Soils of the Municipality of Hamiota

Report No. D93 2013

Canada

Growing Forward

Manitoba

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Part 1 General Description of the Study Area

1.1 Location and Extent

The Rural Municipality (RM) of Hamiota is located in the western part of the province south of Riding Mountain National Park. It is bordered by the RM of Miniota to the west, the RM of Blanshard on the east, the RM of Shoal Lake to the north and the RM of Woodworth to the south. It is situated about 50 km west of Minnedosa or 85 km northwest of the city of Brandon. The largest centre is the Town of Hamiota. Others include Oakner, Decker and McConnell. The RM of Hamiota covers an area of 6 townships or 58,050 hectares (143,433 acres). It covers Townships 13, 14 and 15 of Range 23W and 24W as seen in Map 1.

This report contains soil resource information and maps at a scale of 1:50,000 for an area formerly covered in the reconnaissance survey (1:126,720) of the Rossburn and Virden Map Sheet Areas, Report No. 6, 1956.

1.2 Landscape and Surface Deposits

The study area is located entirely in the Newdale Plain subsection of the Saskatchewan Plain. It is characterized by an undulating to hummocky ground moraine with numerous potholes, sloughs and intermittent lakes. Several pockets of Marringhurst association soils are located along channels east and south of the town of Hamiota.

The area is underlain by Cretaceous shale of the Riding Mountain formation. However, the transportation of rock fragments by glacial movement resulted in surface deposits which included material from other rock formations to the east and north of the map area. These materials included sandstones, shales, limestone and granitic rocks and result in some areas of the municipality covered in mixed materials.

The dominant soil material – glacial till – is a mixture of cobbles, gravel, sand, silt and clay that is derived from shale, limestone and granitic origins. The glacial parent material determines the surface texture, drainage, relief and natural fertility of the soils. Calcareous and saline phases of the soils are common. Stones are present in various quantities but are not often a hindrance to agricultural production.

The principle relief and drainage features in the RM of Hamiota are shown in Map 2. The maximum relief is about 75 metres ranging from 480 m asl at the southwest corner of the municipality to 550 m asl at the north of the municipality. Lowest elevations of 480 m asl occur near Hop Lake in the southwest.

Surface drainage of the municipality is provided by a sparse network of creeks and intermittent streams. Those flowing southeast are tributary to Oak River which flows south to the Assiniboine River, and those flowing southwest make their way to the Assiniboine River either directly, or via the Arrow River.

Surficial topography over the area is very gently to gently sloping, with moderate to steep slopes found along channels and river banks. The variation in relief and the hummocky landscape break up the field pattern and limit agricultural use of the land.

Surface drainage ranges from well drained to poorly drained. Poorer drainage exists in depressional areas where natural sloughs, potholes, intermittent lakes and ponding can occur. Soil drainage reflects a combination of surface runoff as well as internal flow through the soil profile.

1.3 Soils

Soil materials are dominantly moderately to strongly calcareous, loamy morainal till of limestone, granite and shale origin or lacustrine deposits (<1 metre) on top of morainal till. These materials account for the majority of the hummocky knoll and depression landscape. Areas of deep, loamy lacustrine deposits or local areas of sandy outwash are also present, often along small channels and streambeds.

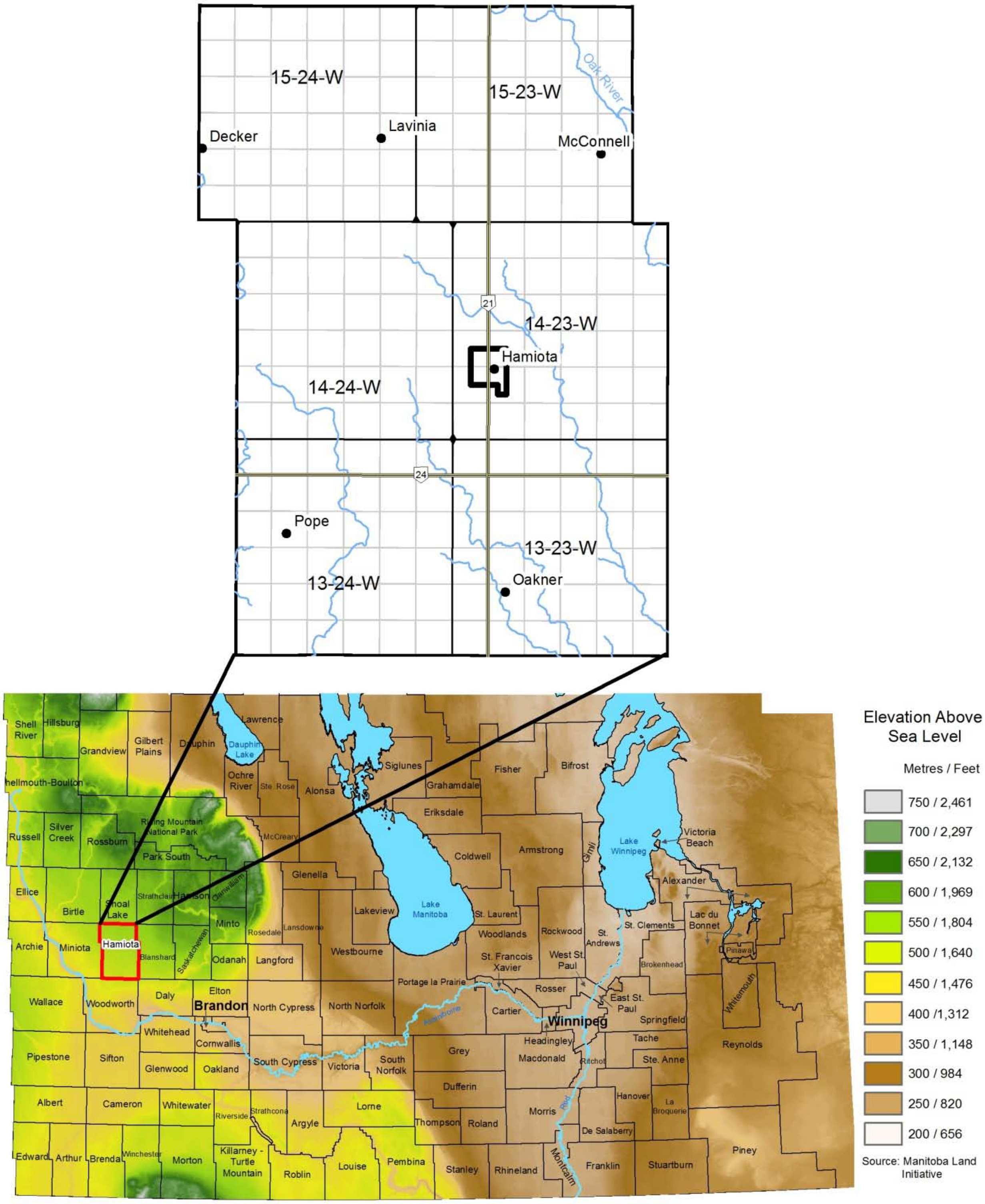
Soils are predominantly classified as Black Chernozems, with Humic Gleysols (poorly drained) found in depressional areas. The majority of the Black Chernozem soils are well drained with areas of imperfectly drained soil on lower slopes.

The loamy morainal till soils are of the Newdale association and cover the majority of the study area. This association consists of three well drained soils (Newdale – Orthic Black Chernozem, Cordova – Calcareous Black Chernozem and Rufford – Rego Black Chernozem), three imperfectly drained soils (Varcoe – Gleyed Rego Black Chernozem, Moore Park – Gleyed Black Chernozem and Angusville – Gleyed Eluviated Black Chernozem) and three poorly drained soils (Drokan – Rego Humic Gleysol, Hamiota – Orthic Gleysol and Penrith – Humic Luvic Gleysol).

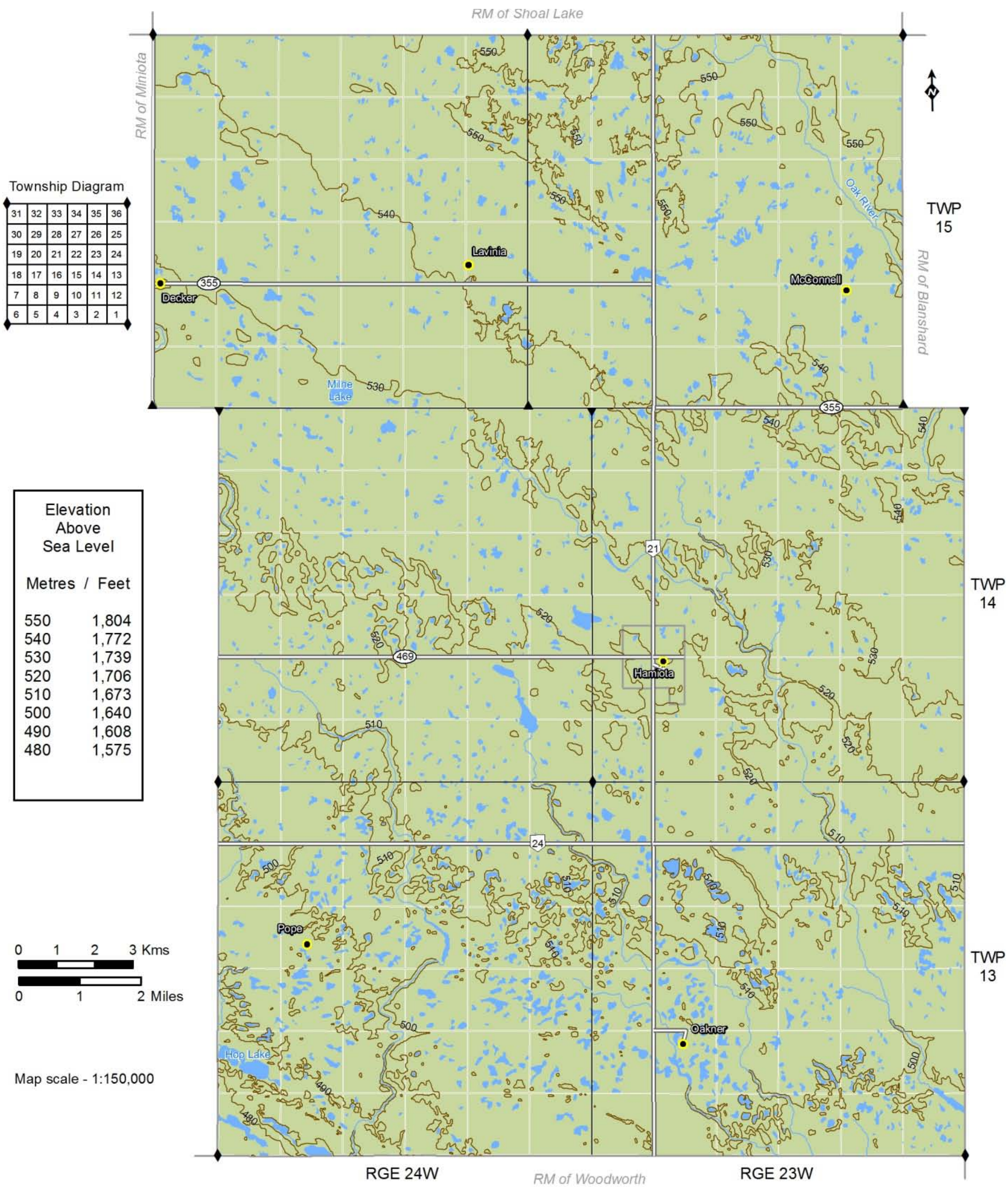
Clay loam lacustrine soil overlying glacial till are also present in the Hamiota area. There are three well drained soils (Clementi – Orthic Black Chernozem, Kleysen – Calcareous Black Chernozem and Chambers – Rego Black Chernozem), one imperfectly drained soil (Beresford – Gleyed Rego Black Chernozem) and one poorly drained soils (Vodroff – Rego Humic Gleysol) in this soil association.

Also present in significant quantities are soils developed on alluvium (recently deposited material), mainly of two soil types; imperfectly drained (Levine – Gleyed Cumulic Regosol) and poorly drained (Basker – Rego Humic Gleysol). As well, sand and gravel outwash areas include two well drained soils (Marringhurst – Calcareous Black Chernozem and Floors – Rego Black Chernozem). A small portion of the study area is covered in Marsh Complex or open water. These poorly drained areas are permanent or semi-permanent and unavailable for agricultural use.

Map 1. Location of Study Area: Rural Municipality of Hamiota



Map 2. Relief and Drainage of the RM of Hamiota



Part 2 Methodology

2.1 Mapping and Map Scale

Detailed soil mapping at a 1:50,000 scale (approx. 2 cm equals one km or 1.25 inches equals 1 mile) was completed for the RM of Hamiota. Approximately 9 inspections per section of land or 1 soil inspection per 28 hectares (1 site per 70 acres) were conducted and soil profiles were examined to a depth of one metre. Sites selected were expected to describe the representative soils and drainage characteristics of the immediate area. Additional sites were examined in complex areas to assist in locating boundaries between soil series or soil phases.

Boundaries delineating the various soil series are completed by digitizing using Geographic Information Systems (GIS) and 3-dimensional viewing software.

2.2 Map Units

The information from soil inspection sites forms 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 soils or non-soils plus a certain proportion of unnamed and un-described 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. Some examples of a non-soil include water or bedrock.

2.3 Simple and Compound Map Units

There are two major types of map units: simple and compound. The difference between a simple and 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 between 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 frequently desirable to indicate a condition or quality of soil property or landscape feature that deviates significantly from the normal definition of the map unit using a map unit symbol. These variations or phases of soil properties and landscape features, varying from delineation to delineation, significantly affect soil behaviour, land management and land 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 identified in the map unit below the soil series symbol are erosion, slope class, degree of stoniness and salinity. The degree or magnitude of each is designated in Figure 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 Figure 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, an x is used in its appropriate designated location in the map symbol (Figure 1).

An example of a compound unit is as follows: 70 percent consists of Newdale (NDL^7) series having no erosion (x), very gently sloping topography (c), no stones at the surface (x), no salinity (x), and 30 percent Varcoe (VRC^3) series having no erosion (x), very gently sloping topography (c), no stones (x) and no (x) salinity (Figure 1).

2.5 Sampling

Selected surface and subsurface soil samples were collected and analyzed for texture (particle size), pH, organic carbon, electrical conductivity (EC) and calcium carbonate content. Soil cation exchangeable capacity (CEC) was also determined in detailed soil profile samples.

