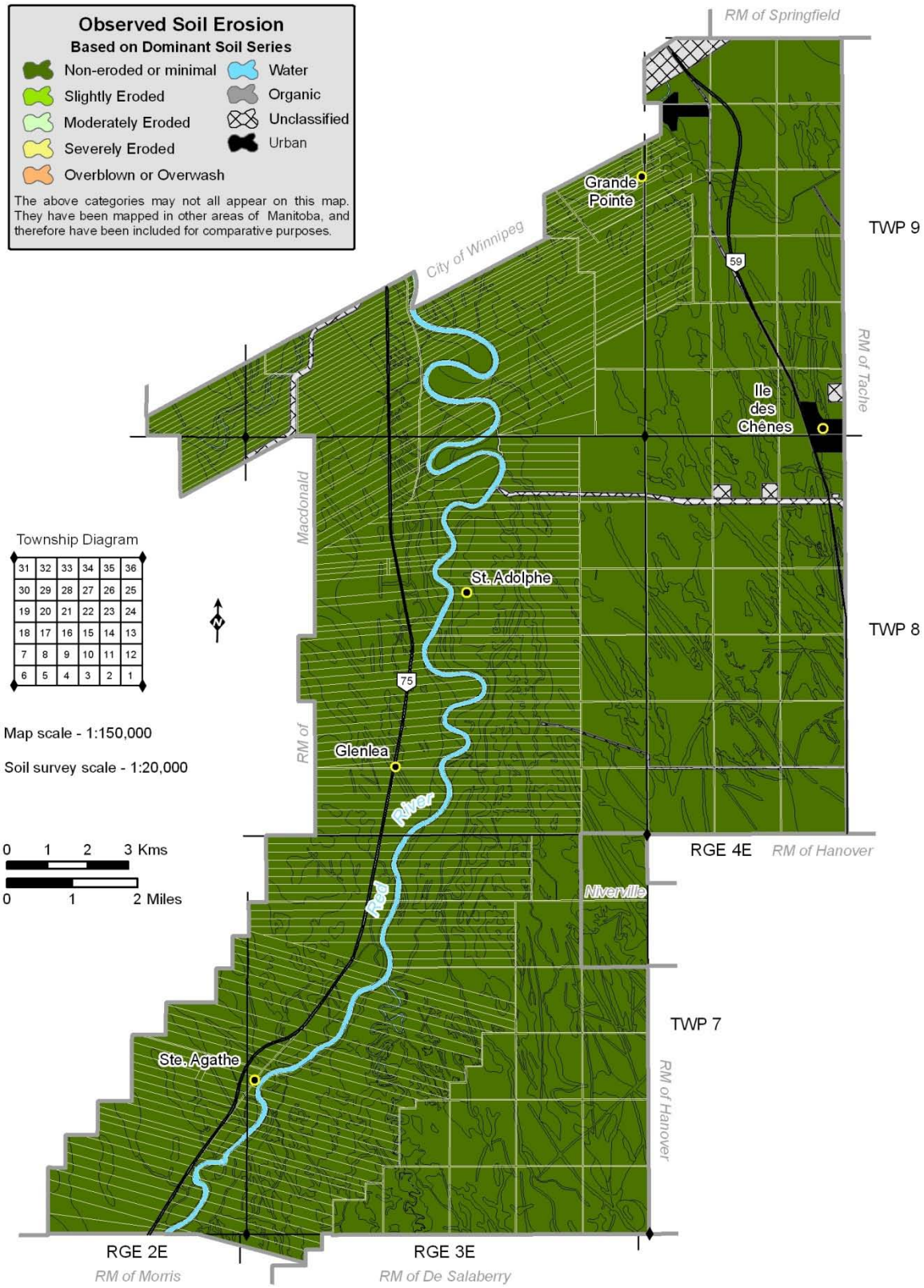
Moderately eroded - soil with the entire A horizon and a part of the B or lower horizons removed.

Severely eroded - soils which have practically all of the original surface soil removed and the tilled layer consists mainly of C-horizon material. This condition occurs on knolls and steep upper slope positions.

The degree of observed soil erosion shown on Map 7 is based on the dominant soil for each polygon.

Observed Erosion Class	Total ac	Total ha	% of RM
Non-eroded or minimal	82,168	33,252	96.77
Slightly	0	0	0.00
Moderately	0	0	0.00
Severely	0	0	0.00
Overblown or overwash	0	0	0.00
Organic	0	0	0.00
Water	1,183	479	1.39
Unclassified	1,215	492	1.43
Urban	343	139	0.40

Map 7. Observed Soil Erosion Map



4.8 Topography

Slope describes the steepness of the landscape surface. The degree and length of slope are important topographic factors affecting the potential for surface runoff and infiltration of precipitation.

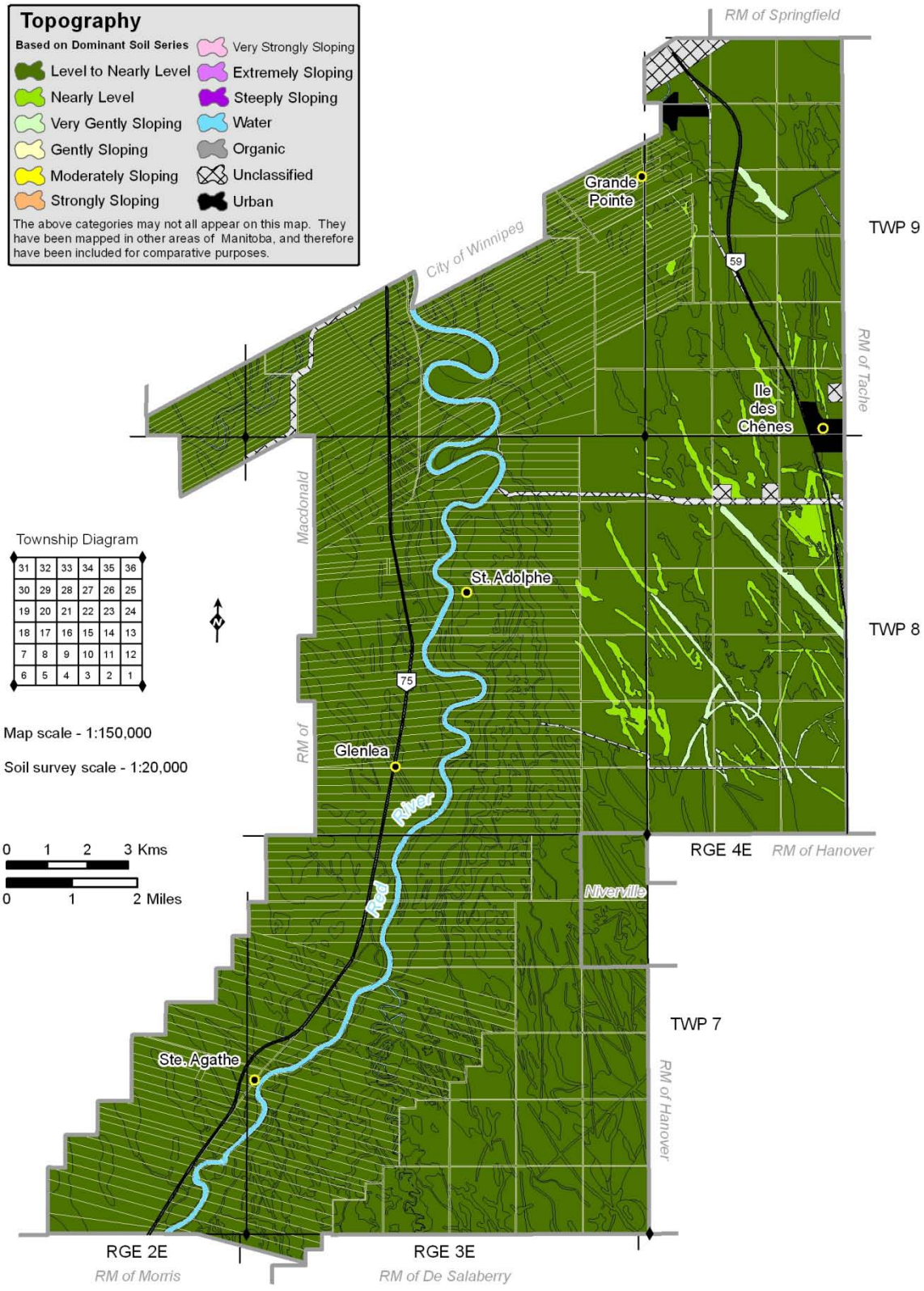
Ten slope classes are used to denote the dominant but not necessarily most severe slopes within a mapping unit.

Slope Class	Slope Description	% Slope
x	Level	0-0.5
b	Nearly level	>0.5-2.0
c	Very gently sloping	>2.0-5.0
d	Gently sloping	>5.0-9.0
e	Moderately sloping	>9.0-15.0
f	Strongly sloping	>15.0-30.0
g	Very strongly sloping	>30.0-45.0
h	Extremely sloping	>45.0-70.0
i	Steeply sloping	>70.0-100
j	Very steeply sloping	>100

Topography classes shown on Map 8 are based on the dominant soil for each polygon.

Topography (slope classes)	Total ac	Total ha	% of RM
x	79,469	32,160	93.59
b	2,153	871	2.54
c	546	221	0.64
Water	1,183	479	1.39
Unclassified	1,215	492	1.43
Urban	343	139	0.40

Map 8. Topography Map



4.9 Stoniness

Soils with stones can hinder tillage, planting and harvesting operations. The degree of stoniness is described by 5 classes. Class 1 stoniness is not considered a limitation for soil capability since there is little or no hindrance to cultivation and clearing is generally not required. Although stone clearing can be a mechanized procedure, it presents a management cost that does not occur in non-stony soils.

Size and amount describe rock fragments.

Gravel sized fragments are rounded or angular, 0.2 to 7.5 cm in diameter.

Cobbles are 7.5 to 25 cm in diameter and **stones** are 25 to 60 cm in diameter or if flat 38 to 60 cm long. The classes of stoniness are defined as follows:

Stones 0 or x. (Non-stony) - Land having less than 0.01% of surface occupied by stones.

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

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

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

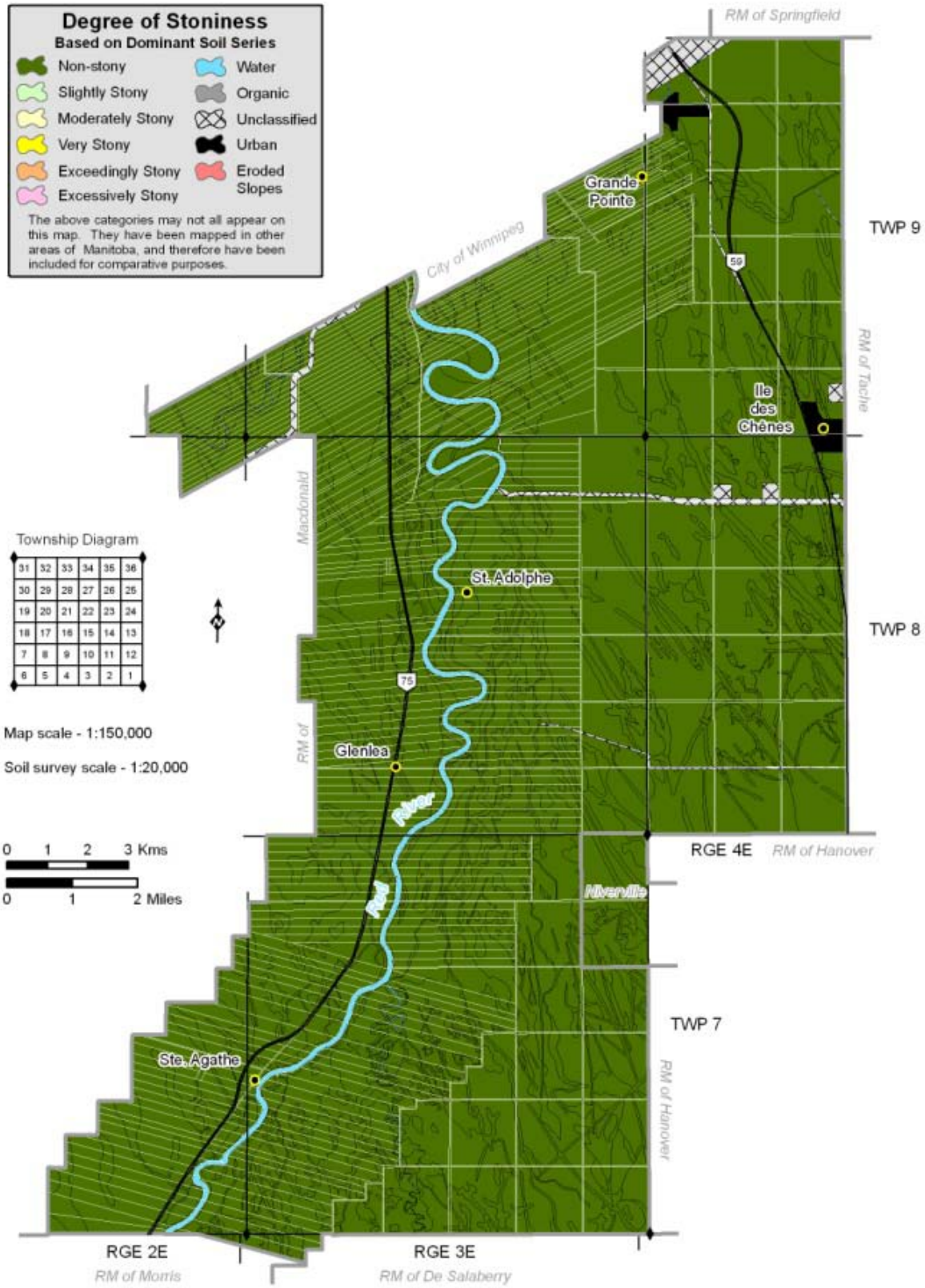
Stones 4. (Exceedingly stony) - Land having 15 to 50% of surface occupied by stones. Stones 15 to 30 cm in diameter, 0.7 to 1.5 m apart. There are sufficient stones to prevent cultivation until considerable clearing has been done.

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

The degree of stoniness shown on Map 9 is based on the dominant soil for each polygon.

Degree of Stoniness	Total ac	Total ha	% of RM
Non-stony	82,168	33,252	96.77
Slightly stony	0	0	0.00
Moderately stony	0	0	0.00
Very stony	0	0	0.00
Exceedingly stony	0	0	0.00
Excessively stony	0	0	0.00
Water	1,183	479	1.39
Unclassified	1,215	492	1.43
Urban	343	139	0.40

Map 9. Degree of Stoniness Map



4.10 Salinity

Saline soils have a high concentration of soluble salts (those which dissolve in water). The salts include sodium sulphate, magnesium sulphate, calcium sulphate, sodium chloride, magnesium chloride, calcium chloride and others.

The primary effect of salts in soils is the deprivation of water to plants. If the soil solution becomes too high in salts, the plants slowly starve, though the supply of water and dissolved nutrients in the soil may be sufficient.

In saline soils, crops usually grow poorly or not at all. At certain times of the year the salts may precipitate out on the surface of the soil leaving a white crust. Generally plants which are affected by soil salinity have a bluish-green appearance. Common field weeds such as Russian Thistle, Kochia, and Wild Barley often occur in areas of high salt concentration. In uncultivated areas plants such as Samphire, Desert Salt grass and Greasewood are frequently dominant species (Henry et al., 1987).

Soil salinity is difficult to manage because it is influenced by soil moisture conditions. In wet years, there is sufficient leaching and dissolving of salts that salts are not visible on the surface and some crop growth may be possible. In dry years, increased evaporation dries out the soil and draws salts up to the soil surface, producing a white crust.

Field instrumentation, using a non-contacting terrain conductivity meter (EM-38 or a Dual EM) can determine whether or not soluble salts are present.

Identification of salt affected areas and the selection of a salt tolerant crop are the most important management practices available to farmers.

A saline soil is defined as a soil with an electrical conductivity (EC) of the saturation extract greater than 4 milli-Siemens/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:

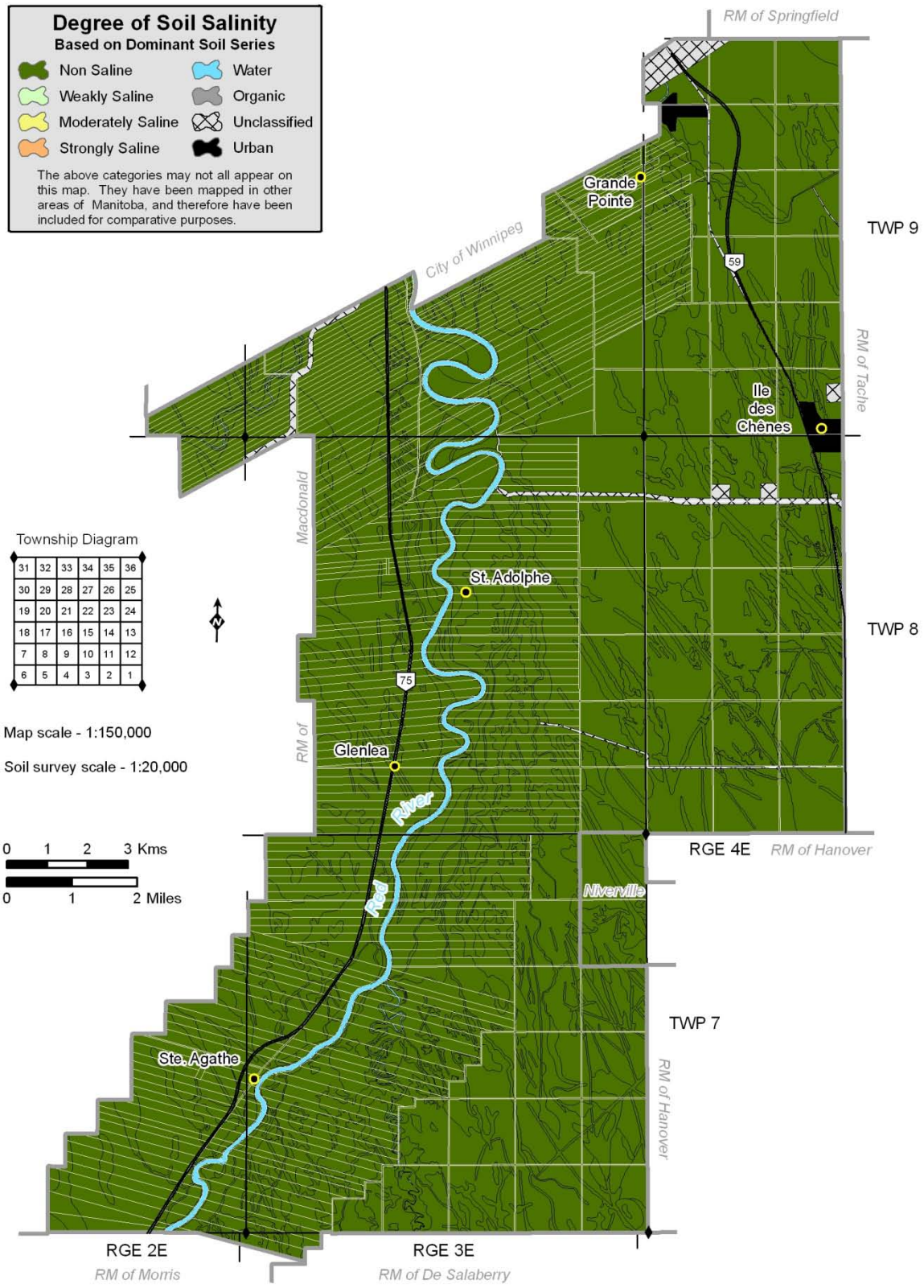
Class	EC mS/cm
Non-saline (x)	0 to 4
Weakly saline (s)	>4 to 8
Moderately saline (t)	>8 to 16
Strongly saline (u)	>16

Note: mS/cm is equivalent to dS/m

The degree of salinity shown on Map 10 is based on the dominant soil for each polygon.

Degree of Salinity	Total ac	Total ha	% of RM
Non-saline	82,168	33,252	96.77
Weakly saline	0	0	0.00
Moderately saline	0	0	0.00
Strongly saline	0	0	0.00
Water	1,183	479	1.39
Unclassified	1,215	492	1.43
Urban	343	139	0.40

Map 10. Degree of Salinity Map



Part 5 Soil Suitability for Selected Engineering and Recreational Uses

5.1 Introduction

This section provides information that can be used by engineers and land use planners. It is intended to supplement the information on the soil map with additional data on engineering properties of soils.

5.2 Soil Suitability for Selected Engineering Uses

The criteria used to evaluate soil suitability for selected engineering and related recreational uses are adopted from guides found in Coen et al. (1977), and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture (USDA, 1971), and the Canada Soil Survey Committee (CSSC, 1973).

The 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. 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:

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

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

(P) Poor - Soils in their present state have one or more severe limitations that can severely affect the proposed use. To overcome these severe limitations, the removal of the limitation would be difficult or costly.

(V) Very Poor - Soils have one or more unfavourable features for the proposed use and the limitation is very difficult and expensive to overcome, or the soil requires such extreme alteration that the proposed use is economically impractical.

The basic soil properties that affect soil suitability for selected engineering and recreation uses are provided in Table 5. These subclass designations identify the limitation or hazard for a particular use.

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.

Table 5. Codes used to identify subclass limitations in evaluating soil suitability for selected Engineering uses in Table 6.

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

The suitability rating of soils for ten selected engineering uses are shown in Table 6. When using these interpretations, consideration must be given to the following assumptions:

1. Soil ratings do not include site factors such as proximity to towns and highways, water supply, aesthetic values, etc.

2. Soil ratings are based on natural, undisturbed conditions.

3. Soil suitability ratings are usually given for the entire soil depth, but for some uses, they may be based on the limitations of an individual soil horizon or layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1 to 2 metres, but in some soils, reasonable estimates can be given for soil material at greater depths.

4. Poor and very poor soil ratings do not imply that a site cannot be changed to remove, correct or modify the limitations.

5. 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.

Table 6. Suitability Ratings of Soils for Selected Engineering Uses

Soil Code	Phase	Soil Name	Top Soil	Sand and Gravel	Road Fill	Permanent Bldg. with Basements	Local Roads & Streets	Sanitary Trench	Land-fill Area	Cover Material	Sewage Lagoon	Septic Field
$UL	xxxx	Unclassified land	-	-	-	-	-	-	-	-	-	-
$UR	xxxx	Urban land	-	-	-	-	-	-	-	-	-	-
$ZZ	xxxx	Water	-	-	-	-	-	-	-	-	-	-
BCK	xxxx	Black Lake	Ps	Va	Pa	Pa	Pa	Ps	Fi	Ps	G	Vk
DCS	xxxx	Dencross	Ps	Va	Paf	Paw	Pa	Psw	Fw	Ps	Fjk	Phk
DCS	xbxx	Dencross	Ps	Va	Paf	Paw	Pa	Psw	Fw	Ps	Fjk	Phk
DCS	xcxx	Dencross	Ps	Va	Paf	Paw	Pa	Psw	Fw	Ps	Fkt	Phk
DFS	xxxx	Dufresne	Pi	Va	Paw	Viw	Vi	Viw	Viw	Psw	Vi	Vhi
FIH	xxxx	Fisher	Ps	Va	Fa	Piw	Pi	Piw	Pi	Fs	Pi	Pik
FTY	xxxx	Fort Garry	Ps	Va	Pa	Fa	Pa	Ps	G	Ps	Fjk	Pk
FTY	xcxx	Fort Garry	Ps	Va	Pa	Fa	Pa	Ps	G	Ps	Fkt	Pk
GOOd	xxxx	Glenmoor, dr.	Ps	Va	Paw	Vw	Paw	Vw	Pw	Psw	Ph	Vh
GOOd	xbxx	Glenmoor, dr.	Ps	Va	Paw	Vw	Paw	Vw	Pw	Psw	Ph	Vh
GOO	xxxx	Glenmoor	Ps	Va	Paw	Vw	Paw	Vw	Pw	Psw	Ph	Vh
HDG	xxxx	Hodgson	G	Va	Fa	Fa	Fai	Fis	Fi	Fs	Fak	Pk
HDN	xxxx	Hoddinott	Ps	Va	Pa	Pw	Pa	Psw	Fw	Ps	Fjk	Pk
LKD	xxxx	Lakeland	Fs	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fak	Phk
MRS	xxxx	Morris	Ps	Va	Pal	Paw	Pa	Psw	Fw	Ps	G	Vk
MYT	xxxx	Myrtle	Ps	Va	Pal	Pa	Pa	Ps	G	Ps	G	Vk
OBO	xxxx	Osborne	Ps	Va	Pal	Vw	Paw	Vw	Pw	Psw	G	Vhk
OBOd	xxxx	Osborne	Ps	Va	Pal	Vw	Paw	Vw	Pw	Psw	G	Vhk
OBOv	xxxx	Osborne, vp	Ps	Va	Vw	Vw	Paw	Vhw	Vw	Vw	G	Vhk
RIV	xxxx	Red River	Ps	Va	Pal	Paw	Pa	Psw	Fw	Ps	G	Vk
RIV	xbxx	Red River	Ps	Va	Pal	Paw	Pa	Psw	Fw	Ps	G	Vk
SCY	xxxx	Scanterbury	Ps	Va	Pal	Paw	Pa	Psw	Fw	Ps	G	Vk
SCY	xbxx	Scanterbury	Ps	Va	Pal	Paw	Pa	Psw	Fw	Ps	G	Vk
SOR	xxxx	St Norbert	Ps	Va	Pal	Pa	Pa	Ps	G	Ps	G	Pk
SRE	xxxx	Seine River	Pis	Va	Pa	Pai	Pai	Piw	Piw	Ps	Pi	Vk

5.3 Soil Suitability for Selected Recreational Uses

This section provides interpretations of the soil suitability for recreational development. All types of soil can be used for recreational activities of some kind.

Soils and their properties contribute to the determination of the type and location of recreational facilities. Wet soils are not suitable for campsites, roads, playgrounds or picnic areas. Soils that pond and dry out slowly after heavy rains present problems where intensive use is planned. It is difficult to maintain grass cover for playing fields and golf courses on droughty soils. The feasibility of many kinds of outdoor activities are determined by many basic soil properties such as depth to bedrock, stoniness, topography or land pattern, and the ability of the soil to support vegetation of different kinds as related to its natural fertility.

The suitability of the various soil series and phases for selected recreation uses is shown in Table 7. The four classes, Good, Fair, Poor and Very Poor are defined previously in the section on Engineering Uses. Subclasses are employed to identify the kind of limitation or hazard for a particular use. An explanation of subclass symbols is provided.

Codes used to identify subclass limitations in evaluating soil suitability for selected recreational uses in Table 7.