The laboratory analyses used to determine soil characteristics are:

Calcium carbonate: Calcimeter using 1M HCl
CEC: Ammonia electrode
EC: Saturated paste
pH: 2:1 water to soil ratio
Organic carbon: Walkley-Black method
Particle size: Pipette method

Figure 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

NDLp
xb2x

Variant/Phase Symbol(s)*

d = drained phase
p = peaty phase
v = very poorly drained variant
1 = textural variant

*Variants/Phases 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 class of xxxx (The denominator shown in the above example is referred to as the ‘class’)

Compound Map Units

(Contain up to 3 soils or non-soils)

NDL[4] – VRC[3] – DRO[3]
xc2x xc2x xb3s

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

NDL[7]-VRC[3]
xcxx
← 2 Soil Series with the same class

NDL[7]-VRC[3] ← 2 soil series, both with a class 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. Soil development is related to the regional climate and the degree of leaching, translocation and accumulation of soluble and colloidal fractions of the soil. Soil drainage also plays a significant role in soil development. Soils in the RM of Hamiota have developed under a cool sub-humid boreal climate in the trasitional area between Blackearth soils and Grey Wooded soils. There is sufficient moisture and heat for development of aspen-oak groves, tall prairie grasses and associated herbs. Consequently, the majority of soils in the area are Chernozemic soils.

3.2 Classification

Soils in the study area are classified according to the Canadian System of Soil Classification (SCWG, 1998). 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 effects of the 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 conformity to the central concept of the great group ex. Orthic intergrades toward soils in other orders, ex. Gleyed or special features such as 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 Table 1. Table 2 shows the soil series that are found in the RM of Hamiota, the proportion of the area that they cover and their major descriptive characteristics. Detailed descriptions of each soil series can be found in Appendix 2.

Table 1-1. Relationship between Soil Series, Soil Drainage, Mode of Origin, Parent Material and Soil Classification

Soil Drainage	Classification	Lacustrine							Lacustrine over Outwash			Outwash	Alluvium	
		Coarse (FS, LS, LFS)	Mod. Coarse (VFS, LVFS, FSL)	Medium (VFSL, L, SiL, Si)	Mod. Fine (SCL, CL, SiCL)	Fine (SC, SiC, C)	Medium over Coarse	Mod. Fine over Coarse	Coarse over outwash	Mod. Coarse over outwash (VFS, LVFS, SL, FSL)	Medium to Mod. Fine over outwash	Sand and Gravel	Medium to Mod. Fine (VFSL, L, SiL, CL, SiCL)	Fine (SiC, C)
Well to Mod. Well Drained	Orthic Regosol	Arizona (AIZ)	Brownridge (BWD)	Knolls (KLS)	Barren (BAE)									
	Cumulic Regosol												Mowbray (MOW)	Manson (MXD)
	Orthic Black Chernozem	Stockton (SCK)	Prosser (PSE)	Fairland (FND)	Ramada (RAM)	Janick (JIK)	Glenboro (GBO)	Wellwood (WWD)	Wheatland (WHL)	Miniota (MXI)	Croyon (CYN)	Dorset (DOT)		
	Calcareous Black Chernozem			Traverse (TAV)	Rempel (RMP)							Marringhurst (MRH)		
	Rego Black Chernozem	Cactus (CCS)	Porple (POR)	Durnan (DRN)	Carroll (CXF)	Bankton (BAO)					Zarnet (ZRT)	Floors (FLS)		
	Orthic Dark Gray Chernozem	Dobbin (DOB)	Halstead (HAT)	Pollen (POL)	Firdale (FIR)									
Imperfectly Drained	Gleyed Cumulic Regosol												Levine (LEI)	Assiniboine (ASB)
	Gleyed Black Chernozem	Lavenham (LVH)	Gateside (GTD)	Torcan (TOC)	Charman (CXV)	Harding (HRG)	Petrel (PTR)	Oberon (OBR)	Hughes (HGH)	Wytonville (WVI)	Druxman (DXM)	Dexter (DXT)		
	Gleyed Eluviated Black Chernozem				Gregg (GRG)									
	Gleyed Rego Black Chernozem	Hummerston (HMO)	Pleasant (PLE)	Taggart (TGR)	Prodan (PDA)	Sigmund (SGO)	Grover (GRO)	Crookdale (CKD)	Gendzel (GDZ)	Kilmury (KUY)	Capell (CXT)	Mansfield (MFI)		
	Gleyed Dark Gray Chernozem		Bone (BNE)		Danlin (DLN)									
Poorly Drained	Rego Humic Gleysol	Sewell (SEE)	Poolex (POX)	Vordas (VDS)	Tadpole (TDP)	Lowton (LWN)	Grayson (GYS)	Sutton (SXP)	Lowry (LOW)	Bornett (BOR)	Carvey (CAV)	Fortina (FTN)	Basker (BKR)	Kerran (KRN)
					Tadpole, peaty (TDPp)		Grayson, peaty (GYSp)	Sutton, peaty (SXPp)				Fortina, peaty (FTNp)	Basker, peaty (BKRp)	

Table 1-2. Relationship between Soil Series, Soil Drainage, Mode of Origin, Parent Material and Soil Classification

Soil Drainage	Classification	Lacustrine and fluvial materials over glacial till					Glacial Till		Shaly Till	Lacustrine over Fluvial over Glacial till
		Fine (SiC, C)	Mod. Fine (SCL, CL, SiCL)	Mod. Coarse (VFS, LVFS, FSL)	Coarse (FS, LS, LFS)	Very Coarse (Sand & Gravel)	Mod. Fine (SCL, CL, SiCL) Mixed Till	Loamy Extr. Calc. Till	Medium to Mod. Fine Shaly Till	(L, SiL, CL, SiCL) over Sand & Gravel over Mixed Till
Well to Moderately Well drained	Orthic Regosol		Roddan (ROD)							
	Orthic Black Chernozem	Everton (EVO)	Clementi (CLN)	Lockhart (LKH)	Kirkness (KKS)		Newdale (NDL)	Hilton (HIT)	Lenore (LNO)	Jaymar (JAY)
	Eluviated Black Chernozem									
	Calcareous Black Chernozem		Kleysen (KYS)			Chater (CXW)	Cordova (CVA)			Dogand (DGA)
	Rego Black Chernozem		Chambers (CBS)				Rufford (RUF)	Bermont (BMN)		
Imperfectly Drained	Gleyed Black Chernozem	Justice (JUC)	Cobfield (CBF)				Moore Park (MPK)			
	Gleyed Calcareous Black Chernozem						Lavinia (LAV)			
	Gleyed Eluviated Black Chernozem						Angusville (ANL)			Longdens (LGD)
	Gleyed Rego Black Chernozem	Forrest (FRT)	Beresford (BSF)	Lindstrom (LDM)	Killeen (KLL)	Barager (BAA)	Varcoe (VRC)	Barwood (BWO)		Melland (MXT)
Poorly Drained	Orthic Gleysol						Hamiota (HMI)			
	Rego Humic Gleysol	Fenton (FET)	Vodroff (VFF)	Lonery (LOE)			Drokan (DRO)	Hickson (HKS)		Marsden (MDN)
	Humic Luvic Gleysol						Penrith (PEN)			

Table 2. Soils of the Study Area

Soil code	Soil name	Drainage	Surface texture	Textural group of soil profile	Total area		% of RM
					ha	ac	
ANL	Angusville	Imperfect	Loam	Medium	2435.4	6018.1	4.2
BAA	Barager	Imperfect	Loamy sand	Coarse	4.0	10.0	0.01
BKR	Basker	Poor	Silty clay loam	Moderately Fine	157.9	390.2	0.3
BSF	Beresford	Imperfect	Clay loam	Moderately Fine	647.0	1598.7	1.1
CAV	Carvey	Poor	Clay loam	Moderately Fine	14.3	35.3	0.02
CBS	Chambers	Well	Clay loam	Moderately Fine	4.9	12.0	0.01
CCS	Cactus	Well	Loamy fine sand	Coarse	16.0	39.5	0.003
CLN	Clementi	Well	Clay loam	Moderately Fine	203.6	503.1	0.4
CVA	Cordova	Well	Clay loam	Moderately Fine	1931.2	4772.0	3.3
CXW	Chater	Well	Loamy sand	Coarse	110.2	272.2	0.2
DOT	Dorset	Rapid	Loamy coarse sand	Coarse	13.4	33.2	0.02
DRO	Drokan	Poor	Clay loam	Moderately Fine	6672.8	16488.9	11.5
FET	Fenton	Poor	Silty clay	Fine	126.6	312.8	0.2
FLS	Floors	Well	Gravelly sandy loam	Coarse	95.2	235.2	0.2
HMI	Hamiota	Poor	Clay loam	Moderately Fine	193.8	478.8	0.3
KKS	Kirkness	Well	Loamy fine sand	Coarse	7.4	18.2	0.01
KYS	Kleysen	Well	Clay loam	Moderately Fine	220.1	544.0	0.4
LEI	Levine	Imperfect	Clay loam	Moderately Fine	56.7	140.2	0.1
LKH	Lockhart	Well	Fine sandy loam	Moderately Coarse	0.4	1.1	0.001
LWN	Lowton	Poor	Clay	Fine	8.0	19.8	0.01
MDN	Marsden	Poor	Loam	Medium	92.9	229.5	0.2
MPK	Moore Park	Imperfect	Clay loam	Moderately Fine	175.9	434.6	0.3
MRH	Marringhurst	Well	Sandy loam	Moderately Coarse	27.8	68.8	0.05
MXI	Miniota	Well	Sandy loam	Moderately Coarse	13.7	33.7	0.02
MXT	Melland	Imperfect	Clay loam	Moderately Fine	56.5	139.7	0.1
NDL	Newdale	Well	Clay loam	Moderately Fine	24314.4	60082.0	41.9
PEN	Penrith	Poor	Loam	Medium	207.1	511.7	0.4
RUF	Rufford	Well	Clay loam	Moderately Fine	8762.3	21652.0	15.1
TDP	Tadpole	Poor	Clay loam	Moderately Fine	6.0	14.9	0.01
VFF	Vodroff	Poor	Clay loam	Moderately Fine	698.9	1727.1	1.2
VRC	Varcoe	Imperfect	Clay loam	Moderately Fine	10067.2	24876.5	17.4
$MH	Marsh	Very Poor	Loam	Medium	133.3	329.3	0.2
$UL	Unclassified land	-			38.9	96.2	0.1
$UR	Urban land	-			138.8	342.9	0.2
$ZZ	Water	-			349.9	864.7	0.6
Total	-	-	-	-	**143443.3**	**58049.8**	**100**

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. Single factor maps and interpretive 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 soil map and related soil analysis and landscape information was used to generate these colour thematic maps.

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 soil capability for agriculture and irrigation suitability.

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) (Appendix 1, Section A).

The class indicates the general suitability of the soils for agriculture. There are seven possible classes. 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.

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 Appendix 1, Section B.

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. They may also be subject to salinity or inundation.

Class 4 soils present a severe restriction to the growth of crops or choice of crops. The timing of cultivation or choice of crops is severely limited.

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

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

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

A summary of agriculture capability as affected by soil characteristics and landscape is shown in Table A1 of Appendix 1.

In the Rural Municipality of Hamiota, the majority of the soils (79.9%) fall into Class 2 due to topography (T) or wetness (W) (Table 3). Nearly four percent of the soil is Class 3. Class 5 soils comprise 14.5% of the municipality. Minor amounts of Class 1 (0.04%), Class 4 (0.45%) and Class 7 (0.23%) cover the rest of the area.

The most limiting factors in Class 2 lands are topography (2T=56.9%) and excess water (2W=19.5%). Soils described as Class 3 and Class 4 are not very abundant, but salinity, topography, moisture limitation and inundation are contributing factors. Class 5 soils are predominantly caused by excess water (5W=13.8%) and Class 7 soils are marsh land (Table 3).

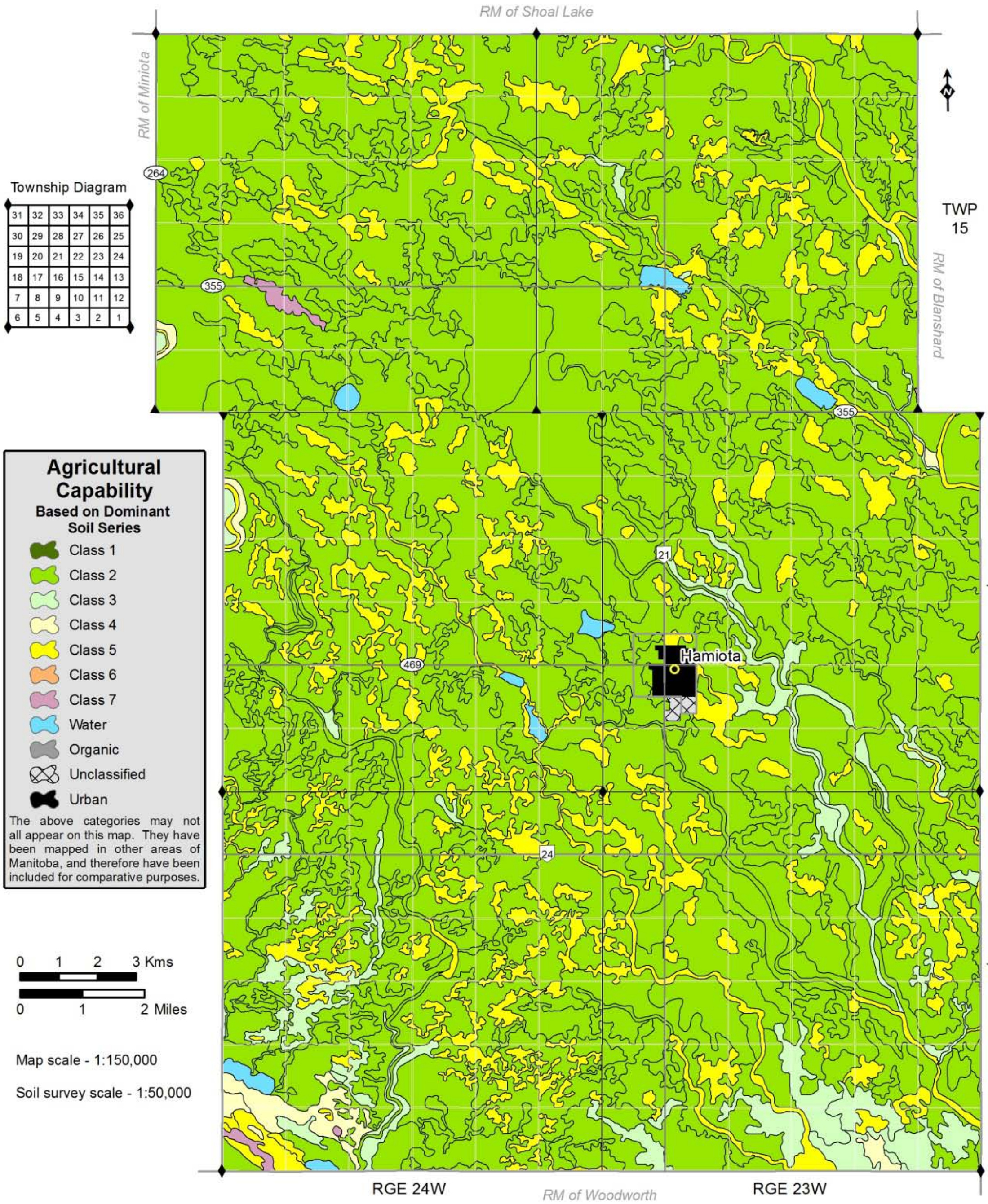
An interpretive map (Map 3) illustrates the rating of the dominant soil series and landscape features for each polygon. The nature of the subclass limitations and the rating of sub-dominant soil and landscape components are not shown at the scale of this map. However, subdominant soil components and the nature of the subclass limitations are indicated in Table A2 of Appendix 1.