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 7. Suitability Ratings of Soils for Recreational Uses

Soil Code	Phase	Soil Name	Play Ground	Picnic Area	Camp Area	Paths and Trails	Permanent Bldg. without Basements
$UL	xxxx	Unclassified land	-	-	-	-	-
$UR	xxxx	Urban land	-	-	-	-	-
$ZZ	xxxx	Water	-	-	-	-	-
BCK	xxxx	Black Lake	Fs	Fs	Fis	Fs	Pa
DCS	xxxx	Dencross	Ps	Ps	Ps	Ps	Pa
DCS	xbxx	Dencross	Ps	Ps	Ps	Ps	Pa
DCS	xcxx	Dencross	Ps	Ps	Ps	Ps	Pa
DFS	xxxx	Dufresne	Viw	Piw	Viw	Psw	Vi
FIH	xxxx	Fisher	Fiw	Fsw	Pi	Fsw	Pi
FTY	xxxx	Fort Garry	Fs	Fs	Fs	Fs	Pa
FTY	xcxx	Fort Garry	Fst	Fs	Fs	Fs	Pa
GOOd	xxxx	Glenmoor	Psw	Psw	Psw	Psw	Paw
GOOd	xbxx	Glenmoor	Psw	Psw	Psw	Psw	Paw
GOO	xxxx	Glenmoor	Psw	Psw	Psw	Psw	Paw
HDG	xxxx	Hodgson	Fs	Fs	Fis	Fs	Fa
HDN	xxxx	Hoddinott	Ps	Ps	Ps	Ps	Pa
LKD	xxxx	Lakeland	Fsw	Fsw	Fsw	Fsw	Faw
MRS	xxxx	Morris	Pks	Psw	Pks	Ps	Pa
MYT	xxxx	Myrtle	Fks	Fs	Fks	Fs	Pa
OBO	xxxx	Osborne	Psw	Psw	Psw	Psw	Paw
OBOd	xxxx	Osborne	Psw	Psw	Psw	Psw	Paw
OBOv	xxxx	Osborne, vp	Vw	Vw	Vw	Psw	Vaw
RIV	xxxx	Red River	Pks	Psw	Pks	Ps	Pa
RIV	xbxx	Red River	Pks	Psw	Pks	Ps	Pa
SCY	xxxx	Scanterbury	Pks	Psw	Pks	Ps	Pa
SCY	xbxx	Scanterbury	Pks	Psw	Pks	Ps	Pa
SOR	xxxx	St Norbert	Fks	Fs	Fks	Fs	Pa
SRE	xxxx	Seine River	Pks	Psw	Pis	Ps	Pai

Appendix 1

Guides for Evaluating Soil Conditions and Landscape Features for Selected Uses

Table 8. Definitions of the Agricultural Capability Classes

Class 1

Soils in this Class have no important limitations for crop use. The soils have level or gently sloping topography; are deep, well to imperfectly drained and have moderate water holding capacity. The soils are naturally well supplied with plant nutrients, easily maintained in good tilth and fertility. Soils are moderately high to high in productivity for a wide range of cereal and special crops.

Class 2

Soils in this Class have moderate limitations that reduce the choice of crops or require moderate conservation practices. The soils have good water holding capacity and are either naturally well supplied with plant nutrients or are highly responsive to inputs of fertilizer. They are moderate to high in productivity for a fairly wide range of crops. The limitations are not severe and good soil management and cropping practices can be applied without serious difficulty.

Class 3

Soils in this Class have moderate limitations that restrict the range of crops or require moderate conservation practices. The limitations in Class 3 are more severe than those in Class 2 and conservation practices are more difficult to apply and maintain. The limitations affect the timing and ease of tillage, planting and harvesting, the choice of crops and maintenance of conservation practices. The limitations include one or more of the following: moderate climatic limitation, erosion, structure or permeability, low fertility, topography, overflow, wetness, low water holding capacity or slowness in release of water to plants, stoniness and depth of soil to consolidated bedrock. Under good management, these soils are fair to moderately high in productivity for a fairly wide range of field crops.

Class 4

Soils in this Class have severe limitations that restrict the choice of crops or require special conservation practices or both. These soils have such limitations that they are only suited for a few crops or the yield for a range of crops may be low, or the risk of crop failure is high. The limitations may seriously affect such farm practices as the timing and ease of tillage, planting and harvesting, and the application and maintenance of conservation practices. These soils are low to medium in productivity for a narrow range of crops but may have higher productivity for a specially adapted crop. The limitations include the adverse effects of one or more of the following: climate, accumulative undesirable soil characteristics, low fertility, reduced storage capacity or release of soil moisture to plants, structure or permeability, salinity, erosion, topography, overflow, wetness, stoniness, and depth of soil to consolidated bedrock.

Class 5

Soils in this Class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. These soils have severe soil, climatic or other limitations and are not capable of sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame perennial forage species. Feasible improvement practices include clearing of bush, cultivation, seeding, fertilizing and water control. Some soils in Class 5 can be used for cultivated field crops provided intensive management is used. Some of these soils are also adapted to special crops requiring soil conditions unlike those needed by the common crops.

Class 6

Soils in this Class are capable only of producing perennial forage crops and improvement practices are not feasible. Class 6 soils have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic or other limitations as to make impractical the application of improvement practices that can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents the use of farm machinery, or because the soils are not responsive to improvement practices, or because stock watering facilities are inadequate.

Class 7

Soils in this Class have no capability for arable culture or permanent pasture because of extremely severe limitations. Bodies of water too small to delineate on the map are included in this class. These soils may or may not have a high capability for forestry, wildlife and recreation.

Table 9. Agricultural Capability Subclass Limitations

C - Adverse climate: This subclass denotes a significant adverse climate for crop production as compared to the "median" climate which is defined as one with sufficiently high growing season temperatures to bring field crops to maturity, and with sufficient precipitation to permit crops to be grown each year on the same land without a serious risk of partial or total crop failures.

D - **Undesirable soil structure and/or low permeability:** This subclass is used for soils difficult to till, or which absorb water very slowly or in which the depth of rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

E - **Erosion:** Subclass E includes soils where damage from erosion is a limitation to agricultural use. Damage is assessed on the loss of productivity and on the difficulties in farming land with gullies.

F - Low fertility: This subclass is made up of soils having low fertility that either is correctable with careful management in the use of fertilizers and soil amendments or is difficult to correct in a feasible way. The limitation may be due to lack of available plant nutrients, high acidity or alkalinity, low exchange capacity, high levels of carbonates or presence of toxic compounds.

I - Inundation by streams or lakes: This subclass includes soils subjected to inundation causing crop damage or restricting agricultural use.

L - **Coarse wood fragments:** In the rating of organic soils, woody inclusions in the form of trunks, stumps and branches (>10 cm diameter) in sufficient quantity to significantly hinder tillage, planting and harvesting operations.

M - Moisture limitation: This subclass consists of soils where crops are adversely affected by droughtiness owing to inherent soil characteristics. They are usually soils with low water-holding capacity.

N - **Salinity:** Designates soils, which are adversely affected by the presence of soluble salts.

P - **Stoniness:** This subclass is comprised of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations. Stony soils are usually less productive than comparable non-stony soils.

R - **Consolidated bedrock:** This subclass includes soils where the presence of bedrock near the surface restricts their agricultural use. Consolidated bedrock at depths greater than 1 metre from the surface is not considered as a limitation, except on irrigated lands where a greater depth of soil is desirable.

T - **Topography:** This subclass is made up of soils where topography is a limitation. Both the percent of slope and the pattern or frequency of slopes in different directions are important factors in increasing the cost of farming over that of smooth land, in decreasing the uniformity of growth and maturity of crops, and in increasing the hazard of water erosion.

W - Excess water: Subclass W is made up of soils where excess water other than that brought about by inundation is a limitation to their use for agriculture. Excess water may result from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.

X - **Cumulative minor adverse characteristics:** This subclass is made up of soils having a moderate limitation caused by the cumulative effect of two or more adverse characteristics which singly are not serious enough to affect the class rating.

Table 10. Dryland Agriculture Capability Guidelines for Manitoba*

Subclass Limitations	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7
	No significant limitations in use for crops.	Moderate limitations that restrict the range of crops or require moderate conservation practices.	Moderate severe limitation that restrict the range of crops or require special conservation practices.	Severe limitations that restrict the range of crops or require special conservation practices or both.	Very severe limitations that restrict soil capability to produce perennial forage crops, and improvement practices are feasible.	Soils are capable only of producing perennial forage crops, and improvement practices are not feasible.	No capability for arable culture or permanent pasture.
Climate (C)	All Ecodistricts[1] within ARDA boundary not explicitly listed under 2C and 3C.	Ecodistricts: 664, 666, 668, 670, 671, 672, 674, 675, 676, 677, 714, 715, 716	Ecodistricts: 356, 357, 358, 359, 363, 366, 663, 665	None within ARDA boundary			
Consolidated Bedrock (R)				> 50 -100 cm	20 - 50 cm	< 20 cm	Surface bedrock Fragmental over bedrock
Moisture limitation[2] (M)		Stratified loams Moderate moisture holding capacity	Loamy sands Low moisture holding capacity	Sands Very low moisture holding capacity	Skeletal sands Very severe moisture deficiency	Stabilized sand dunes	Active sand dunes
Topography[3] (T)	a, b (0 - 2%)	c (> 2 - 5%)	d (> 5 - 9%)	e (> 9 - 15%)	f (> 15 - 30%)	g (> 30 - 45%) Eroded slope complex	h (> 45 - 70%) i (> 70 - 100%) j (> 100%)
Structure and/or Permeability (D)	Granular clay	Massive clay or till soils[4] Slow permeability	Solonetzic intergrades Very slow permeability	Black Solonetz Extremely slow permeability			
Salinity[5] (N) **0 - 60 cm depth** **60 - 120 cm depth**	NONE < 2 dS/m < 4 dS/m	WEAK 2 - 4 dS/m 4 - 8 dS/m	MODERATE (s) > 4 - 8 dS/m > 8 - 16 dS/m	STRONG (t) > 8 - 16 dS/m > 16 - 24 dS/m	VERY STRONG (u) [6] > 16 - 24 dS/m > 24 dS/m		Salt Flats
Inundation[7] (I)	No overflow during growing season	Occasional overflow (1 in 10 years)	Frequent overflow (1 in 5 years) Some crop damage	Frequent overflow (1 in 5 years) Severe crop damage	Very frequent (1 in 3 years) Grazing > 10 weeks	Very frequent Grazing 5 - 10 weeks	Land is inundated for most of the season
Excess Water (W)	Well and Imperfectly drained		Loamy to fine textured Gleysols with improved drainage	Coarse textured Gleysols with improved drainage	Poorly drained, no improvements	Very Poorly drained	Open water, marsh
Stoniness (P)	Nonstony (0) and Slightly Stony (1)	Moderately Stony (2)	Very Stony (3) [8]	Exceedingly Stony (4) [9]		Excessively Stony (5)	Cobbly Beach Fragmental
Erosion[10] (E)		Moderate erosion (2)	Severe wind or water erosion (3) lowers the basic rating by one class to a minimum rating of Class 6 [11].				
Cumulative minor adverse Characteristics[12] (X)							

* Based on the Canada Land Inventory Soil Capability Classification for Agriculture (1965), with modifications made for soil application at larger mapping scales. (Rev. 2008)

1 Smith, R.E., H. Veldhuis, G.F. Mills, R.G. Eilers, W.R. Fraser, M. Santry, 1996. Terrestrial Ecoregions and Ecodistricts of Manitoba, An Ecological Stratification of Manitoba's Natural Landscapes. Agriculture and Agri-Food Canada, Research Branch, Brandon Research Centre, Manitoba Land Resource Unit, Winnipeg, MB. Report and Provincial Map at scale of 1:1.5m.

2 With the exception of Class 2, ratings as indicated are based on the assumption of a single parent material, using the most readily drained representative of each textural class. Prevailing climatic conditions within the Ecodistrict, soil drainage and stratification will affect the moisture limitation accordingly.

3 Topographic classes are based on the most limiting slope covering a significant portion of an area of complex, variable slopes. Map units with long, unidirectional slopes may be considered equivalent or one class worse due to an increased erosion hazard.

4 Extremely calcareous loamy till soils with a high bulk density (>1.7 g/cm^3) are rated 3D.

5 Soil Salinity is reported in DeciSiemens/metre (dS/m). Soil will be classed according the the most saline depth. For example, if a soil is non-saline from 0-60 cm but moderately saline from 60 - 120 cm, the soil will be classed as moderately saline (3N).

6 Strongly saline (u) soils are rated 5N with the exception of poorly and very poorly drained soils, which are rated 6NW.

7 Inundation may be listed as a secondary subclass for some fluvial soils. In this case, inundation is not class determining, but may become a limitation if the soil is otherwise improved.

8 Extremely calcareous loamy till soils with a high bulk density (>1.7 g/cm^3) and stony 3 are rated 4DP (4RP if depth to bedrock is 50 - 100 cm).

9 Stony 4 soils will be rated 4P unless their primary physical composition is sandy skeletal or their parent material is till. In either or both of these cases, the soil will be rated 5P.

10 If erosion is moderate, a subclass of E is assigned as a secondary limitation, but the basic rating is not lowered. If erosion is severe, the basic soil rating is downgraded by one class, and E becomes the primary limitation. For example, if a soil has a basic rating of 4T, the presence of moderate erosion will result in a rating of 4TE. If erosion is severe, the rating will be lowered to 5ET. Erosion will be the sole limitation only if the basic rating has a subclass of X. For example, a soil with a rating of 3X will be assigned a rating of 3E if moderate erosion is present.

11 The rating is not lowered from Class 6 based on erosion. A rating of 6TE indicates a soil with g topography and either moderate or severe erosion.

12 Use only for soils with no other limitation except climate. The subclass represents soils with a moderate limitation caused by the cumulative effect of two or more adverse characteristics which are singly not serious enough to affect the rating. Because the limitation is moderate, soils may only be downgraded by one class from their initial climate limitation. Therefore, a soil with a climate limitation of 2C and 2 or more minor adverse characteristics will be rated as 3X. This symbol is always used alone.

Table 11. Description of Irrigation Suitability Classes

General Rating	Class	Degree of Limitation	Description
Excellent	**1A**	No soil or landscape limitations	These soils are medium textured, well drained and hold adequate available moisture. Topography is level to nearly level. Gravity irrigation methods may be feasible.
Good	**1B** **2A** **2B**	Slight soil and/or landscape limitations	The range of crops that can be grown may be limited. As well, higher development inputs and management are required. Sprinkler irrigation is usually the only feasible method of water application.
Fair	**1C** **2C** **3A** **3B** **3C**	Moderate soil and/or landscape limitations	Limitations reduce the range of crops that may be grown and increase development and improvement costs. Management may include special conservation techniques to minimize soil erosion, limit salt movement, limit water table build-up or flooding of depressional areas. Sprinkler irrigation is usually the only feasible method of water application.
Poor	**1D** **2D** **3D** **4A** **4B** **4C** **4D**	Severe soil and/or landscape limitations	Limitations generally result in a soil that is unsuitable for sustained irrigation. Some land may have limited potential when special crops, irrigation systems, and soil and water conservation techniques are used.

Table 12. Landscape Features Affecting Irrigation Suitability*

Symbol	Landscape Features	Degree of Limitation			
		None (A)	Slight (B)	Moderate (C)	Severe (D)
t1	Slope - Simple %	<2	2 - 10	10 - 20	>20
t2	- Complex %	<5		5 - 15	>15
E	Relief m (Average Local)	<1	1 - 3	3 - 5	>5
P	Stoniness -Classes -Cover (%)	0, 1 & 2 (0 to 3%)	3 (3 to 15%)	4 (15 to 50%)	5 (>50)
I	Inundation -Frequency of Flooding (period)	1:10 (yr)	1:5 (yr)	1:1 (annual-spring)	1:<1 (seasonal)

* Suitability interpretations are based on the criteria for Complex slopes

Table 13. Soil Features Affecting Irrigation Suitability

Symbol	Soil Feature	Degree of Limitation			
		None (1)	Slight (2)	Moderate (3)	Severe (4)
d	Structure	Granular, Single Grained, Prismatic, Blocky, Subangular Blocky	Columnar, Platy	Massive	Massive
k	Ksat (mm/hr) (0 - 1.2 m)	> 50	50 - 15	< 15 - 1.5	< 1.5
x	Drainability (mm/hr) (1.2 - 3 m)	> 15	15 - 5	< 5 - 0.5	< 0.5
m	AWHC subhumid (mm/1.2 m) (% by volume) Subarid (mm/1.2 m) (% by volume)	 > 120 (> 10) > 150 (> 12)	 120 - 100 (10 - 8) 150 - 120 (12 - 10)	 < 100 - 75 (< 8 - 6) < 120 - 100 (< 10 - 8)	 < 75 (< 6) < 100 (< 8)
q	Intake Rate (mm/hr)	> 15	15 - 1.5	15 - 1.5	< 1.5
s	Salinity (mS/cm or dS/m) 0 - 0.6 m depth 0.6 - 1.2 m depth 1.2 - 3 m depth	 < 2 < 4 < 8	 2 - 4 4 - 8 8 - 16	 > 4 - 8 > 8 - 16 > 16	 > 8 > 16 > 16
n	Sodicity (SAR) 0 - 1.2 m depth 1.2 - 3 m depth	 < 6 < 6	 6 - 9 6 - 9	 > 9 - 12 > 9 - 12	 > 12 > 12
g	Geological (0 - 1.2 m) Uniformity (1.2 - 3m)	1 Textural Group 2 Textural Groups	2 Textural Groups Coarser below 3 Textural Groups Coarser below	2 Textural Groups Finer below 3 Textural Groups Coarser below 3 Textural Groups Finer below	3 Textural Groups Finer below
r	Depth to Bedrock (m)	> 3	3 - 2	< 2 - 1	< 1
h	Depth to Water Table (m)	> 2	2 - 1.2 (if salinity is a problem)	2 - 1.2 (if salinity is a problem)	< 1.2
w	Drainage Class	Well, Moderately Well	Imperfect	Imperfect	Poor, Very Poor, Excessive, Rapid
	*Texture (Classes) (0 - 1.2 m)	L, SiL, VFSL, FSL	CL, SiCL, SCL, SL, LVFS	C, SC, SiC VFS, FS, LS, CoSL	HvC GR, CoS, LCoS, S
	*Organic Matter %	> 2	2 - 1	2 - 1	< 1
	*Surface Crusting Potential	Slight	Low	Low	Moderate

* Other important factors used to interpret type and degree of limitation but which do not present a limitation to irrigation themselves. No symbol is proposed for these factors since they will not be identified as subclass limitations. Rev. (2008)

Table 14a. Guide for Assessing Land Suitability for Irrigated Potato Production on Rapid, Well and Moderately Well Drained Soils

In assessing suitability of land for irrigated potato production, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed characteristics or properties.

Characteristic or Property	Suitability Rating				
	Class 1	Class 2	Class 3	Class 4	Class 5
Texture Group*	CL CL/SF CL/SF/SC CL/FL/SF CL/LY LY/SF LY	SY,SY/SC, SY/CL, SY/LY, SY/FL, SY/SS/LY, SF, SY/UD/LY,SF/CS, SF/SC, SF/LY, SF/FL, SC/LY, SC, SF/SS/FL, CL/FL, SC/FL, CL/SS/FL, LY/FL, LY/SC, LY/LS, LY/SS/SF, LY/SS/SC, LY/FL/SF, LY/SS/LY, LY/SS/FL, FL, FL/SF, FL/LY, FL/FL, FL/SY/SF, FL/SS/LY, FL/SS/FL, FL/CL	SY/SS, SY/CY/LY, SF/SS, CL/SS, SF/CY, CL/CY, SF/CY/LY, CL/CY/LY, CL/SS/CY, LY/CY, LY/SS, FL/SS	FL/CY, FL/CY/SF	SK, SS, SS/RK, SS/LY, SS/FL, SS/CY, SC/RK, SF/RK, CS, CL/RK, CL/FR, CL/FR/RK, LS/RK, LY/RK, LY/SY/RK, FL/LY/RK, CY, CY/SS, CY/SC, CY/SY, CY/SF, CY/CL, CY/LY, CY/FL, CY/CY, CY/RK, CY/TX, CY/SS/CY, CY/LY/CY, CY/FL/CY, CY/LY/RK, CY/FL/RK, RK, TX, TX/LY, UD, UD/LY
Topography[1] (Slope)	0 - 5% (a, b, c)			> 5 - 9% (d)	> 9% (e, f, g, h, i, j)
Stoniness[2] Class	-			St. 1	St. 2, 3, 4, 5
Salinity[3] (mS/cm)	< 2		2 - 4	> 4 - 8	> 8
Soil Order and / or Subgroup			Orthic Regosol		Organic Order, Solonetzic Order, Solonetzic Subgroups

Topography[1]	Stoniness[2] (Surface covered)		Salinity[3] (mS/cm)	
< 5 % level to very gently sloping	- non-stony	< 0.01 %	very low	0 - 2
5 - 9 % gently sloping	1 slightly stony	0.01 - 0.1 %	low	> 2 - 4
> 9 % mod. to extremely sloping	2 moderately stony	> 0.1 - 3 %	weakly (s)	> 4 - 8
	3 very stony	> 3 - 15 %	moderately (t)	> 8 - 16
	4 exceedingly stony	> 15 - 50 %	strongly (u)	> 16
	5 excessively stony	> 50 %		

* SK = Skeletal
SS = Sandy Skeletal
LS = Loamy Skeletal
CS = Clayey Skeletal
SC = Sandy Coarse
SY = Sandy
SF = Sandy Fine
CL = Coarse Loamy
LY = Loamy
FL = Fine Loamy
CY = Clayey
RK = Bedrock
FR = Fragmental
UD = Undifferentiated
TX = Texture Complex

Table14b. Guide for Assessing Land Suitability for Irrigated Potato Production on Imperfectly, Poorly and Very Poorly Drained Soils

In assessing suitability of land for irrigated potato production, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed characteristics or properties.

Characteristic or Property	Suitability Rating				
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Texture Group*			SY, SY/SS, SY/SC, SY/CL, SY/LY, SC/LY, SY/SS/LY, SY/UD/LY, SC, SF, SF/SS, SF/CS, SF/LY, SF/SC, SF/FL, SY/FL, SF/SS/FL, CL, CL/SS, CL/SF, CL/LY, CL/FL, CL/SF/SC, CL/SS/FL, CL/FL/SF, LY/SS, LY/SC, LY/SF, LY/LS, LY/SS/SF, LY/SF/SC, SC/FL, LY, LY/FL, LY/SS/LY, LY/SS/FL, FL, FL/SF, FL/SS, FL/CL, FL/LY, FL/FL, FL/SY/SF, FL/SS/LY, FL/SS/FL	SF/CY, SY/CY/LYSF/CY/LY, SF/CY/FL, CL/CY, CL/CY/LY, CL/SS/CY, LY/CY, FL/CY/SF, FL/CY	SK, SS, SS/RK, SS/LY, SS/FL, SS/CY, SC/RK, SF/RK, CS, CL/RK, CL/FR, CL/FR/RK, LS/RK, LY/RK, LY/SY/RK, FL/LY/RK, CY, CY/SS, CY/SC, CY/SY, CY/SF, CY/CL, CY/LY, CY/FL, CY/CY, CY/RK, CY/TX, CY/SS/CY, CY/LY/CY, CY/FL/CY, CY/LY/RK, CY/FL/RK, RK, TX, TX/LY, UD, UD/LY
Topography[1] (Slope)			0 - 5%	> 5 - 9%	> 9%
Stoniness[2] Class				St. 1	St. 2, 3, 4, 5
Salinity[3] (mS/cm)			< 4	4 - 8	> 8
Soil Order and / or Subgroup					Organic Order, Gleysolic Order, Solonetzic Order, Solonetzic Subgroups

Topography[1]	**Stoniness[2]**	**(Surface covered)**	**Salinity[3]**	**(mS/cm)**
< 5 % level to very gently sloping	- non-stony	< 0.01 %	very low	0 - 2
5 - 9 % gently sloping	1 slightly stony	0.01 - 0.1 %	low	> 2 - 4
> 9 % mod. to extremely sloping	2 moderately stony	> 0.1 - 3 %	weakly (s)	> 4 - 8
	3 very stony	> 3 - 15 %	Moderately (t)	> 8 - 16
	4 exceedingly stony	> 15 - 50 %	Strongly (u)	> 16
	5 excessively stony	> 50 %		

* SK = Skeletal
SS = Sandy Skeletal
LS = Loamy Skeletal
CS = Clayey Skeletal
SC = Sandy Coarse
SY = Sandy
SF = Sandy Fine
CL = Coarse Loamy
LY = Loamy
FL = Fine Loamy
CY = Clayey
RK = Bedrock
FR = Fragmental
UD = Undifferentiated
TX = Texture Complex

Table 15. Guide for Assessing Soil Suitability as Source of Topsoil

The term "topsoil" includes soil materials used to cover barren surfaces exposed during construction, and materials used to improve soil conditions on lawns, gardens, flower beds, etc. The factors to be considered include not only the characteristic of the soil itself, but also the ease or difficulty of excavation, and where removal of topsoil is involved, accessibility to the site.

Symbol[1]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	**Moist Consistence**[2]	Very friable, friable	Loose, firm	Very firm	Cemented
i	**Flooding**	None	May flood occasionally for short periods	Frequent flooding (every year)	Constantly flooding
w	**Wetness**[2]	Wetness is not determining if better than very poorly drained.			Very poorly drained and permanently wet soils
t	**Slope**	5% (a, b, c)	> 5 - 9% (d)	> 9 - 15% (e)	> 15% (f, g, h, i, j)
p	**Stoniness**[2]	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)
c	**Coarse fragments**[2] **(% by volume)**	3%	> 3 - 15%	> 15 - 35%	> 35%
s	**Texture**[2]	SL, FSL, VFSL, L, SiL; SC if 1:1 clay is dominant	SCL, CL, SiCL; SC if 2:1 clay is dominant; C and SiC if 1:1 clay is dominant	S, LS; SiC and C if 2:1 clay is dominant. organic soils[3]	Marl, diatomaceous earth
b	**Depth of Topsoil**[4]	> 40 cm	> 15 - 40 cm	8 - 15 cm	< 8 cm
n	**Salinity of Topsoil**[5]	EC < 1	EC 1 - 4	EC > 4 - 8 (s)	EC > 8 (t, u)

Revised 2011

1 The symbol is used to indicate the property affecting use.
2 For an explanation of texture, consistence, stoniness, coarse fragments and soil drainage classes, see the Manual for describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
3 Non-woody organic aterials are assessed as good sources for topsoil if mixed with or incorporated into mineral soil.
4 The remaining soil material (at least 8 cm) must be reclaimable after the uppermost soil is removed.
5 EC = Electrical Conductivity (milliSiemens/cm).

Additional Notes:
Well drained Till soils with erosion 1, rated as **Fb** for depth of topsoil; erosion 2 rated as **Pb** for depth of topsoil; and erosion 3 rated as **Vb** for depth of topsoil.
Well drained Luvisols and Dark Gray Chernozems with erosion 2 or 3 rated as **Vb** for depth of topsoil.
Regosols rated as **Vb** for depth of topsoil.
Poorly drained Organic soils rated as **Vw** for topsoil and Organic soils, drained phase, are rated as **Ps** for topsoil.

Table 16. Guide for Assessing Soil Suitability as Source of Sand and Gravel

The purpose of this table is to provide guidance for assessing the probable supply as well as quality of the sand or gravel for use as road base material and in concrete. The interpretation pertains mainly to the characteristics of substratum to a depth of 150 cm, augmented by observations made in deep cuts as well as geological knowledge where available.

Symbol[1]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	**Unified Soil Group**[4]	GW GP SW SP	GW - GM GP - GM SW - SM SP - SM	GM GW - GC GP - GC SM SW - SC SP -SC	All other groups and bedrock (ML, CL, OL, MH, CH, OH, PT)
h	**Depth to Seasonal Water Table**	Not class determining if deeper than 50 cm		< 50 cm	
q	**Depth to Sand and Gravel**	< 25 cm	25 - 75 cm²	> 75 cm²	
p	**Stoniness**[3]	Not class determining if stones > 0.5 m apart (Class 0, 1, 2 and 3)		Stones 0.1 - 0.5 m apart (Class 4)	Stones < 0.1 m apart (Class 5)
d	**Depth to Bedrock**	> 100 cm	50 - 100 cm	< 50 cm	
x	**Thickness of sand and gravel**	> 100 cm	50 - 100 cm	< 50 cm	

Revised 2011

1 The symbol is used to indicate the property affecting use.
2 Rated good if it is known that the underlying gravel or sand deposit is thick (> 100 cm).
3 For an explanation of stoniness and rockiness, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
4 Shaly gravels rated as Poor (Pa).

Table 17. Guide for Assessing Soil Suitability as Source of Roadfill

Fill material for building 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]	Property Affecting Use[2]	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	**Subgrade[3]** **a.) AASHO Group Index[4]**	< 5	5 - 8	> 8	
	b.) Unified Soil Group	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**	15% (a, b, c, d, e)	> 15 - 30% (f)	> 30 - 45% (g)	> 45% (h, i, j)
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 exposure < 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

Revised 2011

1 The symbol is used to indicate the property affecting use.
2 The first, three properties pertain to soil after it is placed in a fill; the last six properties pertain to soil in its natural condition before excavation for road fill.
3 This property 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 property 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 (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).