A poster-sized agriculture capability map (1:50,000) is included with this report.

Table 3. Agriculture Capability in the RM of Hamiota

Agricultural Capability Class		Total area ac	Total area ha	% of RM
1		63	25	0.04
2 (79.9)	2M	124	50	0.09
	2MT	17	7	0.01
	2T	81,585	33,016	56.92
	2TE	365	148	0.25
	2W	27,962	11,316	19.51
	2WT	3,009	1,218	2.10
	2X	1,503	608	1.05
3 (3.9)	3I	115	47	0.08
	3IN	25	10	0.02
	3M	18	7	0.01
	3N	1,861	753	1.30
	3T	2,418	978	1.69
	3TE	1,165	471	0.81
4 (0.45)	4M	83	34	0.06
	4N	96	39	0.07
	4T	403	163	0.28
	4TE	64	26	0.04
5 (14.5)	5IW	390	158	0.27
	5M	519	210	0.36
	5ME	90	37	0.06
	5W	19,819	8,020	13.83
7 (0.23)	7W	329	133	0.23
Water/urban/ unclassified		1,304	528	0.91

Map 3. Agriculture Capability in the RM of Hamiota



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.

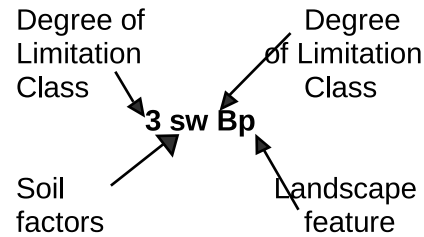
Soil properties considered important for evaluating irrigation suitability are: texture, soil drainage, depth to water table, salinity and geological uniformity.

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 an 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 and landscape feature are 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 A3 of Appendix 1). The guidelines for soil and landscape properties are listed in Table A4 and A5 of Appendix 1 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 (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 (Appendix 1, Table A3).

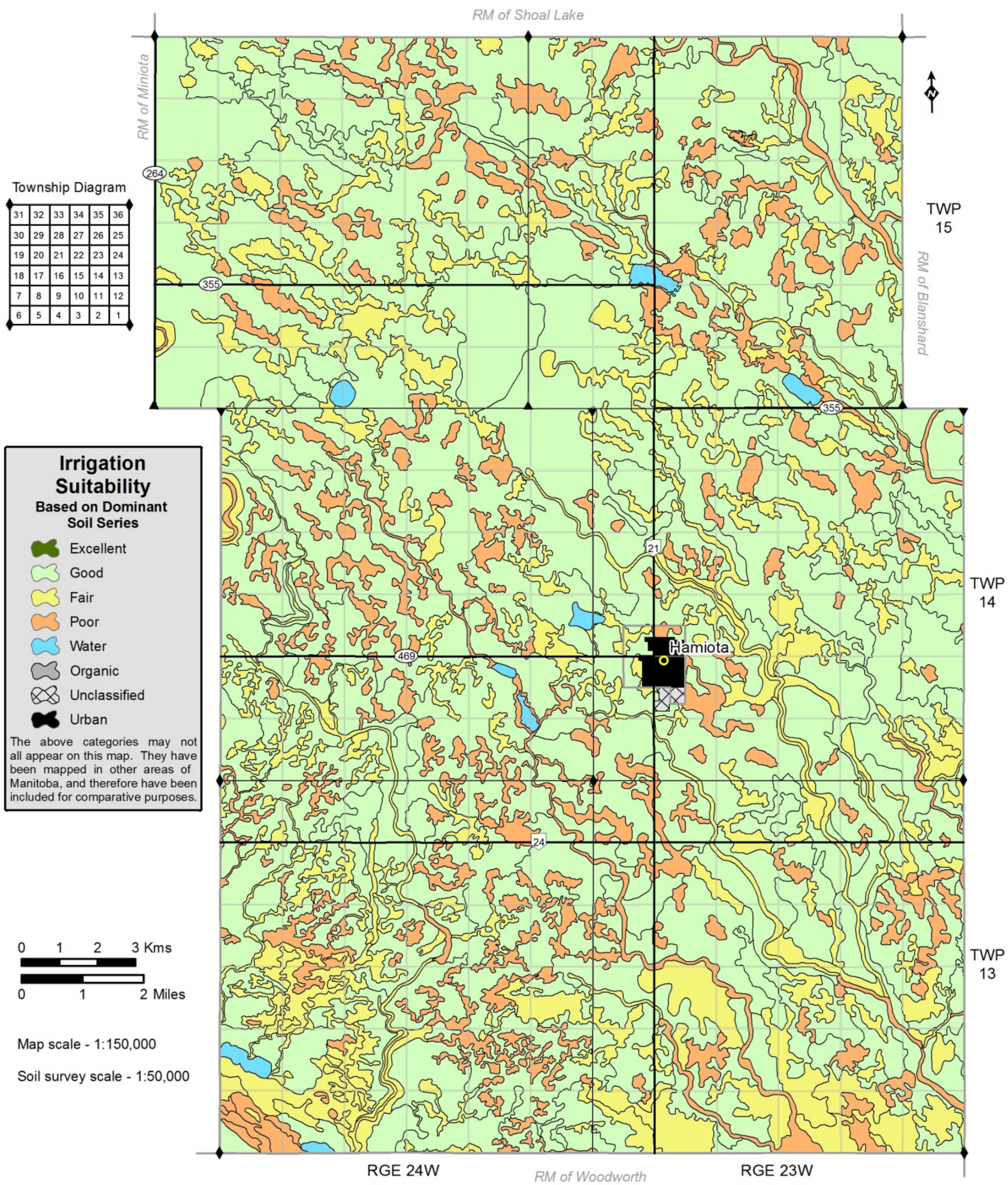
A summary of soils and their irrigation suitability rating is provided in Table 4. Land in the RM of Hamiota falls into 3 irrigation suitability classes; good (58.3%), fair (25.9%) and poor (14.8%). None of the area is excellent for irrigation due to the rolling topography of the landscape and the texture of the soil.

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

Table 4. Irrigation Suitability of Soils in the RM of Hamiota

Irrigation class	Total area		% of RM
	ac	ha	
Excellent	0	0	0.00
Good	83,569	33819.3	58.31
Fair	37,200	15,054	25.95
Poor	21,254	8,601	14.83
Organic	0	0	0.00
Water/urban/ unclassified	1,304	528	0.91

Map 4. Irrigation Suitability in the RM of Hamiota



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. The most suitable soil and landscape conditions occur in **Class 1** and the least desirable conditions occur in **Class 5**. Details regarding the criteria applied in the suitability rating are described in Tables A6 and A7 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, 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.

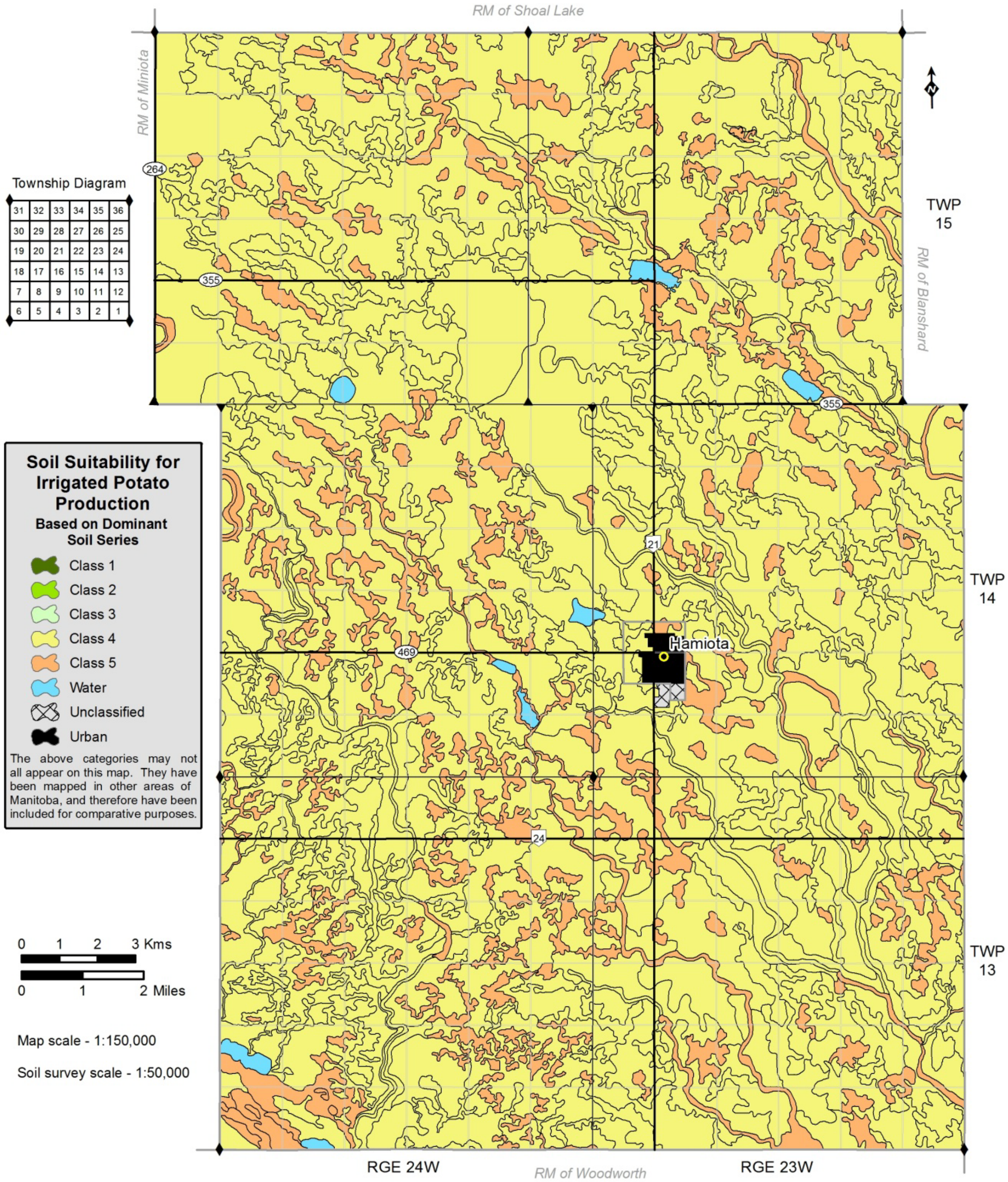
An interpretive map (Map 5) illustrates the rating of the dominant soil and landscape feature for each soil polygon. The nature of the subclass limitations and the rating of subdominant soil and landscape components are not shown at this scale.

In the RM of Hamiota, 83.7% of the land falls into Class 4 for irrigated potato production and 15.3% into Class 5 (Table 5). Most of the land is unsuitable for potato production. This is mainly due to unsuitable topography and soil drainage.

Table 5. Soil Suitability for Irrigated Potato Production in the RM of Hamiota

Potato Suitability Class	Total Acres	Total Hectares	% of RM
Class 1	0	0	0.00
Class 2	0	0	0.00
Class 3	152	62	0.11
Class 4	119,920	48,530	83.67
Class 5	21,950	8,883	15.31
Water/urban/ unclassified	1,304	528	0.91

Map 5. Soil Suitability for Irrigated Potato Production in the RM of Hamiota



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 2). The presence of larger particles (diameter is greater than 2mm) 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 5 cm in diameter

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

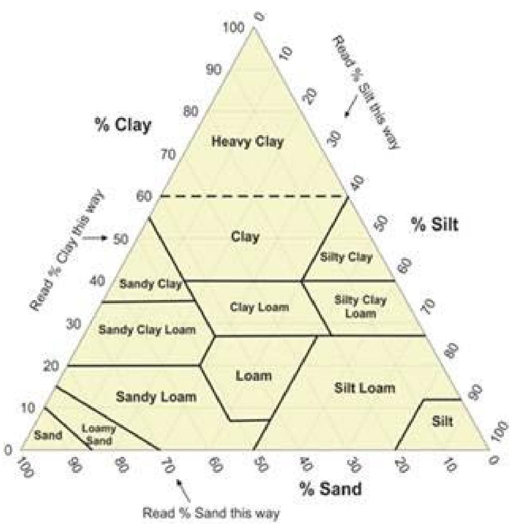


Figure 2. Soil Texture Triangle

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 are grouped as coarse, medium and fine (Table 6).

Table 6. Soil Texture Group

Texture group		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
	Med. 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	Mod. 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

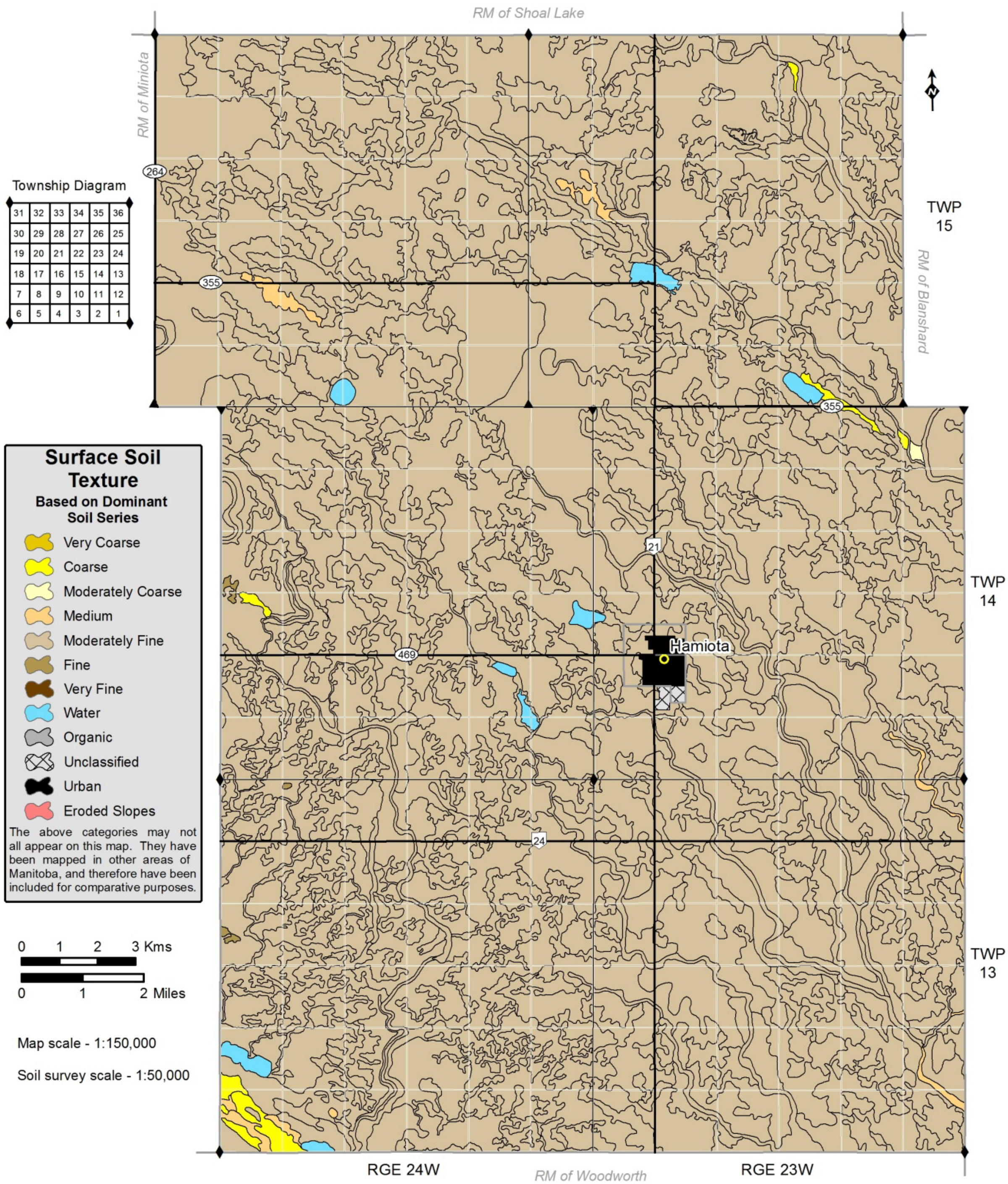
The parent material and therefore surface texture of soils in the RM of Hamiota is fairly uniform. 93.4% of the area has a moderately fine surface texture. This is a function of the morainal till parent material and the mixture of rock formations that it is derived from. The texture groups and the proportions that are present in the RM of Hamiota are shown in Table 7.

Surface soil texture shown in Map 6 illustrates the textural group of the dominant soil for each polygon.

Table 7. Soil Texture Group in the RM of Hamiota

Texture Group	Total area ac	Total area ha	% of RM
Very Coarse	0	0	0.00
Coarse	677	274	0.47
Moderately Coarse	35	14	0.02
Medium	7,089	2,869	4.95
Moderately Fine	133,890	54,184	93.42
Fine	333	135	0.23
Very Fine	0	0	0.00
Organic	0	0	0.00
Water/urban/ Unclassified	1,304	528	0.91

Map 6. Surface Soil Texture in the RM of Hamiota



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 majority of the time that the soil is not frozen. Excess water is present in the soil throughout most of the year.

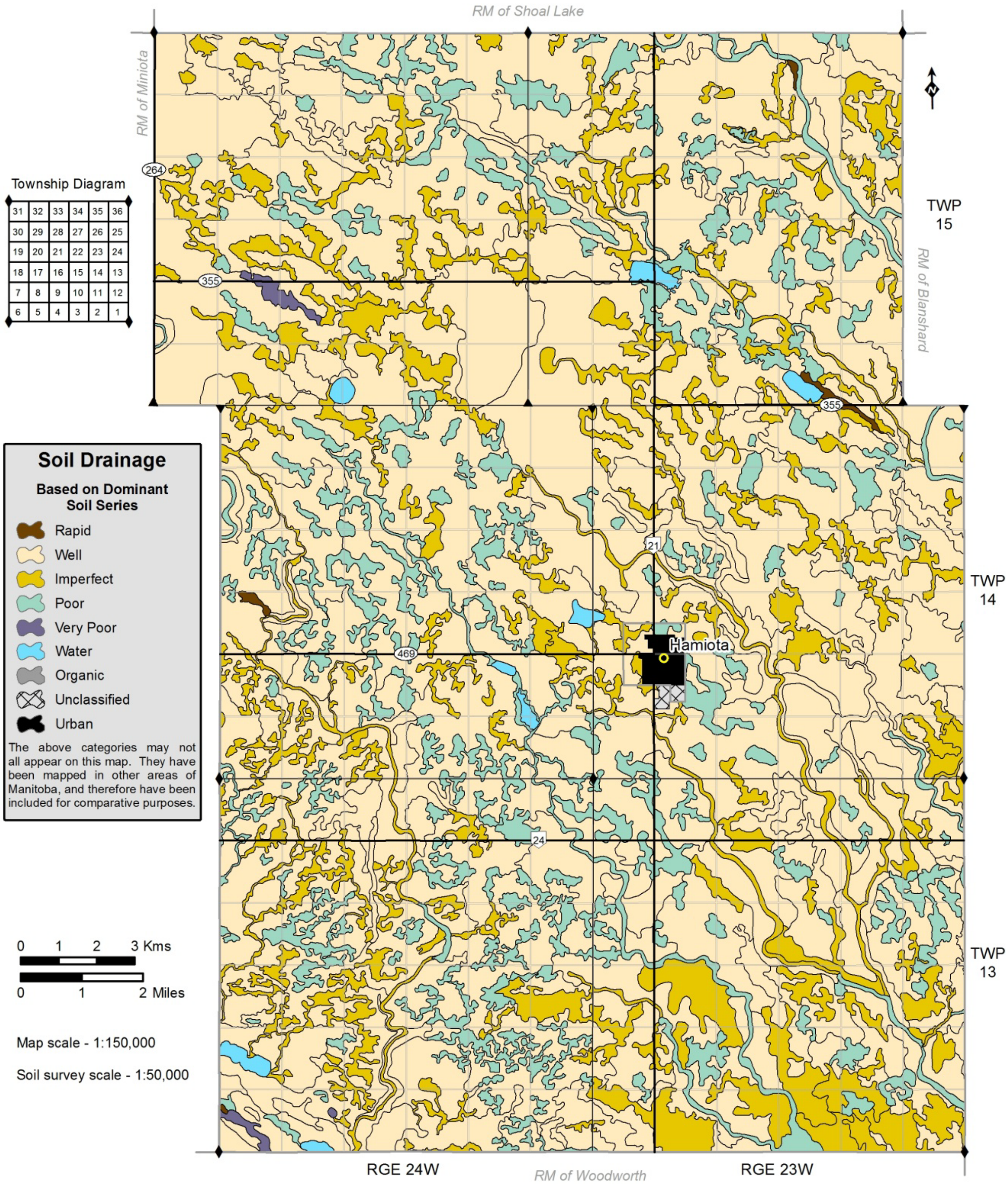
Soil drainage shown in Table 8 indicates that over 61% of the soils in the RM of Hamiota are well drained. Imperfectly drained soils cover 23% of the area and over 14% of the soils are poorly or very poorly drained.

The soil drainage map (Map 7) indicates that soils with each drainage condition can be found throughout the RM of Hamiota. The drainage map shows only the dominant soil for each polygon. Drainage conditions vary substantially in the second or third soils of a polygon.

Table 8. Soil Drainage in the RM of Hamiota

Drainage Class	Total area		% of RM
	ac	ha	
Rapid	337	136	0.24
Well	87,930	35,584	61.35
Imperfect	33,218	13,443	23.18
Poor	20,209	8,178	14.10
Very Poor	329	133	0.23
Water/urban/ unclassified	1,304	528	0.91

Map 7. Soil Drainage in the RM of Hamiota



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 are usually least apparent in the landscape but they are often the most damaging since they cause 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 can 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.

The severity of soil erosion is described by the following 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.

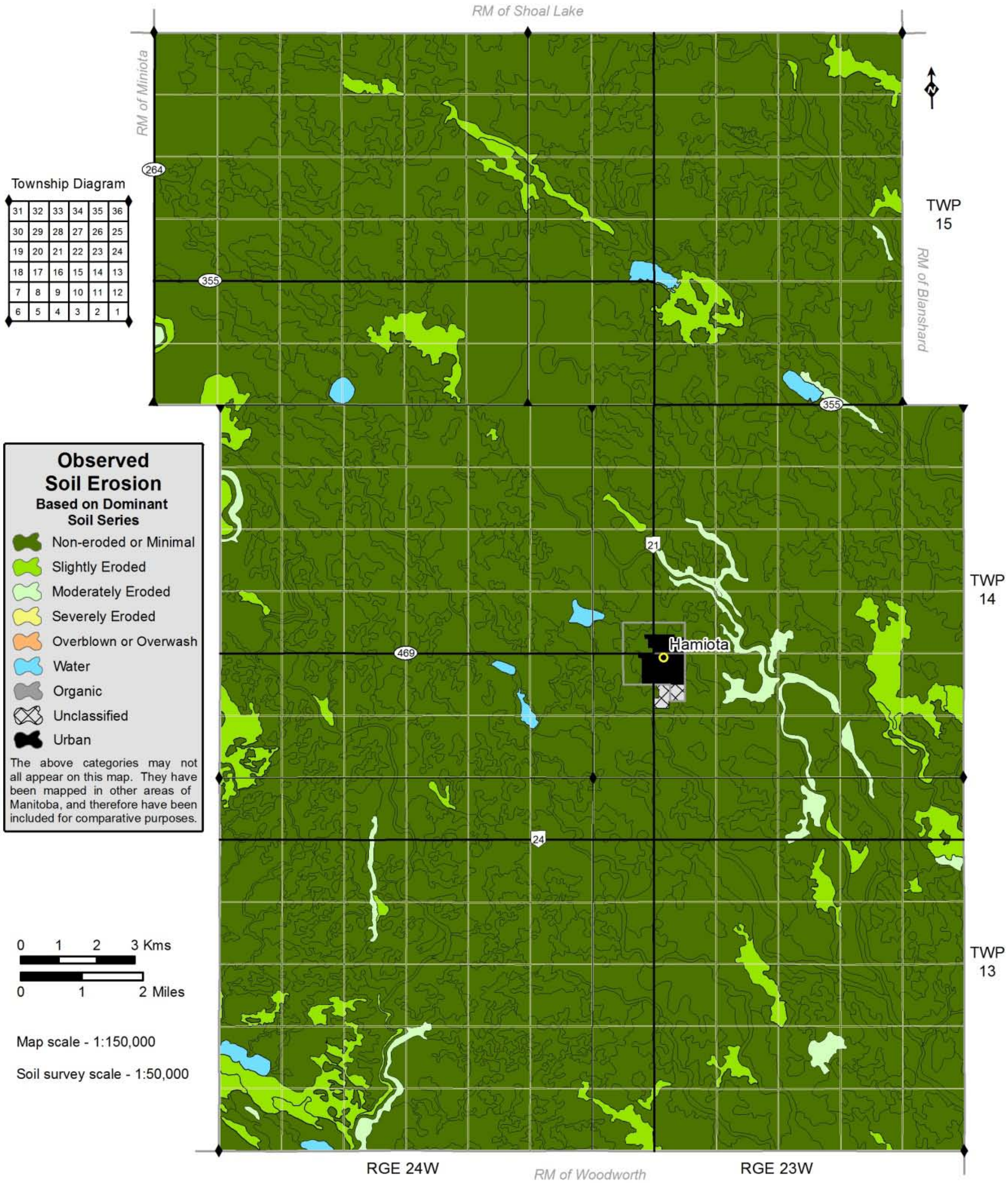
Severely eroded - soils which have practically all of the original surface soil removed and the tilled layer consists mainly of C-horizon material. This condition occurs on knolls and steep upper slope positions.

In most areas of the RM of Hamiota soil erosion is not significant. Only 11.8% of the area is slightly eroded and 1.2% of the area moderately eroded (Table 9). In most cases, erosion is due to tillage erosion moving soil from the top of knolls to lower slope positions, though also could be due to wind and water erosion. The degree of observed soil erosion shown on Map 8 is based on the dominant soil series in the polygon.

Table 9. Soil Erosion in the RM of Hamiota

Observed Erosion Class	Total area		% of RM
	ac	ha	
Non-eroded or minimal	123,311	49,902	86.03
Slightly	17,029	6,891	11.88
Moderately	1,684	681	1.17
Severely	0	0	0.00
Overblown or overwash	0	0	0.00
Water/urban/ unclassified	1,304	528	0.91

Map 8. Soil Erosion in the RM of Hamiota



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. Land use and cultivation are limited by steep slopes.

Ten slope classes are used to denote the dominant but not necessarily most severe slopes within a mapping unit (Table 10).