Table 18. 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 as well. Also considered are soil properties, particularly depth to bedrock, which influence excavation and corosivity, landscaping and septic tank absorption fields.

Symbol[2]	Property 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 drained Without Basements: Poorly drained	With Basements: Poorly, and very poorly drained Permanently wet soils Without Basements: Very poorly drained 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 or ponding (once in 5 years)	Frequent flooding or ponding (every year)
t	**Slope**[5]	9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)
a	**Subgrade**[6] **a.) AASHO Group Index**[7] **b.) Unified Soil Group**	< 5 GW, GP, SW, SP, GC, SM and SC	5 - 8 CL (with P.I.[8] < 15) and ML	> 8 CL (with P.I.[8] of 15 or more), CH and MH	 OH, OL and PT
f	**Potential Frost Action**[9, 13]	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 exposure > 100 m apart and cover < 2% of the surface	Rock exposure 30 - 100 m apart and cover 2 - 10% of the surface	Rock exposure < 30 m apart and cover > 10% of the surface	Rock exposure 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

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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 symbol is used to indicate the property affecting use.

3 Some soils are assessed as fair or poor 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 (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).

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

6 This property 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 Soil Groups 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 building 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.
[12] Moderately well to well drained soils rate one class better.
[13] Use **z** for permanently frozen soils

Table 19. 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, lime or soil cement, stabilized soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They are also 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 metres. 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 bedrock, stoniness, rockiness, and wetness affect the ease of excavation, and the amount of cut and fill to reach an even grade.

Symbol[2]	Property 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**	9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)
d	**Depth to Bedrock**[4]	> 100 cm	50 - 100 cm	< 50 cm	
a	**Subgrade**[5] **a.) AASHO Group Index**[6]	< 5	5 - 8	> 8	
	b.) Unified Soil Group	GW, GP, GC[7], SW, SP, SM, 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 and loose sand with high organic matter
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

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1 These guidelines, with some adjustment of slope and rockiness limits, will also be useful for assessing soils for use as parking lots.
2 The symbol is used to indicate the property affecting use.
3 For an explanation of stoniness, rockiness and soil drainage classes, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
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 property 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 Soil Groups 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 and moisture movement by capillary action 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 20. Guide for Assessing Soil Suitability for Trench-type Sanitary Landfills[1]

The trench-type sanitary landfill, involves the daily burial of dry garbage and trash in an open trench that is covered with a layer of soil material. Suitability of the site is dependent upon the potential for pollution of water sources through groundwater contact with the refuse, or leachate arising from the site. Those properties affecting ease of excavation of the site must be supplemented with geological and hydrological knowledge to provide subsurface soil and groundwater data to a depth of at least 3 to 4.5 m, a common depth of landfills.

Symbol[2]	Property Affecting Use	Degree of Soil Suitability			
		Good - G[3]	Fair - F	Poor - P	Very Poor - V
h	**Depth to Seasonal High Water Table**	Not class determining if deeper than 180 cm		100 - 180 cm	< 100 cm
w	**Wetness[4]**	Not class determining if better than imperfectly drained		Imperfectly drained	Poorly and very poorly drained or permanently wet soils
i	**Flooding**	None	Rare	Occasional (Once in 2 - 4 years)	Frequent (Every year)
k	**Permeability[4,8]**	< 5 cm/hr	< 5 cm/hr	5 - 15 cm/hr	> 15 cm/hr
t	**Slope**	15% (a, b, c, d, e)	> 15 - 30% (f)	> 30 - 45% (g)	> 45% (h, i, j)
s	**Soil Texture[4,6] (dominant to a depth of 150 cm)**	Si, SiL, L, SCL, VFSL, SL, LVFS, LFS, VFS	SiCL[7], CL, SC, LS	SiC, C	Muck, peat, sand (CoS, MS, FS) and gravel
d	**Depth to Hard Bedrock** **Rippable Bedrock**	> 150 cm > 150 cm	> 150 cm 100 - 150 cm	100 - 150 cm 100 - 150 cm	< 100 cm < 100 cm
p	**Stoniness[4]**	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	**Nature of Bedrock**	Impermeable			Highly permeable, fractured, easily soluble.

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1 Based on soil depth (120 cm) commonly investigated in making soil surveys.
2 The symbol is used to indicate the property affecting use.
3 If probability is high that the soil material to a depth of 3 to 4.5 m will not alter a rating of good or fair, indicate this by an appropriate footnote, such as "Probably good to a depth of 3.5 m", or "Probably fair to a depth of 3.5 m".
4 For an explanation of stoniness, texture and soil drainage classes, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
5 Reflects ability of soil to retard movement of leachate from the landfills; may not reflect a limitation in arid and semiarid areas.
6 Reflects ease of digging, moving (workability) and trafficability in the immediate area of the trench where there may not be surfaced roads.
7 Soil high in expansive clays may need to be given a suitability rating of poor.
8 Contamination hazard (g) may apply at high permeability.

Table 21. Guide for Assessing Soil Suitability for Area-type Sanitary Landfills

In the area-type sanitary landfill, refuse is placed on the surface of the soil in successive layers. The daily and final cover material is generally imported. A final cover of soil material at least 60 cm thick, is placed over the fill when it is completed.

The soil under the proposed site should be investigated to determine the probability that leachates from the landfill may penetrate the soil and thereby pollute water supplies.

Symbol[1]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	**Depth to Seasonal Water Table[2]**	> 150 cm	> 100 - 150 cm	50 - 100 cm	< 50 cm
w	**Wetness[2,3]**	Rapid to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
i	**Flooding**	None	Rare	Occasional (Once in 2 - 4 years)	Frequent (Every year)
k	**Permeability[4,5,6]**	Not class determining if less than 5 cm/hr		5 - 15 cm/hr	> 15 cm/hr
t	**Slope**	9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)

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1 The symbol is used to indicate the property affecting use.
2 Reflects influence of wetness on operation of equipment.
3 For an explanation of drainage, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
4 Reflects ability of the soil to retard movement of leachate from landfills; may not reflect a limitation in arid and semiarid areas.
5 Due to possible groundwater contamination, impermeable bedrock is considered poor and permeable bedrock is rated very poor.
6 Contamination hazard (g) may apply at high permeability and/or proximity of the site to water supplies.

Table 22. Guide for Assessing Soil Suitability as Cover Material for Area-type Sanitary Landfills

The term cover material includes soil materials used to put a daily and final covering layer in area-type sanitary landfills. This cover material may be derived from the area of the landfill or may be brought in from surrounding areas.

Symbol[1]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	**Moist Consistence**[2]	Very friable, friable	Loose, firm	Very firm	Cemented
s	**Texture**[2,3]	Si, SiL, SCL, L, VFSL, FSL, LVFS, VFS	SiCL, CL, SC, LFS, LS	SiC, C	Muck, peat, sand, gravel
d	**Depth to bedrock**[4]	> 150 cm	> 100 - 150 cm	50 - 100 cm	< 50 cm
c	**Coarse fragments**[2] **(% by volume)**	15%	> 15 - 35%	> 35%	
p	**Stoniness**[2]	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)
t	**Slope**	9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)
w	**Wetness**[2]	Not class determining if better than poorly drained.		Poorly drained	Very poorly drained or permanently wet soils.
q	**Depth to Sand and Gravel**	> 1.5 m	1 - 1.5 m	< 1 m	

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1 The symbol is used to indicate the property affecting use.
2 For an explanation of consistence, texture, coarse fragments, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
3 Soils having a high proportion of non-expansive clays may be given a suitability rating one class better than is shown for them in this table.
4 Thickness of material excluding topsoil, which will be stockpiled (see guide for topsoil).

Table 23. Guide for Assessing Soil Suitability for Reservoirs and Sewage Lagoons

Factors affecting the ability of undisturbed soils to impound water or sewage and prevent seepage, are considered for evaluating the suitability of soils for reservoir and lagoon areas. This evaluation considers soil both as a vessel for the impounded area and as material for the enclosing embankment. As the impounded liquids could be **potential sources of contamination of nearby water supplies**, e.g. sewage lagoons, the landscape position of the reservoir as it affects risk of flooding must also be considered.

Symbol[1]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	**Depth to Water Table[2]**	> 150 cm	> 100 - 150 cm	50 - 100 cm	< 50 cm
i	**Flooding[3]**	None	None	Subject to infrequent flooding (once in 50 years)	Subject to frequent high level flooding
k	**Soil Permeability**	< 0.05 cm/hr	0.05 - 0.5 cm/hr	> 0.5 - 5 cm/hr	> 5 cm/hr
t	**Slope**	2% (a, b)	> 2 - 5% (c)	> 5 - 9% (d)	> 9% (e, f, g, h, i, j)
o	**Organic Matter**	2 %	> 2 - 10%	> 10 - 30%	> 30%
c	**Coarse Fragments[4] < 25 cm in diameter, (% by volume)**	20%	> 20 - 35%	> 35%	
p	**Stoniness[4], >25 cm diameter, (% of surface area)**	3% (Class 0, 1 and 2)	> 3 - 15% (Class 3)	> 15 - 50% (Class 4)	> 50% (Class 5)
d	**Depth to Bedrock[5]**	> 150 cm	> 100 - 150 cm	50 - 100 cm	< 50 cm
j	**Thickness of Slowly Permeable Layer**	> 100 cm	> 50 - 100 cm	50 - 25 cm	< 25 cm
a	**Sub-grade Unified Soil Group**	CH	GC, SC and CL	GM, SM, ML & MH	GW, GP, SW & SP, OL, OH & PT

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1 The symbol is used to indicate the property affecting use.
2 If the floor of the lagoon has nearly impermeable material at least 50 cm thick, disregard depth to water table.
3 Disregard flooding if it is not likely to enter or damage the lagoon (flood waters have low velocity and depth less than 150 cm).
4 For an explanation of coarse fragments and stoniness classes, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
5 Surface exposures of non rippable rock are rated poor. If underlying bedrock is impermeable, rating should be one class better.

Table 24. 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]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
k	**Permeability**[2,7]	Rapid to moderately rapid	Moderate	Slow	Very Slow
	Percolation Rate[3] **(Auger hole method)**	8 - 18 min/cm (> 3.3 - 7.5 cm/hr)	> 18 - 24 min/cm (2.5 - 3.3 cm/hr)	> 24 min/cm (< 2.5 cm/hr)	
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**	9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)
d	**Depth to Hard Rock, bedrock or other impervious materials**	> 150 cm	> 100 - 150 cm[6]	50 - 100 cm	< 50 cm

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1 The symbol is used to indicate the property affecting use.
2 The suitability ratings should be related to the permeability of soil layers at and below depth of the graded filter bed (50 - 75 cm depth).
3 Soils having a percolating 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.
7 Contamination hazard (g) may apply at high permeability, e.g. (Gg).

Table 25. Guide for Assessing Soil Suitability for Playgrounds

This guide applies to soils to be used intensively for playgrounds, 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 provide 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]	Property 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 ponding or seepage for short duration and imperfectly drained soils. Water table below 50 cm during season use.	Imperfectly drained soils subject to ponding or seepage, 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**	2% (a, b)	> 2 - 5% (c)	> 5 - 9% (d)	> 9% (e, f, g, h, i, j)
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]	L, VFSL, FSL, SL, LVFS, VFS	SiL, CL, SiCL, SCL, LFS, LS, FS	SiC, C, SC[5], Si, S	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	
n	**Salinity**[9]	EC < 4 mS/cm	EC 4 - 8 mS/cm (s)	EC > 8 - 16 mS/cm (t)	EC > 16 mS/cm (u)

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1 The symbol is used to indicate the property affecting use.
2 See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada 2007).
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 SiC, C and SC soils may be rated fair.
6 Depth to sand or gravel is considered a limitation if the levelling operations 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 property 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.
9 EC = Electrical conductivity (milliSiemens/cm, mS/cm or deciSiemens/m, dS/m).

Table 26. 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]	Property 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 seepage or ponding. Water Table above 50 cm for short periods during season of use	Imperfectly drained soils subject to seepage or ponding. Poorly drained soil. 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**	9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)
s	**Surface Soil Texture**[2,3]	L, VFSL, FSL, SL, LVFS, VFS	SiL, CL, SiCL, SCL, LFS, LS, FS and sand other than loose sand.	SiC, C, SC[4], Si	Peaty soils; loose sand subject to blowing.
c	**Coarse Fragments on Surface**[2]	< 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 exposure roughly > 30 - 100 m or more apart and cover < 10% of the surface.	Rock exposure roughly 10 - 30 m apart and cover 10 - 25 % of the surface.	Rock exposure < 10 m apart and cover > 25% of the surface.	Rock exposure 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.	
n	**Salinity**[9]	EC < 4 mS/cm	EC 4 - 8 mS/cm (s)	EC > 8 - 16 mS/cm (t)	EC > 16 mS/cm (u)

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1 The symbol is used to indicate the property affecting use.

2 See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada 2007). Coarse fragments for the purpose of this rating include gravel 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 SiC, C and SC 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 property 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.

9 EC = Electrical conductivity (milliSiemens/cm, mS/cm or deciSiemens/m, dS/m).

Table 27. 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 tent sites may allow rock exposures greater than 10 m apart to be considered slight limitations.

Symbol[1]	Property 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	Moderately slow and slow	Very slow	
t	**Slope**	9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)
s	**Surface Soil Texture**[2,3]	L, VFSL, FSL, SL, LVFS, VFS	SiL, CL, SiCL, SCL,LFS, LS, FS and sand other than loose sand.	SiC, C, SC[4], Si	Peaty soils: loose sand subject to blowing.
c	**Coarse Fragments on Surface**[2,5]	< 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% or less of the area.	Rock exposures < 10 m apart and cover > 25% of the area.	Rock exposures too frequent to permit campground location.
n	**Salinity**[7]	EC < 4 mS/cm	EC 4 - 8 mS/cm (s)	EC > 8 - 16 mS/cm (t)	EC > 16 mS/cm (u)

Revised 2011

1 The symbol is used to indicate the property affecting use.
2 See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
3 Surface soil texture influences soil rating as it affects foot trafficability, dust, and soil permeability.
4 Moderately well and well drained SiC, C and SC 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.
7 EC = Electrical conductivity (milliSiemens/cm, mS/cm or deciSiemens/m, dS/m).