Table 10. Slope Classes

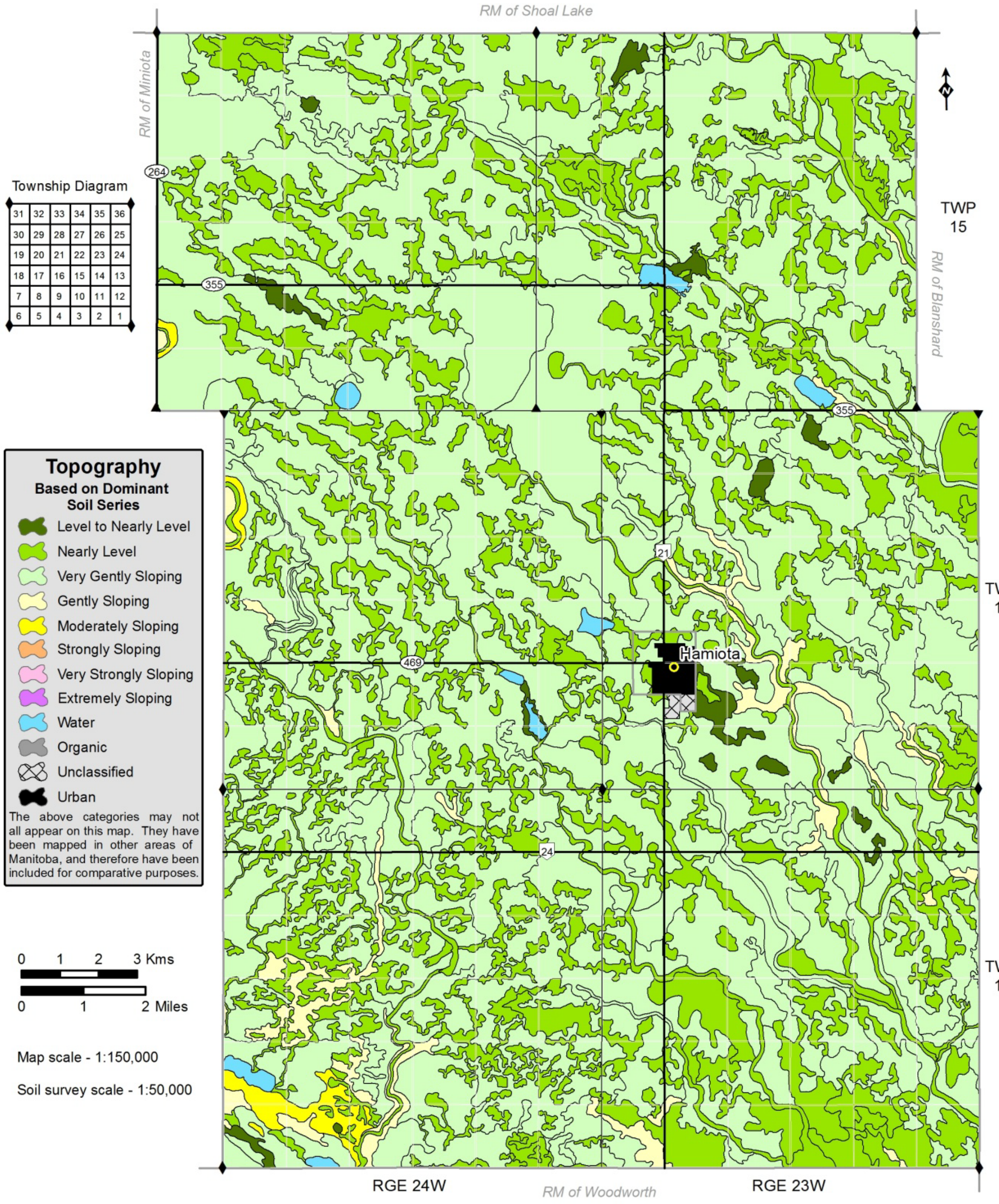
Slope Class	Slope Description	% Slope
x	Level	0 - 0.5
b	Nearly level	>0.5 - 2.0
c	Very gently sloping	>2.0 - 5.0
d	Gently sloping	>5.0 - 9.0
e	Moderately sloping	>9.0 -15.0
f	Strongly sloping	>15.0-30.0
g	Very strongly sloping	>30.0-45.0
h	Extremely sloping	>45.0-70.0
i	Steeply sloping	>70.0-100
j	Very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

The majority of the land in the RM of Hamiota is nearly level (0.5-2%) or very gently sloping (2-5%) (Table 11). Steeper slopes are commonly found along creeks. Slope classes shown on Map 9 are based on the dominant soil series in each polygon.

Table 11. Topography in the RM of Hamiota

Topography (slope classes)	Total area		% of RM
	ac	ha	
x	1,268	513	0.88
b	50,929	20,610	35.53
c	85,568	34,628	59.70
d	3,789	1,533	2.64
e	470	190	0.33
f	687	278	0.48
g	0	0	0.00
h	0	0	0.00
i	0	0	0.00
Water/urban/ Unclassified	1,304	528	0.91

Map 9. Topography in the RM of Hamiota



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 is a management cost that is not incurred with 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.

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 been done.

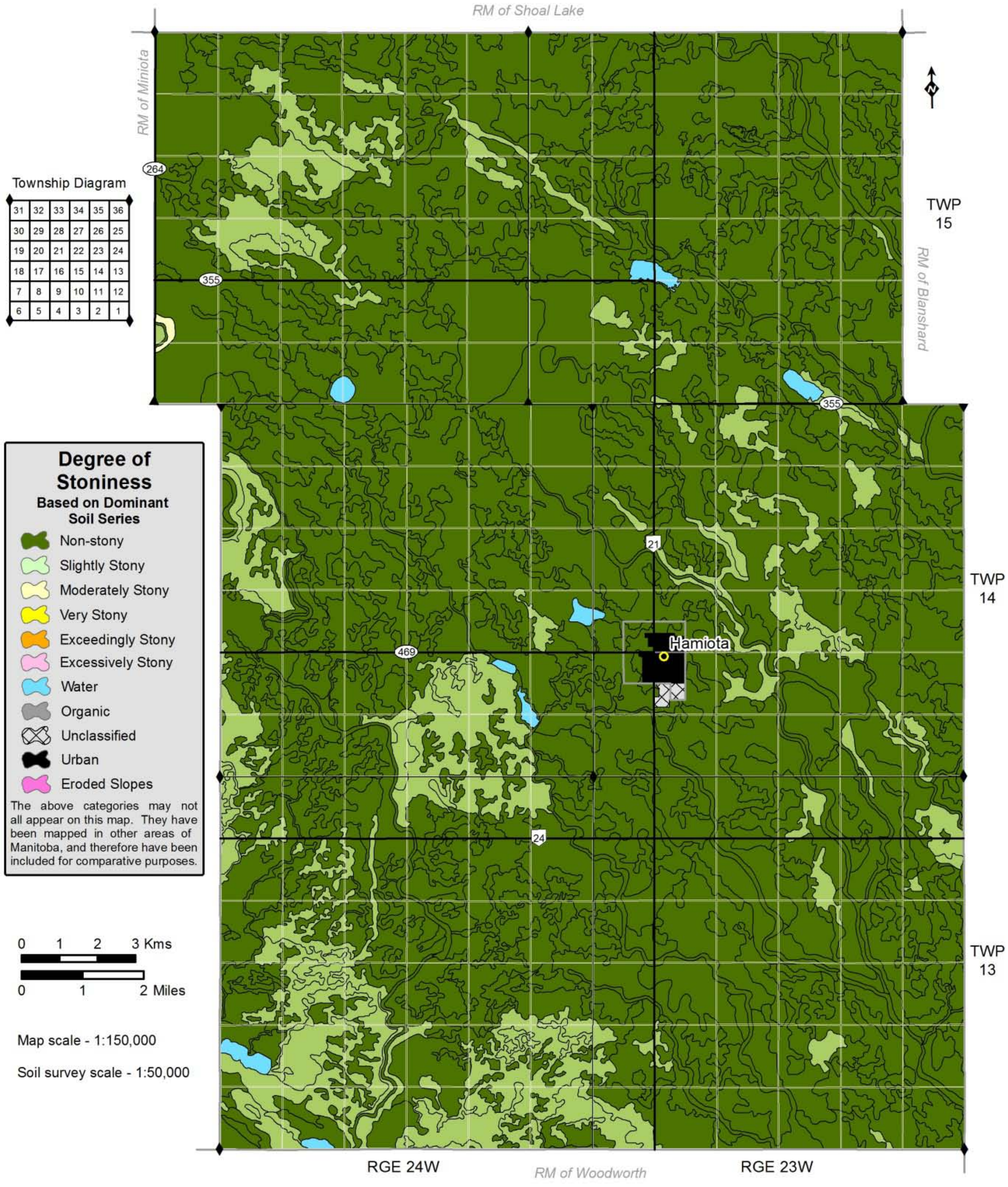
Stones in the RM of Hamiota are minimal. Slightly stony soils account for approximately 14% of the study area (Table 12). Smaller stony patches of varying severity may be present throughout the RM but they are not of a sufficient size to be mapped.

The degree of stoniness shown on the map (Map 10) is based on the dominant condition for each polygon.

Table 12. Stoniness in the RM of Hamiota

Degree of Stoniness	Total area		% of RM
	ac	ha	
Non-stony	120,909	48,930	84.36
Slightly stony	21,072	8,528	14.70
Moderately stony	43	17	0.03
Very stony	0	0	0.00
Exceedingly stony	0	0	0.00
Excessively stony	0	0	0.00
Water/urban/ unclassified	1,304	528	0.91

Map 10. Stoniness in the RM of Hamiota



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 so 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 main 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 milliSiemens/cm (mS/cm), the exchange-able 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

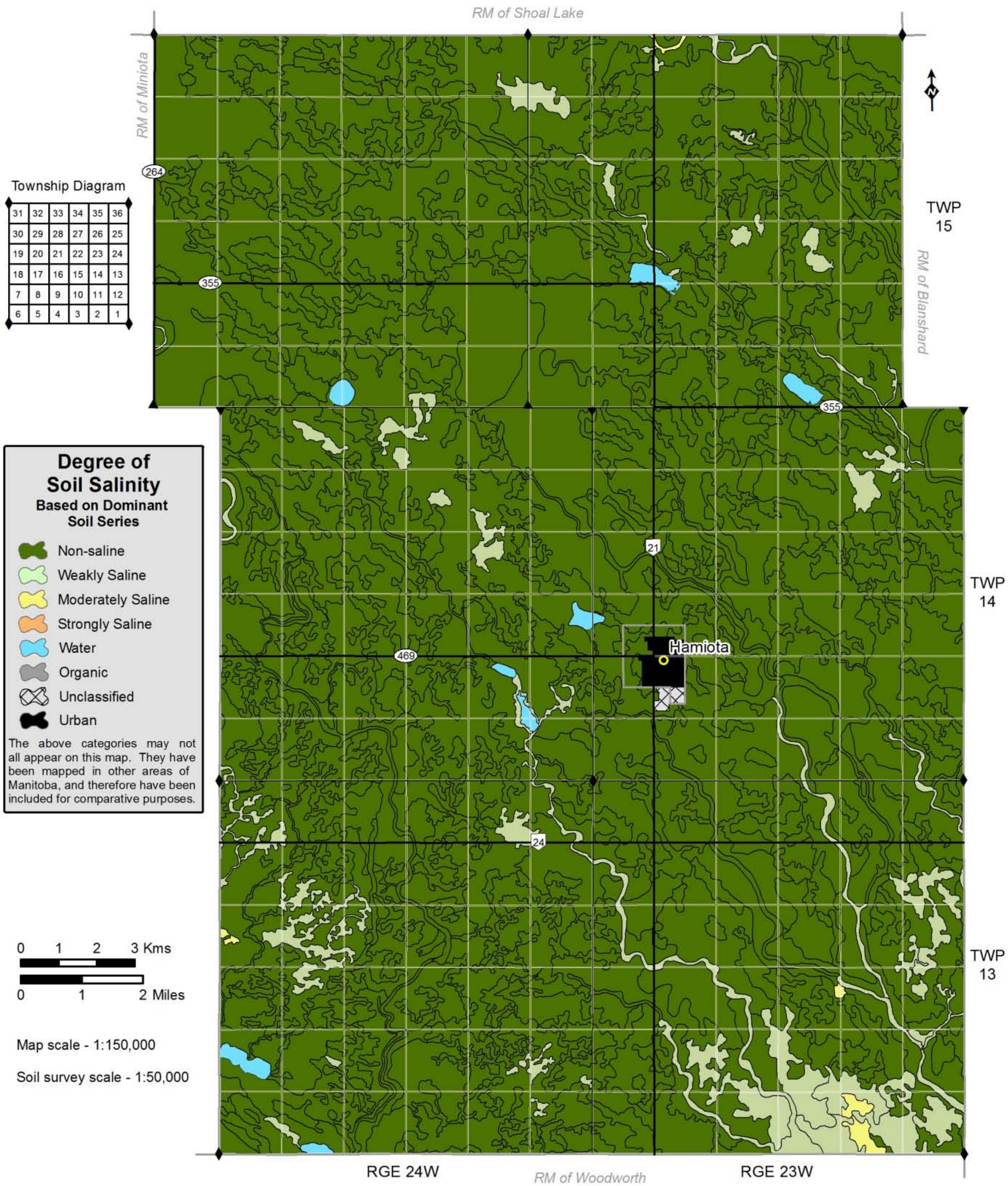
Note: mS/cm is equivalent to dS/m

Only 4.8% of the soils in the RM of Hamiota show weak salinity and a small number of acres moderate salinity (Table 13). Smaller pockets of stronger salinity may be present at times, but they are of insufficient size to affect the entire soil polygon and therefore not mapped. Salinity classes shown on Map 11 are based on the dominant soil for each polygon.

Table 13. Soil Salinity in the RM of Hamiota

Class of Salinity	Total area		% of RM
	ac	ha	
Non-saline	134,952	54,614	94.16
Weakly saline	6,855	2,774	4.78
Moderately saline	215	87	0.15
Strongly saline	0	0	0.00
Water/urban/ Unclassified land	1,304	528	0.91

Map 11. Salinity in the RM of Hamiota



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 severely affect the proposed use. To overcome these limitations the removal of the limitation is 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 would require such extreme alteration that the proposed use is economically impractical.

The basic soil properties that singly or in combination with others affect soil suitability for selected engineering uses are provided in Table 14. These subclass designations serve to identify the kind of 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 "Very Poor" for the final property, 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 cumulative in their effect for a particular use. Judgment 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, only those soil properties which most severely limit that use are specified.

Table 14. Codes Used to Identify Subclass Limitations in Evaluating Soil Suitability for Selected Engineering and Recreational Uses in Table A8 of Appendix 1

Code	Description
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 ratings of soils for ten selected engineering uses are shown in Table A8 of Appendix 1. 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, unmapped inclusions of soils with different properties may be present in an area where a development is planned.

Guides for evaluating soil suitability for engineering uses are presented in Tables A9 to A18 of Appendix 1.

5.3 Soil Suitability for Selected Recreational Uses

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 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 basic soil properties that singly or in combination with others affect soil suitability for selected recreational uses are the same as those provided for engineering uses in Table 14. These subclass designations serve to identify the kind of limitation or hazard for a particular use.

The suitability of the various soil series and phases found in the RM of Hamiota for selected recreation uses is shown in Table A8 of Appendix 1. The four suitability classes, Good, Fair, Poor and Very Poor were defined previously in Section 5.2. Guides for evaluating soil suitability for recreational uses are presented in Tables A19 to A22 of Appendix 1.

Appendix 1

A: Definitions of the Agricultural Capability

<u>Class 1</u>

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.

<u>Class 2</u>

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 the addition 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 difficulty.

<u>Class 3</u>

Soils in this Class have moderately severe limitations that restrict the range of crops or require special 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, inundation, 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.

<u>Class 4</u>

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.

<u>Class 5</u>

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, fertilization 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.

<u>Class 6</u>

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 agriculture 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.

B: 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 (ex. compaction or high bulk density).

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 the land.

F - Low fertility: This subclass is made up of soils having low fertility that either is capable of improvement 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 cation exchange capacity, high levels of carbonates or presence of toxic compounds.