Table 28. 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]	Property[2] Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	**Texture**[3,4]	L, VFSL, FSL, SL, LVFS, LFS, LS, VFS	CL, SiCL, SiL, SCL	SiC, C, SC[5], Si, FS, S	Peaty soils; loose sand subject to blowing
c	**Coarse Fragment Content**[4,6]	< 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 trials.
t	**Slope**[8]	15% (a, b, c, d, e)	> 15 - 30% (f)	> 30 - 45% (g)	> 45% (h, i, j)
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.

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1 The symbol is used to indicate the property affecting use.

2 The properties 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 (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).

5 Moderately well and well drained SiC, C and SC 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.

Appendix 2 Soil Series Descriptions

Black Lake Series (BCK)

The Black Lake series consists of well drained Cumulic Regosol soils developed on moderately to strongly calcareous, deep stratified, clayey, fluvial deposits. These soils occur in upper positions of gentle slopes on terrace landscapes and have moderately slow permeability, moderate surface runoff and a low to medium water table during the growing season. They have medium to high available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes elm, maple, box elder, cottonwood and some oak. Most of these soils are currently used for agriculture or are in their native treed state and are subject to flooding.

In a representative profile the solum is approximately 15 cm thick. The profile is characterized by a gray, weakly calcareous, silty clay, Ah horizon, 0 to 15 cm thick, with a gray (10YR 5/1dry), weakly calcareous, silty clay, Ck1 horizon, 15 to 30 cm, a gray to light gray, moderately calcareous, silty clay, Ck2 horizon, 30 to 50 cm with silt loam to silty clay loam strata and a brownish gray, moderately calcareous, silty clay, Ck3 horizon 50 to 90 cm. The parent material is typically stratified.

Black Lake soils occur in close association with Seine River and Hodgson soils. They are similar to Hodgson soils by having a similar position and mode of deposition but differ from Hodgson soils because of a heavier texture. Black Lake soils were previously mapped as Riverdale in the Winnipeg-Morris Map Sheet, Report No. 5, 1953.

Dencross Series (DCS)

The Dencross series consists of imperfectly drained Gleyed Rego Black Chernozem soils developed on (<1 m) of moderately to strongly calcareous, shallow clayey, lacustrine, deposits over very strongly to extremely calcareous, silty, lacustrine deposits. These soils occur in mid to upper positions of level to very gentle slopes on level to undulating landscapes and have slow to moderate permeability, slow surface runoff and a medium water table during the growing season. Dencross soils are non to slightly eroded, non stony and may be saline. They have medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes prairie grasses, aspen and willow. The majority of these soils are currently used for crop production.

In a representative profile the solum is approximately 40 cm thick. The profile is characterized by a thin, very dark gray, clay Ah horizon, 15 to 25 cm thick; a moderately calcareous, dark gray, clay, AC horizon, 15 to 20 cm thick; a light gray, clay to silty clay, moderately calcareous, Ckgj horizon, 20 to 30 cm thick and a light olive brown, very strongly calcareous, silt loam to silty clay loam, II Ckgj horizon. The parent material is typically clayey over silty. A typical profile also contains an underlay of clay below the silty strata at or below 1 m.

Dencross soils occur in close association with Hodinott and Red River soils. They are similar to Hoddinott soils by having a silty subsoil but differ from Red River soils which are more uniformly clayey throughout. Dencross soils were previously mapped as, part of the Emerson (heavy) Association in the Morris Map Sheet, Report No. 5, 1953.

Dufresne Series (DFS)

The Dufresne series consists of poorly drained Rego Humic Gleysol soils developed on strongly calcareous, deep stratified, clayey, alluvial deposits. These soils occur in low to depressional positions along stream channels and have slow permeability, very slow surface runoff and a high water table during the growing season. Dufresne soils are usually non-eroded, non-stony and non-saline. They have medium to high available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes sedge, rush and willow. The majority of these soils are currently used for natural grazing and woodland.

In a representative profile the solum is approximately 20 cm thick. The profile is characterized by a thin, dark gray, clay, Ah horizon, 15 to 25 cm thick, with a variable, stratified, strongly calcareous, clay to silty clay mottled Ckg horizon with thin former Ah (buried) horizons in the stratified layers. The parent material is typically stratified clay.

Dufresne soils occur in close association with Seine River soils. They are similar to Seine River soils by having similar textures but differ because of having poorer drainage. Dufresne soils were previously mapped as Riverdale soils in the Winnipeg Map Sheet, Report No. 5, 1953.

Fisherton Series (FHT)

The Fisherton series consists of imperfectly drained Gleyed Dark Gray Chernozem soils developed on strongly calcareous, dominantly moderately fine textured (SCL, CL, SiCL) lacustrine sediments overlying extremely calcareous loamy glacial till within 1 metre. The topography is level to very gently sloping; runoff is moderately slow and permeability is moderately slow. Native vegetation consists dominantly of aspen, white spruce with occasional willow.

The Fisherton soil is weakly degraded and is characterized by a thin dark gray Ahej horizon, 4 to 10 cm thick and a weakly developed Bt horizon. A thin gravel or cobble strata may occur at the contact of the extremely calcareous loamy till. Fine to medium yellowish brown iron mottles may be observed at or below this contact. The chemical and physical properties are similar to the Warren series. Fisherton, clay till variant, (FHT1) is similar to the Fisherton soil, except for the clay till nature of the parent material.

Fort Garry Series (FTY)

The Fort Garry series consists of moderately well drained Orthic Black Chernozem soils developed on thin moderately calcareous, clayey lacustrine sediments over a variable depth of very strongly calcareous silty sediments which overlie moderately calcareous lacustrine clay either within or below a 1 metre depth. The general thickness of the silty sediments is 40 to 75 cm but may vary to depths greater than 1.5 metres. The surface texture is clay. The silty sediments below range in texture from silt loam to silty clay. Topography is very gently to gently sloping; runoff is moderate and permeability is variable in the upper clay and silty layers being dependent on the texture and thickness of the stratified silty sediments. Most of the Fort Garry soils are cultivated; native vegetation consisted dominantly of tall prairie grasses with occasional clumps of aspen and bur oak. The Fort Garry soils are associated with the imperfectly drained, Dencross series and the poorly drained Glenmoor series.

Glenmoor Series (GOO)

The Glenmoor series consists of poorly drained Rego Humic Gleysol soils developed on a thin mantle (< 1 m) of moderately to strongly calcareous, clayey lacustrine deposits over very strongly to extremely calcareous, silty, lacustrine deposits. An underlay of lacustrine clay generally occurs below the silty deposits. These soils occur in low to depressional positions of level to nearly level landscapes and have slow to moderate permeability, very slow surface runoff and a high water table during the growing season. Glenmoor soils are non-eroded, non-stony and may be saline. They have medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes sedges, grasses and willow. With adequate drainage, the majority of these soils are currently used for crop production.

In a representative profile the solum is approximately 10 to 25 cm thick. The profile is characterized by a thin, very dark gray (10YR3/1 dry), weakly calcareous, clay to silty clay A horizon 0 to 22 cm thick. A moderately to very strongly calcareous, olive gray (5Y6/2 dry), silty clay, Ckg horizon 22 to 45 cm and a pale olive to olive, very strongly to extremely calcareous, silt loam to silty clay loam, mottled, II Ckg horizon are also present. The parent material is a silty sediment underlain by a clayey substrate.

A Glenmoor, peaty phase consists of soils with similar profile characteristics to the Glenmoor series, but have a thick organic layer at the surface which ranges from 15 to 40 cm. The Glenmoor soils occur in close association with Dencross soils which are imperfectly drained. Glenmoor soils were previously mapped as part of the Fort Garry association in the Winnipeg Map Sheet, Report No. 5, 1953.

Hoddinott Series (HDN)

The Hoddinott series consists of imperfectly drained Gleyed Black Chernozem soils developed on a thin clayey strata over a very strongly to extremely calcareous silty lacustrine strata, which vary in thickness from 20 to 75 cm and in turn overlies calcareous clay. The surface texture may vary from clay loam to clay. The topography is level to very gently sloping; runoff is slow; and permeability is moderately slow in the upper clay strata, and variable from moderately rapid to slow in the silty strata due to the variability of the silt content, stratification and thickness. Permeability of the underlying clay is slow. Native vegetation consisted of tall prairie grasses and dispersed clumps of aspen and willow.

The soil is characterized by a dark granular Ah horizon 12 to 20 cm thick and a dark grayish brown Bmgj horizon 10 to 18 cm thick. The structure is medium prismatic to fine granular. The solum is developed in the upper clay strata with an abrupt change at the extremely calcareous silty strata, although some tonguing of the clay into the silty strata may be noted. Hoddinott soils occur in close association with Dencross and Glenmoor soils. They were previously mapped as the Blackearth-Meadow associate of the Emerson (heavy) association in the Winnipeg-Morris Report No. 5, 1953.

Hodgson Series (HDG)

The Hodgson series consists of moderately well drained Cumulic Regosol soils developed on

strongly to very strongly calcareous stratified dominantly medium to moderately fine textured (VFSL, L, SiL to SCL, CL SiCL), alluvial deposits. These soils occur on the upper parts of the floodplain and levees. The topography is ridged, with gentle to steep short slopes. Runoff is moderate, and permeability varies from moderate to slow depending on the texture of the layers. Native vegetation consists principally of elm, ash, basswood, hazel, rose, forbs and grasses.

The soil is characterized by a thin, weakly developed dark gray to gray Ah horizon 5 to 15 cm thick which is fine granular, friable, neutral to mildly alkaline and may contain lime carbonate. The underlying material is stratified, strongly calcareous and may contain dark colored bands representing former surface layers. These soils occur in close association with Fisher soils and are difficult to separate in levee-dominated units. The chemical and physical analysis of the Hodgson soil is similar to the Fisher soil.

Lakeland Series (LKD)

The Lakeland series consists of imperfectly drained Gleyed Rego Black Chernozem soils developed on moderately to extremely calcareous, dominantly fine loamy sediments. Surface textures range from loam to clay loam and occasionally silty clay. The topography is level to very gently sloping; runoff is slow; and permeability is moderate to moderately slow. The native vegetation consists of meadow grasses with clumps of willow. In some areas, there is an upward flow of groundwater containing soluble salts. Where the salt content in the rooting zone is sufficient to affect crop growth, the Lakeland slightly saline phase is mapped. Lakeland soils like most soils developed on extremely calcareous parent material have shallow soil profiles. The thin 15 to 25 cm very dark gray Ah horizon is granular, and usually moderately to strongly calcareous. This horizon is usually separated from the pale yellow, extremely calcareous Ckgj horizon by a thin (15 to 20 cm) transitional, AC or Cca layer that is usually very strongly calcareous.

Lakeland, slightly saline phase consists of soils with similar profile characteristics as the Lakeland series, except they have an appreciable quantity of soluble salts within the rooting zone of plants to affect crop growth. The salts are dominantly magnesium sulfate and gypsum. These soils were formerly mapped as the imperfectly drained Blackearth-Meadow associates of the Emerson (silty clay loam) Association in the Winnipeg-Morris Report No. 5, 1953.

Morris Series (MRS)

The Morris series consists of imperfectly drained Gleyed Solonetzic Black Chernozem soils developed on moderately to strongly calcareous fine textured (C, HC) lacustrine deposits. They occur on level to very gently sloping topography usually adjacent to or intermediate between poorly drained Osborne clay soils and the imperfectly drained Red River or Scanterbury clay soils. Runoff is moderately slow to slow; permeability is very slow and restricted by the columnar and fine subangular blocky to massive, high swelling B horizons.

In the virgin state, these soils are characterized by a shallow dark gray to gray Ah or Ahej horizon 5 to 8 cm thick, a dark gray to gray columnar Bnjgj1 horizon 10 to 15 cm thick and an amorphous dark gray to black, waxy Bnjgj2 horizon that breaks into coarse subangular blocky peds. Gypsum may be present in the olive gray to grayish brown weakly mottled Ckgj horizon.

Under cultivation, most of the columnar Bnjgj1 horizon is incorporated with the Ap horizon. In the moist condition, the Ap is sticky and massive and breaks under pressure into weak, medium to fine granular peds; in the dry condition, the Ap is cloddy and hard, and breaks with difficulty into coarse clods or rounded blocks. The Morris soils occur in close association with the Red River, Scanterbury and Osborne soils. They were previously mapped as the alkalinized associate of the Red River Association in the Winnipeg-Morris Report No. 5, 1953.

Myrtle Series (MYT)

The Myrtle series consists of well to moderately well drained Orthic Black Chernozem soils developed on moderately to strongly calcareous, clayey (SiC, C, HC) lacustrine deposits. The surface texture ranges from silty clay to clay. The topography is very gently to gently sloping; runoff is moderate; and permeability is moderate in the solum due to granular structure, but moderately slow to slow at greater depths.

The Myrtle soil is characterized by a deep dark gray Ah horizon 30 to 45 cm thick, with friable fine granular structure, a dark brown to dark grayish brown Bm horizon, 25 to 40 cm thick, with moderate medium prismatic breaking to medium granular structure. The Ck horizon is light brownish gray to pale brown and has a pseudo-subangular blocky structure. The Myrtle soil is differentiated from the Scanterbury soil by a deeper, friable Ah horizon, brighter chroma in the B horizon and lack of any mottles in the B or upper part of the Ck horizon. The chemical and physical analyses of the Myrtle soil are similar to the Scanterbury series.

Osborne Series (OBO)

The Osborne series consists of poorly drained Rego Humic Gleysol soils developed on moderately to strongly calcareous, deep uniform, clayey (C, HC), lacustrine deposits. These soils occur in lower to depressional positions of level to nearly level landscapes and have very slow permeability, slow to very slow surface runoff and a high water table during the growing season. Osborne soils are non-eroded, non-stony and may be saline. They have high available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes meadow grasses, reeds, sedges and willow. Most of these soils are currently used for crop production and have improved surface drainage.