I - Inundation by streams or lakes: This subclass includes soils subjected to inundation during certain times of the season 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:** This subclass designates soils that 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 level 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 A1. Dryland Agriculture Capability Guidelines for Manitoba*

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7
Subclass Limitations	No significant limitations in use for crops.	Moderate limitations that restrict the range of crops or require moderate conservation practices.	Moderately 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.

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 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 A2-1. Agricultural Capability and Irrigation Suitability Ratings of Soils

Soil code / phase	Soil name	Drainage	Surface texture	Agriculture capability	Irrigation suitability			Total area	
					Class	General rating	Rating for potatoes	ac	ha
ANL/xbxx	Angusville	Imperfect	L	2W	3kw A	Fair	4	4,691	1,898
ANL/xcxx	Angusville	Imperfect	L	2WT	3kw Bt2	Fair	4	1,327	537
BAA/xb1x	Barager	Imperfect	LS	4M	4gm A	Poor	5	10	4
BKR/xbxs	Basker	Poor	SiCL	5IW	4w Ci	Poor	5	65	26
BKR/xbxx	Basker	Poor	SiCL	5IW	4w Ci	Poor	5	276	112
BKR/xcxx	Basker	Poor	SiCL	5IW	4w Ci	Poor	5	49	20
BSF/xb1x	Beresford	Imperfect	CL	2W	3w A	Fair	4	240	97
BSF/xbxx	Beresford	Imperfect	CL	2W	3w A	Fair	4	980	396
BSF/xcxx	Beresford	Imperfect	CL	2WT	3w Bt2	Fair	4	380	154
CAV/xbxx	Carvey	Poor	CL	5W	4w A	Poor	5	35	14
CBS/xcxx	Chambers	Well	CL	3T	2kx Bt2	Good	3	12	5
CCS/1dxx	Cactus	Well	LFS	4M	3m Ct2	Fair	4	40	16
CLN/1c1x	Clementi	Well	CL	2T	2kx Bt2	Good	4	81	33
CLN/xbxx	Clementi	Well	CL	1	2kx A	Good	4	63	25
CLN/xcxx	Clementi	Well	CL	2T	2kx Bt2	Good	4	359	145
CVA/1cxx	Cordova	Well	CL	2T	2kx Bt2	Good	4	417	169
CVA/1d1x	Cordova	Well	CL	3T	2kx Ct2	Fair	4	227	92
CVA/1dxx	Cordova	Well	CL	3T	2kx Ct2	Fair	4	16	6
CVA/1exx	Cordova	Well	CL	4T	2kx Ct2	Fair	5	21	8
CVA/xc1x	Cordova	Well	CL	2T	2kx Bt2	Good	4	69	28
CVA/xcxx	Cordova	Well	CL	2T	2kx Bt2	Good	4	3,952	1,599
CVA/xd1x	Cordova	Well	CL	3T	2kx Ct2	Fair	4	37	15
CVA/xdxx	Cordova	Well	CL	3T	2kx Ct2	Fair	4	33	13
CXW/1cxx	Chater	Well	LS	5M	4gm Bt2	Poor	5	36	15
CXW/xc1x	Chater	Well	LS	5M	4gm Bt2	Poor	5	236	96
DOT/1c1x	Dorset	Rapid	LCoS	5M	4m Bt2	Poor	5	30	12
DOT/1cxx	Dorset	Rapid	LCoS	5M	4m Bt2	Poor	5	3	1
DRO/xb1s	Drokan	Poor	CL	5W	4w A	Poor	5	740	299
DRO/xb1x	Drokan	Poor	CL	5W	4w A	Poor	5	303	122
DRO/xbxs	Drokan	Poor	CL	5W	4w A	Poor	5	3,489	1,412
DRO/xbxt	Drokan	Poor	CL	5W	4sw A	Poor	5	102	41
DRO/xbxx	Drokan	Poor	CL	5W	4w A	Poor	5	11,039	4,467
DRO/xxxs	Drokan	Poor	CL	5W	4w A	Poor	5	71	29
DRO/xxxx	Drokan	Poor	CL	5W	3w A	Poor	5	746	302
FET/xbxs	Fenton	Poor	SiC	5W	4kw A	Poor	5	89	36
FET/xbxt	Fenton	Poor	SiC	5W	4kw A	Poor	5	17	7
FET/xbxx	Fenton	Poor	SiC	5W	4kw A	Poor	5	207	84
FLS/1c1x	Floors	Well	GRSL	5M	4m Bt2	Poor	5	94	38
FLS/1d1x	Floors	Well	GRSL	5M	4m Ct2	Poor	5	48	19
FLS/1e1x	Floors	Well	GRSL	5M	4m Ct2	Poor	5	3	1
FLS/2d1x	Floors	Well	GRSL	5ME	4m Bt2	Poor	5	50	20
FLS/2dxx	Floors	Well	GRSL	5ME	4m Ct2	Poor	5	41	16
HMI/xbxx	Hamiota	Poor	CL	5W	4w A	Poor	5	479	194
KKS/1cxx	Kirkness	Well	LFS	3M	2mx Bt2	Good	4	18	7
KYS/xcxx	Kleysen	Well	CL	2T	2kx Bt2	Good	4	544	220

Table A2-2. Agricultural Capability and Irrigation Suitability Ratings of Soils

Soil code / phase	Soil name	Drainage	Surface texture	Agriculture capability	Irrigation suitability			Total area	
					Class	General rating	Rating for potatoes	ac	ha
LEI/xbxs	Levine	Imperfect	CL	3IN	3w Bi	Fair	3	25	10
LEI/xbxx	Levine	Imperfect	CL	3I	3w Bi	Fair	3	83	34
LEI/xcxx	Levine	Imperfect	CL	3I	3w Bt2i	Fair	3	32	13
LKH/xcxx	Lockhart	Well	FSL	2MT	2x Bt2	Good	4	1	0
LWN/xbxx	Lowton	Poor	CL	5W	4k A	Poor	5	20	8
MDN/xb1s	Marsden	Poor	L	5W	4w A	Poor	5	52	21
MDN/xbxs	Marsden	Poor	L	5W	4w A	Poor	5	124	50
MDN/xbxx	Marsden	Poor	L	5W	4w A	Poor	5	53	21
MPK/xbxx	Moore Park	Imperfect	CL	2W	3w A	Fair	4	415	168
MPK/xcxx	Moore Park	Imperfect	CL	2W	3w A	Fair	4	20	8
MRH/1cxx	Marringhurst	Well	SL	5M	4m Bt2	Poor	5	20	8
MRH/1d1x	Marringhurst	Well	SL	5M	4m Ct2	Poor	5	29	12
MRH/xcxx	Marringhurst	Well	SL	5M	4m Bt2	Poor	5	20	8
MXI/xc1x	Miniota	Well	SL	4M	2m Bt2	Good	4	34	14
MXT/xbxx	Melland	Imperfect	CL	2M	3w A	Fair	4	124	50
MXT/xcxx	Melland	Imperfect	CL	2MT	3w Bt2	Fair	4	16	6
NDL/1cxx	Newdale	Well	CL	2T	2kx Bt2	Good	4	753	305
NDL/1d1x	Newdale	Well	CL	3T	2kx Ct2	Fair	4	27	11
NDL/2d1x	Newdale	Well	CL	3TE	2kx Ct2	Fair	4	12	5
NDL/xb1x	Newdale	Well	CL	2X	2kx A	Good	4	81	33
NDL/xbxx	Newdale	Well	CL	2X	2kx A	Good	4	1,396	565
NDL/xc1x	Newdale	Well	CL	2T	2kx Bt2	Good	4	5,966	2,414
NDL/xcxx	Newdale	Well	CL	2T	2kx Bt2	Good	4	51,511	20,846
NDL/xd1x	Newdale	Well	CL	3T	2kx Ct2	Fair	4	278	112
NDL/xdxx	Newdale	Well	CL	3T	2kx Ct2	Fair	4	57	23
PEN/xbxx	Penrith	Poor	L	5W	4w A	Poor	5	512	207
RUF/1c1x	Rufford	Well	CL	2T	2kx Bt2	Good	4	4,712	1,907
RUF/1cxx	Rufford	Well	CL	2T	2kx Bt2	Good	4	8,361	3,384
RUF/1d1x	Rufford	Well	CL	3T	2kx Ct2	Fair	4	994	402
RUF/1dxx	Rufford	Well	CL	3T	2kx Ct2	Fair	4	717	290
RUF/1e1x	Rufford	Well	CL	4T	2kx Ct2	Fair	5	340	138
RUF/1e2x	Rufford	Well	CL	4T	2kx Ct2	Fair	5	43	17
RUF/2c1x	Rufford	Well	CL	2TE	2kx Bt2	Good	4	365	148
RUF/2d1x	Rufford	Well	CL	3TE	2kx Ct2	Fair	4	949	384
RUF/2dxx	Rufford	Well	CL	3TE	2kx Ct2	Fair	5	203	82
RUF/2e1x	Rufford	Well	CL	4TE	2kx Ct2	Fair	5	64	26
RUF/xbxx	Rufford	Well	CL	2X	2kx A	Good	5	27	11
RUF/xc1x	Rufford	Well	CL	2T	2kx Bt2	Good	4	1,235	500
RUF/xcxx	Rufford	Well	CL	2T	2kx Bt2	Good	4	3,613	1,462
RUF/xdxx	Rufford	Well	CL	3T	2kx Ct2	Fair	4	31	13
TDP/xxxx	Tadpole	Poor	CL	5W	4w A	Poor	5	15	6
VFF/xb1x	Vodroff	Poor	CL	5W	4w A	Poor	5	150	61
VFF/xbxs	Vodroff	Poor	CL	5W	4w A	Poor	5	340	137
VFF/xbxx	Vodroff	Poor	CL	5W	4w A	Poor	5	1,215	492
VFF/xxxx	Vodroff	Poor	CL	5W	4w A	Poor	5	22	9

Table A2-3. Agricultural Capability and Irrigation Suitability Ratings of Soils

Soil code / phase	Soil name	Drainage	Surface texture	Agriculture capability	Irrigation suitability			Total area	
					Class	General rating	Rating for potatoes	ac	ha
VRC/xb1s	Varcoe	Imperfect	CL	3N	3sw A	Fair	4	41	16
VRC/xb1x	Varcoe	Imperfect	CL	2W	3w A	Fair	4	3,488	1,412
VRC/xbxs	Varcoe	Imperfect	CL	3N	3sw A	Fair	4	1,820	737
VRC/xbxt	Varcoe	Imperfect	CL	4N	4s A	Poor	5	96	39
VRC/xbxx	Varcoe	Imperfect	CL	2W	3w A	Fair	4	18,045	7,303
VRC/xc1x	Varcoe	Imperfect	CL	2WT	3w Bt2	Fair	4	90	36
VRC/xcxx	Varcoe	Imperfect	CL	2WT	3w Bt2	Fair	4	1,212	490
VRC/xxxx	Varcoe	Imperfect	CL	2W	3w A	Fair	4	84	34
$MH/xxxx	Marsh	Very Poor	L	7W	4wx Di	Poor	5	329	133
$UL/xxxx	Unclassified land			$UL				96	39
$UR/xxxx	Urban land			$UR				343	139
$ZZ/xxxx	Water			$ZZ				865	350

Table A3. 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 A4. Landscape Features Affecting Irrigation Suitability

Symbol	Landscape Features	Degree of Limitation			
		None (A)	Slight (B)	Moderate (C)	Severe (D)
t1	Slope - Simple %	<2	2 - 9	> 9 - 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 in10 years	1 in 5 years	Every year (annual-spring)	Every year (seasonal)

* Suitability interpretations are based on the criteria for Complex slopes

Table A5. 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 Sub-humid (mm/1.2 m) (% by volume) Sub-arid (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	HC 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.

Table A6. Guidelines for Assessing Land Suitability for Irrigated Potato Production under Rapid, Well and Moderately Well Drained Soil Conditions

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/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

Table A7. Guidelines for Assessing Land Suitability for Irrigated Potato Production under Imperfectly, Poorly and Very Poorly Soil Conditions

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

Table A8-1. Suitability Ratings of Soils for Selected Engineering and Recreational Uses

Soil code	Soil phases	Soil name	Top soil	Sand & gravel	Road fill	Building - basement		Local roads/ streets	Sanitary trench	Land-fill area	Cover material	Sewage lagoon	Septic field	Play ground	Picnic area	Camp area	Paths & trails
						Yes	No										
ANL	xcxx	Angusville	Pbs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Ftw	Fw	Fw	Fw
ANL	xbxx	Angusville	Pbs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fw	Fw	Fw	Fw
BAA	xb1x	Barager	Pbs	Fx	Faw	Pw	Fw	Fw	Phw	Fwg	Fcs	Pk	Phk	Pqt	Fsw	Fsw	Fw
BKR	xbxs	Basker	Pin	Va	Pw	Viw	Vi	Vi	Viw	Viw	Pw	Vi	Vhi	Viw	Piw	Viw	Piw
BKR	xbxx, xcxx	Basker	Pi	Va	Pw	Viw	Vi	Vi	Viw	Viw	Pw	Vi	Vhi	Viw	Piw	Viw	Piw
BSF	xbxx, xb1x	Beresford	Pi	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fsw	Fsw	Fsw	Fsw
BSF	xcxx	Beresford	Pi	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Ftw	Fsw	Fsw	Fsw
CAV	xbxx	Carvey	Fs	Fhq	Pw	Vhw	Phw	Pw	Vwg	Vhk	Pqw	Vkg	Vhg	Pw	Pw	Pw	Pw
CBS	xcxx	Chambers	Fs	Va	Faw	Fa	Fa	Faw	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
CCS	1dxx	Cactus	Vb	Pa	G	G	G	G	Vks	Vkg	Pqw	Vkg	Gg	Pt	Fms	Fs	G
CLN	xbxx	Clementi	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fak	Pk	Fs	Fs	Fs	Fs
CLN	xcxx, 1c1x	Clementi	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
CVA	1cxx	Cordova	Pb	Va	Faw	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
CVA	xcxx, xc1x	Cordova	Fbs	Va	Faw	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
CVA	xdxx, xd1x	Cordova	Fbt	Va	Faw	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	Fs	Fs	Fs
CVA	1dxx, 1d1x	Cordova	Pb	Va	Faw	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	Fs	Fs	Fs
CVA	1exx	Cordova	Pbt	Va	Faw	Fat	Fat	Fat	Fs	Ft	Fst	Vt	Pk	Vt	Fst	Fst	Fs
CXW	1cxx	Chater	Vb	Fx	G	Fa	G	G	Fsg	Gg	Fcs	Pk	Fk	Fst	Fms	Fs	G
CXW	xc1x	Chater	Pbs	Fx	G	Fa	G	G	Fsg	Gg	Fcs	Pk	Fk	Fst	Fms	Fs	G
DOT	1c1x, 1cxx	Dorset	Pbs	G	G	G	G	G	Vks	Vkg	Vcs	Vck	Gg	Pq	Fms	Fs	G
DRO	xxxs, xbxs, xb1s	Drokan	Pn	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
DRO	xxxx, xbxx, xb1x	Drokan	Fs	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
DRO	xbxt	Drokan	Vn	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pnw	Pnw	Pnw	Pw
FET	xbxx	Fenton	Ps	Va	Paw	Vw	Paw	Paw	Vhw	Pw	Psw	Ph	Vh	Psw	Psw	Psw	Psw
FET	xbxs	Fenton	Pns	Va	Paw	Vw	Paw	Paw	Vhw	Pw	Psw	Ph	Vh	Psw	Psw	Psw	Psw
FET	xbxt	Fenton	Vn	Va	Vaw	Vw	Paw	Paw	Vhw	Pw	Psw	Ph	Vh	Pwt	Pwt	Pwt	Psw
FLS	1c1x, 1cxx	Floors	Pbs	G	G	G	G	G	Vks	Vkg	Vcs	Vck	Gg	Pq	Fms	Fs	G
FLS	1d1x	Floors	Pbs	G	G	G	G	G	Vks	Vkg	Vcs	Vck	Gg	Pqt	Fms	Fs	G
FLS	2dxx, 2d1x	Floors	Vb	G	G	G	G	G	Vks	Vkg	Vcs	Vck	Gg	Pqt	Fms	Fs	G
FLS	1e1x	Floors	Pbs	G	G	Ft	Ft	Ft	Vks	Vkg	Vcs	Vck	Ft	Vt	Fst	Fst	G

Table A8-2. Suitability Ratings of Soils for Selected Engineering and Recreational Uses

Soil code	Soil phases	Soil name	Top soil	Sand & gravel	Road fill	Building - basement		Local roads/ streets	Sanitary trench	Land-fill area	Cover material	Sewage lagoon	Septic field	Play ground	Picnic area	Camp area	Paths & trails
						Yes	No										
HMI	xbxx	Hamiota	Fs	Va	Pw	Vw	Pw	Pw	Vw	Vhw	Pw	Ph	Ph	Pw	Pw	Pw	Pw
KKS	1cxx	Kirkness	Ps	Pax	Fa	Fa	G	G	Fs	G	Fs	Pk	Fk	GFst	Fms	Fs	G
KYS	xcxx	Kleysen	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
LEI	xbxs	Levine	Pn	Va	Faw	Piw	Pi	Pi	Piw	Pi	Fs	Pi	Phi	Fnw	Fnw	Pi	Fsw
LEI	xbxx	Levine	Fis	Va	Faw	Piw	Pi	Pi	Piw	Pi	Fs	Pi	Phi	Fiw	Fsw	Pi	Fsw
LEI	xcxx	Levine	Fis	Va	Faw	Piw	Pi	Pi	Piw	Pi	Fs	Pi	Phi	Fit	Fsw	Pi	Fsw
LKH	xcxx	Lockhart	Fb	Vax	Faw	Fa	Fa	G	Fs	G	G	Fkt	Fk	Ft	G	G	G
LWN	xbxx	Lowton	Ps	Va	Paw	Vw	Paw	Paw	Vhw	Pw	Psw	G	Vhk	Psw	Psw	Psw	Psw
MDN	xbxs,xb1s	Marsden	Pn	Pax	Pw	Vw	Pw	Pw	Vwg	Phw	Pw	Pkg	Vhg	Pw	Pw	Pw	Pw
MDN	xbxx	Marsden	Fb	Pax	Pw	Vw	Pw	Pw	Vwg	Phw	Pw	Pkg	Vhg	Pw	Pw	Pw	Pw
MPK	xbxx, xcxx	Moore Park	Fbs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fsw	Fsw	Fsw	Fsw
MRH	xcxx,1cxx	Marringhurst	Pbs	G	G	G	G	G	Vks	Vkg	Vcs	Vck	Gg	Pq	Fms	Fs	G
MRH	1d1x	Marringhurst	Pbs	G	G	G	G	G	Vks	Vkg	Vcs	Vck	Gg	Pqt	Fms	Fs	G
MXI	xc1x	Miniota	Fb	Faq	G	G	G	G	Vks	Vkg	Pcq	Vak	Gg	Fqt	Fms	G	G
MXT	xbxx	Melland	Fb	Pax	Faw	Pw	Faw	Faw	Pwg	Fwg	Fcs	Pkg	Fhg	Fw	Fw	Fw	Fw
MXT	xcxx	Melland	Fb	Pax	Faw	Pw	Faw	Faw	Pwg	Fwg	Fcs	Pkg	Fhg	Fwt	Fw	Fw	Fw
NDL	xbxx, xb1x	Newdale	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fak	Pk	Fs	Fs	Fs	Fs
NDL	xcxx, xc1x	Newdale	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
NDL	1cxx	Newdale	Fbs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
NDL	xdxx, xd1x, 1d1x	Newdale	Fst	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	Fs	Fs	Fs
NDL	2d1x	Newdale	Pb	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	Fs	Fs	Fs
PEN	xbxx	Penrith	Fb	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
RUF	xbxx	Rufford	Fb	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fak	Pk	Fs	Fs	Fs	Fs
RUF	xcxx, xc1x	Rufford	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
RUF	1c1x, 1cxx	Rufford	Pb	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
RUF	2c1x	Rufford	Vb	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
RUF	xdxx	Rufford	Fbt	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	Fs	Fs	Fs
RUF	1d1x, 1dxx	Rufford	Pb	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	Fs	Fs	Fs
RUF	2d1x, 2dxx	Rufford	Vb	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	Fs	Fs	Fs
RUF	1e1x	Rufford	Pbt	Va	Fa	Fat	Fat	Fat	Fs	Ft	Fst	Vt	Pk	Vt	Fst	Fst	Fs
RUF	1e2x	Rufford	Pbt	Va	Fa	Fat	Fat	Fat	Fps	Ft	Fpt	Vt	Pk	Vt	Fst	Fpt	Fs
RUF	2e1x	Rufford	Vb	Va	Fa	Fat	Fat	Fat	Fs	Ft	Fst	Vt	Pk	Vt	Fst	Fst	Fs

Table A8-3. Suitability Ratings of Soils for Selected Engineering and Recreational Uses

Soil code	Soil phases	Soil name	Top soil	Sand & gravel	Road fill	Building - basement Yes	Building - basement No	Local roads/ streets	Sanitary trench	Land-fill area	Cover material	Sewage lagoon	Septic field	Play ground	Picnic area	Camp area	Paths & trails
TDP	xxxx	Tadpole	Fs	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
VFF	xbxs	Vodroff	Pn	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
VFF	xxxx, xbxx, xb1x	Vodroff	Fs	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
VRC	xxxx, xbxx, xb1x	Varcoe	Fbs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fsw	Fsw	Fsw	Fsw
VRC	xbxs, xb1s	Varcoe	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fnw	Fnw	Fnw	Fsw
VRC	xbxt	Varcoe	Vn	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Pn	Pn	Pn	Fsw
VRC	xcxx, xc1x	Varcoe	Fbs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Ftw	Fsw	Fsw	Fsw
$MH	xxxx	Marsh	Vw	Vah	Vhw	Vhw	Vhw	Vaw	Vhw	Vhw	Vw	Vhi	Vhi	Vsw	Vsw	Vsw	Vsw
$UL	-	Unclassified land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
$UR	-	Urban land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
$ZZ	-	Water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A9. 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 Consistence²**	Very friable, friable	Loose, firm	Very firm	Cemented
i	**Flooding**	None	May flood occasionally for short periods	Frequent flooding (every year)	Constantly flooding
w	**Wetness²**	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	**Texture²**	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)

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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 materials 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 A10. 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 [2]**	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 cm [3]	> 75 cm [3]	
p	**Stoniness[4]**	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	

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[1] The symbol is used to indicate the property affecting use.
[2] Shaly gravels rated as Poor (Pa). Meanings of the definition letters can be found at http://en.wikipedia.org/wiki/Unified_Soil_Classification_System
[3] Rated good if it is known that the underlying gravel or sand deposit is thick (> 100 cm).
[4] 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).

Table A11. 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]** **b.) Unified Soil Group**	< 5 GW, GP, SW, SP SM, GC[5] and SC[5]	5 - 8 CL (with P.I.[6] <15) and ML	> 8 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 A12. 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, 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. Use **z** for permanently frozen soils.
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.

Table A13. 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 A14. 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[4,5,8]**	< 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 A15. 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 A16. 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 A17. 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 A18. 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 A19. 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.

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)

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, or dS/m).

Table A20. 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)

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, or dS/m).

Table A21. 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, or dS/m)

Table A22. 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.

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.

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

Angusville Series (ANL)

The Angusville series is characterized by a Gleyed Eluviated Black Chernozem soil profile developed on moderately to strongly calcareous, slightly stony, fine loamy (L, CL) morainal till of limestone, granitic and shale bedrock origin. These soils are imperfectly drained and occur in lower to mid slope positions of undulating to hummocky landscapes, in close association with the well drained Newdale, Rufford and Cordova soils, the imperfectly drained Varcoe series, and the poorly drained Drokan and Penrith series. Surface runoff is slow to moderately slow; permeability is moderately slow to slow within the solum and moderately slow in the subsoil. Vegetation on non-cultivated lands consists of trembling aspen.

The average thickness of the soil profile is 83 cm and varies from 45 to 100 cm. The A horizon has a thickness of 32 cm and ranges from 20 to 50 cm. The very dark gray to gray Ap horizon is 15 to 20 cm thick, and the dark gray to gray Ahe horizon, 5 to 30 cm thick. The dark brown to dark yellowish brown Btjgj or Btgj horizon is 25 to 35 cm thick. A carbonate enriched layer of 10 to 20 cm is usually present. The Ckg horizon is light olive brown with yellowish brown mottles.

The Angusville soil profile is more strongly developed, deeper and free of carbonate as compared to the closely associated, shallower, carbonated Gleyed Rego Black Chernozem, Varcoe series.

Barager Series (BAA)

The Barager series consists of imperfectly drained, carbonated, Gleyed Rego Black Chernozem soils developed on a variable mantle (30 to 90 cm) of moderately to strongly calcareous outwash and glacio-fluvial sediments of medium sand to gravel texture overlying very strongly calcareous loamy glacial till. Strongly calcareous loam to clay loam till of shale, limestone and granitic origin usually occurs within a two meter depth. The soils occur in a level to gently undulating topography. The soil drainage is imperfect because of a perched water condition above the slowly permeable till and to lateral flow and seepage from adjacent upland areas. The permeability of the upper sediments is rapid.

The Barager soil is characterized by a black to very dark gray Ah horizon 12 to 18 cm thick; and an AC horizon which grades to a carbonate accumulation (Cca) horizon. The solum is relatively shallow and varies with depth from loamy sand to sand. Yellowish brown mottles occur above the contact of the coarse materials and the till.

Basker Series (BKR)

The Basker series consists of poorly to very poorly drained Rego Humic Gleysol soil developed on moderately to strongly calcareous, stratified, loamy (FSL, VFSL, L, SiL, SiCL), recent alluvial deposits. These soils occur in depressional positions of nearly level slopes on flood plain landscapes and have slow permeability, very slow surface runoff, and a high water table during the growing season. Basker soils are slightly water eroded, non-stony, and occasionally slightly saline. They have high available water holding capacity, medium organic matter content, and low natural fertility. Native vegetation includes sedges, rushes and willows. The majority of these soils are currently in native vegetation because they are subject to flooding and saturated conditions in the spring.

In a representative profile of Basker soil there is no soil solum. The profile is characterized by light grayish brown Ahk horizon, 5 to 20 cm thick, with iron stains, and a stratified, olive brown Ckg horizon, with prominent iron mottles in the sandy strata. A typical profile also contains thin organic layers indicating former surfaces.

Basker soils occur in close association with Levine soils. They are similar to Kerran soils by having a poorly drained profile developed in recent alluvium but differ from them in having mostly loam rather than clay textures. Basker soils were previously mapped as Meadow associates of the Assiniboine Complex in the South-Central (1943) and Carberry (1957) reports.

Beresford Series (BSF)

The Beresford series consists of imperfectly drained Gleyed Rego Black Chernozem soil developed on a thin mantle (<1 m) of loamy (L, SiL, CL, SiCL), carbonated lacustrine sediments over strongly to very strongly calcareous, loam to clay loam glacial till of shale, limestone and granitic origin. These soils occur on near level to undulating topographic landscapes in association with the Clementi (Orthic Black Chernozem) soils. They occur in landscapes which are considered to be in a discharge to weak recharge (groundwater) area and may have soluble salts within the rooting zone or subsoil. The runoff is slow, and permeability is moderately slow to slow.

The Beresford soils are characterized by a very dark gray to black Ah horizon 20 to 30 cm, a dark gray ACk horizon of 6 to 12 cm thick. A lime accumulation zone may occur in the loamy lacustrine sediments if the overlay is thick; the underlying strongly calcareous till of shale limestone and granitic origin is generally more compact.

Cactus Series (CCS)

The Cactus series consists of well drained Rego Black Chernozem soil developed on moderately calcareous, deep, stratified, sandy (FS, LFS, LS), lacustrine and deltaic deposits. These soils occur in upper slope and crest positions of gentle slopes on undulating duned landscapes and have moderately rapid to rapid permeability, minimal surface runoff, and a low water table during the growing season. Cactus soils are highly prone to wind erosion, and are non-stony, and non-saline. They have low available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation includes aspen, bur oak and tall prairie grasses. The majority of these soils are currently used for natural grazing. Cactus soils occur in close association with Stockton, Arizona and Sewell soils. They are similar to Stockton soils by having a well drained profile developed in sandy deposits but differ from them in having no Bm horizon. Cactus soils were previously mapped as minor Blackearth associates of the Stockton Association in the Carberry (1957) soil report.

In a representative profile of Cactus soil the solum is approximately 15 cm thick. The profile is characterized by a very dark gray Ah horizon, 12 to 16 cm thick, a dark gray AC horizon, 4 to 8 cm thick which is calcareous, a thin Cca horizon, 5 to 10 cm thick with lime accumulation and a light gray to pale brown Ck horizon.