In a representative profile the solum is approximately 30 cm thick. The profile is characterized by a very dark gray, noncalcareous, clay, Ap horizon, 15 to 20 cm thick, with a thin transitional, dark gray to olive gray weakly calcareous AC horizon, 8 to 10 cm thick and an olive gray, moderately to strongly calcareous, clayey, mottled Ckg horizon. The parent material is typically a uniform clayey lacustrine deposit.

Osborne soils occur in close association with Red River, Morris and Scanterbury soils. They are similar to these soils by having developed on the same parent material but differ because of poorer drainage. Osborne soils were previously mapped as Osborne clay in the Winnipeg-Morris Map Sheet, Report No. 5, 1953.

Red River Series (RIV)

The Red River series consists of imperfectly drained Gleyed Rego Black Chernozem soils developed on moderately to strongly calcareous, deep, uniform, clayey (C, HC), lacustrine deposits. These soils occur in level to upper positions of level to very gentle slopes on level landscapes and have slow permeability, slow to moderate surface runoff and a medium water table during the growing season. Red River soils are non-eroded, non-stony and may be saline. They have a high available water holding capacity, medium organic matter content, and medium natural fertility. The majority of these soils are currently used for crop production.

In a representative profile the solum is approximately 30 cm thick. The profile is characterized by a black, to very dark gray, clayey Ap horizon, 15 to 20 cm thick, a very dark gray, clayey Ah horizon, 8 to 10 cm thick, a thin, dark gray, calcareous, clay, AC horizon, 6 to 10 cm thick and a dark grayish brown, calcareous, clay Ckgj horizon with faint mottles are present. The parent material is typically a clay texture. A typical profile contains frequent tonguing of the A horizon into the C horizon.

Red River soils occur in very close association with Scanterbury, Morris and Osborne soils. They are similar to the above soils by having developed on the same parent material but differ because of drainage and profile development. Red River soils were previously mapped as the Red River Association in the Winnipeg-Morris Map Sheet, Report No. 5, 1953.

Scanterbury Series (SCY)

The Scanterbury series is a Gleyed Black Chernozem soil developed on imperfectly drained, moderately to strongly calcareous, clayey (SiC, C, HC), lacustrine deposits. These soils occur on level to very gently sloping topography on the Red River Plain in association with Red River, Morris and Osborne soils. Surface runoff is slow and permeability is very slow. The tall prairie and prairie-meadow grasses once found associated with these soils have been mostly replaced by cultivated fields.

The Scanterbury soil profile has a very dark gray Ah horizon, 15 to 30 cm thick that frequently tongues through the B horizon; a very dark gray to dark grayish brown Bmgj horizon, 12 to 40 cm thick; a very dark grayish brown BC, 10 to 15 cm thick, and an olive gray calcareous Ckgj horizon with many, fine, faint mottles. This soil differs from the similar Plum Coulee soil series in having more uniform textures in the subsoil. It differs from Red River soils in having a prominent Bmgj horizon. Scanterbury, Red River and Morris soils are usually found together in such close and intricate association with each other that all three can occur in the same field. Scanterbury soils were part of the Red River Association in the Winnipeg-Morris Map Sheet, Report No. 5, 1953.

St. Norbert Series (SOR)

The St. Norbert series consists of moderately well to well drained Orthic Dark Gray Chernozem soils developed on moderately calcareous, fine textured (SiC, C) lacustrine and alluvial deposits. They occur on the well drained upper slope of the floodplain. They have moderate runoff, and moderately slow to slow permeability. The native vegetation is dominantly bur oak, with some maple, elm, aspen, herbs, and grasses.

The soils are characterized by a thin leaf mat 2 to 3 cm thick, a granular, gray Ahe 5 to 8 cm thick, a coarse prismatic, dark gray Btj 30 to 60 cm thick, and an olive gray clay Ck horizon.

Seine River Series (SRE)

The Seine River series consists of imperfectly drained Gleyed Cumulic Regosol soils developed on moderately to strongly calcareous, clayey alluvial deposits. They occur mainly on the intermediate position between the river bed and upper levees of the Assiniboine, La Salle, Rat, Red and Seine Rivers. They are subject to seasonal flooding during the spring runoff period; otherwise they have moderate runoff, and moderately slow to slow permeability. The native vegetation consists of Manitoba maple, elm, ash, basswood and native grasses.

The soil is characterized by a thin partially decomposed leaf mat 2 to 4 cm thick, and a variable dark gray Ah horizon of 3 to 6 cm thick; the Ckgj horizon has a variable texture of silty clay to clay and may have thin former Ah horizons in the stratified layers below. In the upper slope positions these soils may have weak development of an Ah and Bm horizon grading to the Scanterbury or Myrtle series. This soil was mapped as the immature alluvial soil of the Riverdale Association in the Winnipeg-Morris Map Sheet, Report No. 5, 1953.

Appendix 3 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. See pH and Reaction, soil.

Alkali soil - (i) A soil having a high degree of alkalinity (pH of 8.5 or higher), or having a high exchangeable sodium content (15 % or more of the exchangeable capacity), or both**.** (ii) A soil that contains enough alkali (sodium) to interfere with the growth of most crop plants.

Alkaline soil - A soil having a pH greater than 7. See pH and Reaction, soil.

Alluvium - A general term for all deposits of rivers and streams. Sediments can be different sizes depending upon the location in the floodplain of the river.

Arable soil - Soil suitable for plowing and cultivation.

Association - A sequence of soils of about the same age, derived from similar parent material, and occurring 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 at field capacity for loam textured soils.

Atterberg limits - See **liquid limit** and **plastic limit**.

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

Available water - The portion of water in a soil that can be readily absorbed by plant roots: generally considered to be that water held in the soil against a pressure of up to approximately 15 atmospheres. See also **field capacity** and **wilting point**.

Bearing capacity - Capacity of soil (in moist to wet conditions) to support loads such as buildings, people, vehicles, and animals. The average load per unit area that is required to rupture a supporting soil mass.

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

Blocky structure - Aggregates arranged with faces rectangular and flattened, vertices sharply angular.

Bog - A peat-covered or peat-filled area, generally nutrient-poor, in which mosses and especially sphagnum are dominant. The water table is at the surface for most of the year.

Boulders - Rock fragments larger than 60 cm (2ft) in diameter.

Brunisolic - An order of soils whose horizons are developed sufficiently to exclude the soils from the Regosolic order, but that lack the degrees or kinds of horizon development specified for soils of the other orders.

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 (1N) 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:

non-calcareous. . . . . .< 1%
weakly calcareous. . . . . 1 - 5%
moderately calcareous. . . . . 6 - 15%
strongly calcareous. . . . . .16 - 25%
very 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. It is expressed in milliequivalents per 100g of soil.

Channery - A descriptive term used for thin and flat limestone, sandstone, or schist fragments up to 15 cm (6 inches) in length.

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

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 clay, less than 45 % sand and less than 40 % silt.

Clod - A compact, coherent mass of soil produced by digging or plowing. Clods usually slake easily with repeated wetting and drying.

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

Cobbles - Rock fragments 8 to 25 cm (3 to 10 inches) 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.

Columnar structure - Having prism-like aggregates with vertical edges near the top of columns, not sharp.

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

Concretion - Hard grains, pellets or nodules from concentration of chemical compounds, such as calcium carbonate or iron oxide, in the soil that cement soil grains together.

Conductivity, electrical - A physical quantity that measures the readiness with which a medium (irrigation water and soil extracts) transmits electricity. It expresses the concentration of salt in terms of the conductance (reciprocal of the electric resistance in ohms) in milliSiemens per cm (mS/cm) or deciSiemens per meter (dS/m).

Consistence (soil) - The mutual attraction of the particles in a soil mass, or their resistance to separation or deformation. Terms such as loose, soft, friable, firm, hard, sticky, plastic or cemented are used to describe consistence at various soil moisture contents.

Consumptive use factor (CU) - The ratio of consumptive use of water by a crop to potential evapo-transpiration 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 evapo-transpiration.

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:

(i) Vegetation or other material providing protection; (ii) In forestry, low growing shrubs and herbaceous plants under trees (i.e., ground cover vs. tree cover); (iii) 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.

Crotovina - A former animal burrow in one soil horizon that has become filled with organic matter or material from another horizon. It is also spelled “krotovina”.

Crust - A surface layer of soil, from a few millimetres to 2.5 cm (1 inch) thick, that when dry is much more compact, hard, and brittle than the soil material below.

Cryic layer - A perennially frozen layer.

Cryosolic - An order of mineral or organic soils that have permafrost either within 1 m of the surface or within 2 m if the soil has been strongly cryoturbated laterally within the active layer, as indicated by disrupted, mixed, or broken horizons.

Cryoturbation - Frost action, including frost heaving.

Cultivation - Tillage to prepare land for seeding or transplanting, and later to control weeds and loosen the soil.

Decile portion - A one-tenth portion. As used in the soil map symbol A^7- B^3 means that soil A soil covers seven tenths and soil B covers three tenths of the map unit.

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.

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

Deposit - Material left in a new position by a natural transporting agent such as water, wind, ice, or gravity, or by the activity of man.

Dispersion - Is rated high, moderate or low depending on how readily the soil structure breaks down or slakes because of excess moisture. A rating of high indicates that soil aggregates slake readily; a rating of low indicates that aggregates are resistant to dispersion and remain clumped together.

Drainage (soil) - (i) The rate and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (ii) 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 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 pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity 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 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 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 equalled by losses. Soil horizons are usually bright colored. These soils are usually free of mottles within 100 cm of the surface but may be mottled below this depth.

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 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 the main source, flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the 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. Poorly drained soils have a wide range in available water storage capacity, texture, and depth.

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. These soils have a wide range in available water storage capacity, texture, and depth.

Drained phase - Soils with extensive surface or subsurface (tile) drainage improvements.

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

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

Dunes - Wind-built ridges and hills of sand formed in the same manner as snowdrifts.

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.

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

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.

Exchange acidity - The amount of hydrogen and aluminium that can be replaced from the adsorption complex by a neutral salt solution. It is usually expressed as milli-equivalents per 100 g of soil (meq/100 g soil).

Exchangeable sodium percentage - The extent to which the adsorption complex of a soil is occupied by sodium. It is expressed as:

$$ESP = \frac{\text{exchangeable sodium (meq/100 g soil)}}{\text{cation exchange capacity (meq/100 g soil)}} \times 100.$$

Extract, soil - The solution separated from a soil suspension or from a soil by filtration, centrifugation, suction, or pressure.

Fen - A peat-covered or peat-filled area, generally not acidic, in which grasses, sedges, or reeds are dominant. The water table is at the surface for most of the year.

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

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.

Field capacity - The percentage of water remaining in the soil 2 or 3 days after the soil has been saturated and free drainage has practically ceased. It is also defined as the maximum amount of water that will normally be held in the soil and be useful to plants. The percentage may be expressed in terms of weight or volume.

Fifteen - atmosphere percentage - The percentage of water contained in a soil that has been saturated, subjected to, and is in equilibrium with, an applied pressure of 15 atm. Pressure is applied in a pressure membrane or ceramic pressure plate apparatus. This moisture content approximates the permanent wilting point of a soil.

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

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

Fragipan - A natural subsurface horizon having a higher bulk density than the solum above; seemingly cemented when dry, but showing moderate to weak brittleness when moist.

Friable - A consistence term pertaining to soil aggregates that are soft and easily crushed between thumb and forefinger.

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

Glacio-fluvial 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.

Glacial-lacustrine deposits - Silt and clay sediments formed in the quiet waters of lakes that received meltwater from glaciers.

Glacial outwash -Well sorted sand, or sand and gravel, deposited by meltwater from a glacier.

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.

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

Granular structure - The arrangement of soil particles into spheroidal aggregates characterized by rounded vertices.

Ground moraine - An unsorted mixture of rocks, boulders, sand, silt and clay deposited by glacial ice. The predominant material is till; most 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 ablation. 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 hills and enclosed depressions.

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

Grumic - Very fine textured soils with self-mulching horizons (A and B), that occur in the Chernozemic, Gleysolic, and Solonetzic orders. Redefined as vertic features in 1998, Third Edition of the Canadian System of Soil Classification.

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

Heavy soil - A soil having a high content of fine particles, particularly clay, or a soil having a high drawbar pull and therefore hard to cultivate.

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 soil forming processes. It differs from adjacent layers in properties such as color, structure, texture, consistence, and chemical, biological and mineralogical composition.

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	Form
abrupt - less than 2 cm	smooth - nearly plain
clear - 2 to 5 cm	wavy - pockets are wider than deep
gradual - 5 to 15 cm	irregular - pockets are deeper than wide
diffuse - more than 15 cm	broken - parts of the horizon are unconnected with other parts

Humic - Highly decomposed organic soil material; small amounts of fibre are present that can be identified as to their botanical origin. Fibres are easily destroyed by rubbing.

Humus - The fraction of the soil organic matter that remains after most of the added plant and animal residues have decomposed. It is usually dark colored.

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. The classes are described in general or specific terms as:

High	> 15 cm/hr
Medium	0.5 -15 cm/hr
Low	< 0.5 cm/hr

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.

Hydromorphic soil - A general term for soils that develop under conditions of poor drainage in marshes, swamps, seepage areas, or flats.

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 as a layer of accumulation.

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

Impervious - Resistance to penetration by fluids or roots.

Inclusion - Soil type (series) 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.

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

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

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).

Land classification - The arrangement of land units into various categories based on the properties of the land or its suitability for some particular purpose.

Landforms - The various shapes of the land surface resulting from a variety of actions such as deposition or sedimentation. Mineral landforms are described by terms such as apron, blanket, fan, hummocky, level, pitted, ridged, rolling, terrace, undulating, veneer, inclined and steep.

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

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

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

Hummocky - A very complex sequence of slopes extending from somewhat rounded depression or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls and depressions. Slopes are generally 5 to 70% (3 to 35º).

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% (1º).

Pitted - A level to gently undulating surface containing a number of pits or hollows.

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

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

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

Undulating - A very regular sequence of gentle slopes that extend from rounded, sometimes 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 slope gradient is 2 to 5% (1 to 3º).

Veneer - Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer ranges from 10 cm to 1 m in thickness and possesses no form typical of the materials' genesis.

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

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

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

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

Lime, agricultural - A soil amendment consisting principally of calcium carbonate, and including magnesium carbonate and perhaps other materials. It is used to supply calcium and magnesium as essential elements for growth of plants and to neutralize soil acidity.

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 l.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 field moisture equivalent) to the shrinkage limit.

Lithic phase - Soils having a lithic contact (consolidated bedrock) within the control section below a depth of 10 cm.

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

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 dominantly with sedges, cattails, rushes or other hydrophytic plants. The waters are rich in nutrients, varying from fresh to highly saline.

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

Mesic - Organic material in an intermediate stage of decomposition; intermediate amounts of fibre are present that can be identified as to their botanical origin.

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 (meq) - 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.

Mineral soil - A soil consisting predominantly of, and having its properties by mineral matter. It contains less than 17 % organic carbon except for an organic layer that may be up to 40 cm (16 inches) thick if formed from mesic and humic peat or 60 cm (24 inches) if of fibric peat.

Monolith, soil - A vertical section of a soil profile removed from the soil and mounted for display or study.

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.

Neutral soil - A soil in which the surface layer, to plow depth, is neither acid nor alkaline in reaction.

Organic carbon - Carbon derived from plant and animal residues.

Organic - An order of soils that have developed dominantly from organic deposits. The majority of Organic soils are saturated for most of the year, unless artificially drained. They contains more than 17 % organic carbon and the organic layer must extend be up to 40 cm (16 inches) if formed from mesic and humic peat or 60 cm (24 inches) if of fibric peat.

L, F, and H - These organic horizons developed primarily from the accumulation of leaves, twigs and woody materials with or without a minor component of mosses. They are normally associated with upland forested soils with imperfect drainage or drier conditions.

Organic matter - The fraction of the soil which consists of plant and animal residues at various stages of decomposition, cells and tissues of soil organisms and substances synthesized by the soil population. It is determined on soils that have been sieved through a 2.0 mm sieve. It is estimated by multiplying the organic carbon by a factor of 1.72.

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 to 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 to 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 to 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 to 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 to 35% clay in the fine earth fraction.

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 to 35% clay in the fine earth fraction.

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

Fine-clayey - A clayey particle size that has 35 to 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.

Peat - Soil material consisting largely of undecomposed, or slightly decomposed organic matter.

Peaty phase - Any mineral soil having a surface horizon 15 to 60 cm thick of fibric organic material or 15 to 40 cm of mesic or humic organic material.

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 dealing with the origin, morphology, genesis, distribution, mapping, 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 - (i) Perennially frozen material underlying the solum. (ii) 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. See hydraulic conductivity.

pH - The intensity of acidity and alkalinity, expressed as the negative logarithm of the hydrogen ion concentration. A pH of 7 is neutral, lower values indicate acidity and higher values alkalinity (see Reaction, soil).

Phase, soil - A soil phase is used to characterize soil and landscape properties that are not used as criteria in soil taxonomy. The major phase components are: erosion, slope, stones, salinity, texture, deposition, 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 in moisture content within which a soil exhibits plastic properties.

Platy structure - Consisting of soil aggregates that have developed predominantly along the horizontal axes; laminated; flaky.

Podzolic - An order of soils having B horizons (Bh, Bhf, Bf) in which amorphous combinations of organic matter, Al, and usually Fe are accumulated.

Pore space - The part of the bulk volume of soil not occupied by soil particles. Interstices or voids.

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.

Prismatic structure - A soil structure type having prism-like aggregates that have vertical axes longer than the horizontal axes.

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

Reaction, soil - The degree of acidity or alkalinity of a soil, usually expressed as a pH value.

Soil reaction classes are characterized as follows:

	pH value
extremely acid	<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
neutral	6.6 to 7.3
mildly alkaline	7.4 to 7.8
moderately 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.

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

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 that contains enough soluble salts to interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 millisiemens/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
weakly saline	4 to 8 mS/cm
moderately saline	8 to 16 mS/cm
strongly saline	>16 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 - (i) A soil particle between 0.05 and 2.0 mm in diameter. (ii) Any one of five soil separates: very coarse sand, coarse sand, medium sand, fine sand, or very fine sand. The textural class name for any soil containing 85 percent or more of sand and not more than 10 percent of clay.

Saturation extract - The extract from a soil sample that has been saturated with water.

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

Seepage - (i) The escape of water downward through the soil. (ii) 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.

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 - (i) Individual mineral particles of soil that range in diameter between 0.05 to 0.002 mm. (ii) Soil of the textural class silt contains greater than 80 percent silt and less than 12 percent clay.

Single-grained structure - A soil structure in which the soil particles occur almost completely as individual or primary particles. It is usually found in coarse (sandy) textured soils.

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

Sodic soil - (i) A soil containing sufficient sodium to interfere with the growth of most crop plants. (ii) A soil having an exchangeable-sodium percentage of 15 or more.

Sodium-Adsorption Ratio (S.A.R.) - A ratio for soil extracts and irrigation waters used to express the relative activity of sodium ions in exchange reactions with other cations in the soil. $SAR = Na/((Ca+Mg)/2)^{1}/^{2}$ where the concentrations are expressed as milli-equivalents 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.

Solonetzic - An order of soils thought to have developed from parent materials that were more or less uniformly salinized with salts high in sodium. The soils have a stained brownish solonetzic B (Bnt or Bn) horizon and a saline C horizon.

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

Stones - Rock fragments greater than 25 cm (10 inches) in diameter.

Stoniness - The percentage of land surface occupied by stones. The classes of stoniness are defined as follows:

Stones 0, non-stony - Land having less than 0.01 % of surface occupied by stones.

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

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

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

Stones 4. exceedingly stony - Land having 15 to 50 % of surface occupied by stones. Stones 15 to 30 cm in diameter and 0.7 to 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 to 30 cm in diameter and 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 % 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. 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.

Structure, soil - The combination or arrangement of primary soil particles into aggregates of secondary soil particles, units or peds, which are separated from each other by surfaces of weakness. Structure is expressed in terms of grade, size class and shape type. Grade refers to the distinctness of aggregate development, and is described as structureless, weak, moderate or strong. Structureless refers to the absence of observable aggregation of definite orderly arrangement; the term amorphous is used if soil is massive or coherent, single-grained if noncoherent. The weak to strong aggregates vary in size and are described by class as fine, medium, coarse, and very coarse depending on the shape types. The shape types refer to the dominant configuration of the aggregates and the way they are accommodated. The general shape types are plate-like, block-like and prism-like. The terms are:

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

Prismatic - Having prism-like aggregates with tops and edges, appear plane, level and somewhat angular.

Columnar - Having prism-like aggregates with vertical edges near the top of columns, not sharp.

Granular - Having block-like aggregates that appear as spheroids or polyhedrons having plane or curved surfaces which have slight or no accommodation to the faces of the surrounding peds.

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. In the parent material of soils the material with structural shapes may be designated as pseudo-blocky, pseudo-platy, etc.

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

Subangular blocky structure - Having block-like aggregates with rounded and flattened faces and rounded corners.

Sulfate Hazard - Refers to the relative degree of attack on concrete by soil and water containing various amounts of sulfate ions. It is estimated from electrolyte measurements and salt analysis on selected profiles and soil samples, and by visual examination of free gypsum within the profile during the course of soil investigation.

Swamp - A mineral wetland or peatland with standing water or water gently flows through pools or channels. The watertable is usually at or near the surface. The vegetation is characterized by a cover of deciduous or coniferous trees or shrubs, herbs, and some mosses.

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.

Name of separate	**Diameter (mm)**
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	< 0.002
Fine clay	< 0.0002

Textural Classes

Sand - Sand is a soil material that contains 85% or more sand; the percentage of silt, plus 1.5 times the percentage of clay does not exceed 15.

Coarse sand - 25% or more very coarse and coarse sand, and less than 50% any other one grade of sand.

(Medium) Sand - 25% or more very coarse, coarse, and medium sand (but less that 25% very coarse and coarse sand), and less that 50% of either fine or very fine sand.

Fine sand - 50% or more fine sand, or less than 25% very coarse, coarse, and medium sand and less that 50% very fine sand.

Very fine sand - 50% or more very fine sand.

Loamy sand - Loamy sand is a soil material that contains at the upper limit 85 to 90% sand, and the percentage of silt plus 1.5 times the percentage of clay is not less than 15; at the lower limit it contains not less than 70 to 85% sand, and the percentage of silt plus twice the percentage of clay does not exceed 30.

Loamy coarse sand - 25% or more very coarse and coarse sand, and less that 50% any other one grade of sand.

Loamy sand - 25% or more very coarse, coarse, and medium sand (but less that 25% very coarse and coarse sand), and less that 50% fine or very fine sand.

Loamy fine sand - 50% or more find sand, or less than 50% very fine sand and less than 25% very coarse, coarse, and medium sand.

Loamy very fine sand - 50% or more very fine sand.

Sandy loam - Sandy loam is a soil material that contains either 20% clay or less, with the percentage of silt plus twice the percentage of clay exceeding 30, and 52% or more sand; or less than 7% clay, less that 50% silt, and 43 to 52% sand.

Coarse sandy loam - 25% or more very coarse and coarse sand and less than 50% any other one grade of sand.

(Medium) Sandy loam - 30% or more very coarse, coarse, and medium sand (but less than 25% very coarse and coarse sand), and less than 30% of either very fine or fine sand.

Fine sandy loam - 30% or more fine sand and less than 30% very fine sand; or between 15 to 30% very coarse, coarse, and medium sand; or more than 40% fine and very fine sand, at least half of which is fine sand, and less that 15% very coarse, coarse and medium sand.

Very fine sandy loam - 30% or more very fine sand, or more than 40% fine and very find sand, at least half of which is very fine sand, and less that 15% very coarse, coarse, and medium sand.

Loam - Loam is a soil material that contains 7 to 27% clay, 28 to 50% silt, and less than 52% sand.

Silt loam - Silt is a soil material that contains 50% or more silt and 12 to 27% clay, or 50 to 80% silt and less than 12% clay.

Silt - Silt is a soil material that contains 80% or more silt and less than 12% clay.

Sandy clay loam - Sandy clay loam is a soil material that contains 20 to 35% clay, less than 28% silt, and 45% or more sand.

Clay loam - Clay loam is a soil material that contains 27 to 40% clay and 20 to 45% sand.

Silty clay loam - Silty clay loam is a soil material that contains 27 to 40% clay and less than 20% sand.

Sandy clay - Sandy clay is a soil material that contains 35% or more clay and 45% or more sand.

Silty clay - Silty clay is a soil material that contains 40% or more clay and 40% or more silt.

Clay - Clay is a soil material that contains 40% or more clay, less that 45% sand, and less that 40% silt.

Heavy clay - Heavy clay is a soil material that contains more that 60% clay.

In addition to these thirteen basic soil textural classes, three of which are modified according to the predominant sand fraction, other modifiers are added. The word "mucky" is used as an adjective modifying the textural class name for horizons of mineral soils, especially of Humic Gleysols, that contain 15 to 30% organic matter (9 to 17% organic carbon).

Rock fragments in the soil are also used to modify the textural class name. These are gravel, cobbles, stones, and boulders (see the descriptions of these size classes). The adjective form of the rock fragment class name is used as a modifier according to the following rules:

Less than 15% by volume: No special term is used; or "non-gravelly" and "non-stony" are used in writing for contrast with soils having more that 15% pebbles, cobbles, stones, or boulders.

15 to 35% by volume: The adjective term of the dominant kind of rock fragment is used as a modifier of the textural terms: "gravelly loam", "stony loam", "bouldery loam".

35 to 60% by volume: The adjectival term of the dominant kind of rock fragment is used with the word "very" as a modifier to the textural terms: "very gravelly loam", "very bouldery loam".

More than 60% by volume: If enough fine earth is present to determine the texture class (approximately 5 percent or more by volume) the adjectival term of the dominant kind of rock fragment is used with the word "extremely" as a modifier of the textural terms: "extremely gravelly loam", "extremely bouldery loam". If there is too little fine earth to determine the texture class (less than about 5% by volume) the terms "gravel", "cobbles", "stones", and "boulders" are used in the place of fine earth texture.

Table 29. Soil Textural Groups and Soil Texture Classes

Texture Group		Texture Class	Texture Class Symbol
Coarse	**Very Coarse**	Very coarse sand	VCoS
		Coarse sand	CoS
		Medium sand	S or MS
	Coarse	Fine sand	FS
		Loamy coarse sand	LCoS
		Loamy sand	LS or LMS
		Loamy fine sand	LFS
	Moderately Coarse	Very fine sand	VFS
		Loamy very fine sand	LVFS
		Coarse sandy loam	CoSL
		Sandy loam	SL or MSL
		Fine sandy loam	FSL
Medium	**Medium**	Very fine sandy loam	VFSL
		Loam	L
		Silt loam	SiL
		Silt	Si
Fine	**Moderately Fine**	Sandy clay loam	SCL
		Clay loam	CL
		Silty clay loam	SiCL
	Fine	Sandy clay	SC
		Silty clay	SiC
		Clay	C
	Very Fine	Heavy clay (>60 %)	HC

Figure 1. Soil Texture Triangle

Till, glacial - Unstratified glacial drift deposited by ice and 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 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.

Slope Class	Slope Name	Percent slope	Approximate degrees
1	level	0 - 0.5	0
2	nearly level	0.5 - 2.5	0 .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 table depths	(cm)
Generally High	< 100
Very High	0 - 50
Moderately High	250 - 100
Medium High	100 - 150
Generally Low	> 150
Medium Low	150 - 200
Low	> 200
Moderately Low	200 - 300
Very Low	> 300

Water-holding capacity - The ability of a soil to hold water against the force of gravity in a freely drained soil.

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

Wilting point - The moisture content of a soil at which plants wilt and fail to recover their turgidity when placed in a dark, humid atmosphere. The wilting point is commonly estimated by measuring the 15-atmosphere moisture content of a soil.

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

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