Carvey Series (CAV)

The Carvey series consists of poorly drained Rego Humic Gleysol soil developed on a mantle (25 to 100 cm) of moderately to strongly calcareous, uniform, loamy (SiL, L, SL) lacustrine sediments over moderately to strongly calcareous, sandy to sandy skeletal glaciofluvial deposits. These soils occur in depressional positions of nearly level slopes on level landscapes and have moderate permeability slow surface runoff and a high water table during the growing season. Carvey soils are occasionally slightly saline. They have medium over low available water holding capacity, high organic matter content, and medium natural fertility. Native vegetation often includes sedges and meadow grasses. The majority of these soils are currently used for natural grazing. In a representative profile of Carvey soil the solum is approximately 20 cm thick. The profile is characterized by a thin (2 to 5 cm) moderately decomposed LFH horizon a very dark gray, calcareous Ah horizon, 7 to 15 cm thick and a dark gray, calcareous, transition AC horizon, 10 to 20 cm thick, and a pale brown, calcareous II Ck horizon with yellowish brown mottles. A typical profile also contains manganese concretions in the subsoil and shells at the surface.

Carvey soils occur in close association with Capell, and Croyon soils. They are similar to Tadpole soils by having a Rego Humic Gleysol profile developed in loamy lacustrine deposits, but differ from Tadpole soils by having a sandy to sandy-skeletal substrate within a meter of the mineral surface. Carvey soils were previously mapped as a Meadow associate with a loamy veneer of the Agassiz Association in the Carberry (1957) soil report.

The Carvey shaly variant, CAV1, series is characterized by a Rego Humic Gleysol (carbonated) solum on poorly drained thin mantle (25 to 90 cm) of moderately to strongly calcareous loamy (L, CL, SiCL, SCL) overlying moderately to strongly calcareous sand and gravel deposits intermixed with varying amounts of shaly fragments. They occur in level to depressional sites which have a water table at or near the surface for part of the year. Runoff is negligible; permeability of the loamy sediments is moderately slow above the saturation zone. In area where the seepage water contains soluble salts, a sufficient concentration of slats may occur in the soil to inhibit the growth of the normal sedge and meadow grasses. The solum has a moderately decomposed organic layer, 2 to 5 cm thick, a very dark gray carbonated Ahk horizon, 7 to 15 cm thick, and a thin dark gray transitional AC horizon. A lime accumulation layer (Cca) is commonly present. Yellowish brown mottles are common in the transitional AC, the Cca horizon and the subsoil.

Chambers Series (CBS)

The Chambers series is a Rego Black Chernozem soil developed on moderately well to well drained loamy (L, CL, SiCL) lacustrine sediments, less than one meter in depth, overlying moderately to strongly calcareous loamy (L, CL) glacial till deposits. These soils occur in the upper slope positions of gently sloping to hummocky, moderately rolling topography. Surface runoff is moderately rapid to rapid depending on the slope gradient. Permeability is moderate in the lacustrine sediments and moderately slow to slow in the glacial till deposit.

The Chambers soil profile is characterized by a very dark gray to black Ah or Ahk horizon of 10 to 15 cm thick, a thin dark gray to grayish brown AC horizon of 3 to 8 cm thick and a thin lime accumulation zone. The underlying till is a light yellowish brown color. Chambers soil series tend to be less stony than the very similar Rufford soils.

Chater Series (CXW)

The Chater series is a Calcareous Black Chernozem soil developed on moderately well to well drained, moderately to strongly calcareous, sandy (S, CoS) to sandy-skeletal (GrS, GrCoS) outwash and glaciofluvial deposits, less than one meter in depth, overlying moderately to strongly calcareous loamy (L, CL) glacial till deposits. These soils occur in gently undulating to moderately rolling topography. Surface runoff is low, while permeability is rapid in the coarser deposits and moderate to moderately slow in the underlying till material. These soils are in favorable topographic positions to allow excess water above the till to flow laterally to downslope positions.

The Chater soil profile is characterized by a 12 to 18 cm thick, very dark gray Ah horizon and a grayish brown to brown Bmk horizon 8 to 15 cm thick, with a lime accumulation horizon (Cca) in the coarser stratum. Chater soils are coarser textured and tend to be droughtier than the similar Clementi soils.

Clementi Series (CLN)

The Clementi series is characterized by an Orthic Black Chernozem profile developed on a thin overlay (25 to 90 cm) of loamy fluvial or lacustrine sediments over moderately to very strongly calcareous morainal till of limestone, granitic, and shale origin. These soils are moderately well drained and occur in mid to upper slope positions of very gently undulating or rolling topography. Runoff is moderate; permeability is moderate in the loamy overlay, and moderately slow to slow in the underlying till.

The solum has a very dark gray to black Ah horizon, 10 to 20 cm thick and a dark brown to brown Bm horizon, 8 to 12 cm thick. The solum is developed dominantly within the overlay, and may extend into the till material.

Cordova Series (CVA)

The Cordova series is characterized by a Calcareous Black Chernozem solum on moderately to strongly calcareous, slightly to moderately stony, loamy (L, CL) morainal till of mixed limestone, granitic and shale rock origin. These soils are well to rapidly drained and occur in the upper slope and crest positions of undulating to hummocky landscapes, in close association with the well drained Rufford and Newdale series. Surface runoff is moderately rapid to rapid, depending upon slope. Permeability is moderately slow. Native vegetation consists of mixed tall prairie grasses and herbs.

The Cordova soil profile has a thin, very dark gray Ap(k) horizon, 12 to 18 cm thick, a calcareous, yellowish brown to dark yellowish brown Bm horizon, 5 to 15 cm thick, a thin transitional BC horizon and a light gray lime carbonate accumulation layer, 25 to 35 cm thick. Secondary carbonates may be found along vertical cracks within the underlying grayish brown (dry) or dark grayish brown (moist) Ck horizon. In many areas, these soils have been altered by wind and water erosion; the crest positions have lost most of the A horizon and part of the B horizon has been cultivated. In a few areas, the Cca horizon has been incorporated into the plow layer, imparting a light gray surface color.

The Cordova series differs from the Rufford series, a carbonated Rego Black in having a Bmk horizon. Both Cordova and Rufford series differ from the Newdale series, the former having free lime carbonate present in the solum, while the latter has an A and B horizon free of carbonates.

Dorset Series (DOT)

The Dorset series consists of moderately well to well drained Orthic Black Chernozem soils developed on moderately to strongly calcareous, deep , stratified, sandy to sandy skeletal (S, GrS, GrCoS), outwash and glaciofluvial deposits. These soils occur in upper positions of gentle slopes on hummocky landscapes and have very rapid permeability, low rapid surface runoff, and a low water table during the growing season. Dorset soils are non-eroded, non-stony, and non-saline. They have a low available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation includes aspen-oak stands and tall prairie grasses. The majority of these soils are currently used for grazing or are excavated for gravel deposits.

In a representative profile the solum is approximately 30 cm thick. The profile is characterized by a very dark gray Ah horizon, 12 to 18 cm thick, a dark brown Bm horizon, 15 to 22 cm thick, a Cca (lime accumulation) horizon, 6 to 12 cm thick and a light brown Ck horizon, with stratified sand and gravel. The Dorset, shaly gravel variant, DOT1, has a high proportion of shale fragments in the gravel.

Dorset soils occur in close association with Mansfield soils. They are similar to Marringhurst soils by having well drained profile in glaciofluvial deposits but differ from them in having a Bm horizon.

Drokan Series (DRO)

The Drokan series is characterized by a Rego Humic Gleysol (carbonated) solum, developed on moderately to strongly calcareous, loamy (L, CL) morainal till of limestone, granitic and shale rock origin. They are poorly to very poorly drained and occur in depressional positions of the undulating to hummocky morainal landscape. Surface runoff is negligible and the soils may remain in a ponded condition unless the surface drainage has been improved. Permeability is moderately slow to slow. In some landscapes, these areas are influenced by seepage from adjacent higher lands, and may have a considerable content of soluble salts. Native vegetation consists of sedges, cattails, rushes and willows. Saline areas have baltic rush, wild barley and saline goosefoot.

The Drokan soil profile has a moderately decomposed organic layer, 2 to 5 cm thick, a very dark gray Ah horizon, 10 to 18 cm thick, a mottled transitional AC horizon, 4 to 8 cm thick and a lime accumulation layer, 8 to 12 cm thick. The C horizon is olive gray to olive with yellowish brown mottles. Gypsum crystals are common in the lime accumulation layer and C horizon. In saline areas, white flecks of salt and gypsum are present in the Ah and AC horizons; soils with appreciable soluble salt are delineated as Drokan saline phase.

Generally, the average A horizon is 22 cm thick and varies from 15 to 35 cm; the average depth of its solum is 35 cm and varies from 15 to 70 cm. It differs from the closely related Penrith soil series in being less well developed and having shallower, less distinct horizons.

Fenton Series (FET)

The Fenton series consists of poorly drained, carbonated Rego Humic Gleysol soils developed on a thin mantle (25 to 75 cm) of silty clay to clay sediments over a thin strata (10 to 40 cm) of very strongly calcareous loamy glacial till of limestone and granitic origin over a strongly calcareous loam to clay loam glacial till of shale, limestone and granitic origin. These soils occur in level to depressional topography and are subject to ponding and prolonged wetness. Runoff is very slow; permeability is slow to very slow. Some salts may occur in the soil in areas of seepage or upward movement of groundwater containing appreciable soluble salts toward the surface.

The soil is characterized by a thin, moderately decomposed organic layer 2 to 5 cm thick, a very dark gray Ah horizon, 8 to 12 cm thick, a thin olive gray AC horizon, and olive C horizon that may have some yellowish brown mottles. Silt sized pseudo-mycelium of magnesium sulfate or gypsum may be present in the surface horizon of saline areas.

Floors Series (FLS)

The Floors series consists of moderately well to well drained Rego Black Chernozem soils developed on moderately to strongly calcareous, deep, stratified, sandy to sandy skeletal (S, GrS, GrCoS) outwash and glaciofluvial deposits. These soils occur in upper positions of gentle slopes on hummocky landscapes and have very rapid permeability, rapid surface runoff, and a low water table during the growing season. They have low available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation includes aspen-oak stands and tall prairie grasses. The majorities of these soils are used for grazing or are excavated for gravel deposits.

Floors soils occur in close association with Dorset and Mansfield soils. They are similar to Marringhurst soils by having well drained profile in glaciofluvial deposits but differ from them lacking a Bm horizon.

Hamiota Series (HMI)

The Hamiota series is characterized by an Orthic Humic Gleysol solum, developed on moderately to strongly calcareous, loamy (L, CL) morainal till of limestone, granitic and shale rock origin. They are poorly to very poorly drained and occur in depressional positions of the undulating to hummocky morainal landscape. Surface runoff is negligible and the soils may remain in a ponded condition unless the surface drainage has been improved. Permeability is moderately slow to slow. In some landscapes, these areas are influenced by seepage from adjacent higher lands, and may have a considerable content of soluble salts. Native vegetation consists of sedges, cattails, rushes and willows.

The Hamiota series differs from the closely related Drokan soil series in being more developed (presence of B horizon) and is less leached than the Penrith series.

Kirkness Series (KKS)

The Kirkness series consists of moderately well to well drained Orthic Black Chernozem soil developed on a thin mantle (25 to 60 cm) of sandy sediments (FS, LFS, LS) over a thin strata (10 to 40 cm) of very strongly calcareous loamy glacial till of limestone and granitic origin over a strongly calcareous loam to clay loam glacial till of shale, limestone and granitic origin. They occur on gently sloping to gently undulating topography. Runoff is low; permeability is rapid in the upper strata and moderately slow in the underlying till deposits.

The soil is characterized by a very dark gray Ah horizon 15 to 22 cm thick and a brown Bm horizon 12 to 18 cm thick. The depth of the solum varies with the thickness of the overlay; generally the BC extends to the contact of the sandy strata and the very strongly calcareous loamy till, which appears as a prominent Cca horizon.

Kleysen Series (KYS)

The Kleysen series consists of moderately well to well drained Calcareous Black Chernozem soils developed on a thin mantle (25 to 60 cm) of loamy lacustrine sediments over a thin strata (10 to 40 cm) of very strongly calcareous loamy glacial till of limestone and granitic origin over a strongly calcareous loam to clay loam till of shale limestone and granitic origin. These soils in the upper slope positions are of gently sloping, undulating or rolling topography. Runoff is moderate to moderately rapid; permeability is moderate in the lacustrine sediments and in the loose, very strongly calcareous till, and moderately slow to slow in the more compact, somewhat fissile loam to clay loam till.

The soil is characterized by a very dark gray to black Ah horizon 10 to 14 cm thick and a brown to dark brown calcareous Bm horizon 8 to 12 cm thick. The solum usually extends to the contact of the very strongly calcareous till.

Levine Series (LEI)

The Levine series consists of imperfectly drained Gleyed Cumulic Regosol soil developed on moderately to strongly calcareous, deep, stratified, coarse loamy to fine loamy (VFSL, L, CL) recent alluvial deposits. These soils occur in flood plains on level slopes in level landscapes. They have rapid permeability, moderately slow surface runoff and a medium water table during the growing season. Levine soils are occasionally slightly saline and are subject to periodic inundation during spring runoff or after heavy rains. They have a moderate to low available water holding capacity, low 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 15 cm thick and the profile is characterized by a dark gray Apk or Ahk horizon 10 to 20 cm thick and a light yellowish brown Ck horizon. The underlying strata may vary in colour from light to dark. The thin dark colored mineral and organic layers are former surface horizons that have been exposed to soil forming processes for a significant period before burial by alluvial deposits. Medium, distinct yellowish brown iron mottles occur through the soil. Levine soils were previously mapped as inclusions of Eroded Slope Complexes in the reconnaissance soil survey of South-Central Manitoba (1943).

Lockhart Series (LKH)

The Lockhart series consists of moderately well to well drained Orthic Black Chernozem soils developed on a thin mantle (25 to 60 cm) of very fine sandy sediments (VFS, LVFS, FSL) over a thin strata (10 to 50 cm) of very strongly calcareous loamy glacial till of limestone and granitic origin, over a strongly calcareous loam to clay loam glacial till of shale, limestone, and granitic origin. These soils occur on gently sloping to undulating topography. Runoff is moderate to moderately rapid; permeability is moderately rapid in the upper sandy strata and moderately slow in the underlying till. These soils have been slightly eroded.

The soil is characterized by a very dark gray Ah horizon 18 to 25 cm thick and a grayish brown to brown Bm horizon 12 to 20 cm thick. The depth of solum varies with the depth of the sandy overlay with the BC terminating at the contact of the sandy surface and very strongly calcareous till.

Lowton Series (LWN)

The Lowton series consists of poorly drained Rego Humic Gleysol soil developed on moderately to strongly calcareous, clayey, (SiC, C), lacustrine deposits. These soils occur in lower to depressional positions of nearly level landscapes and have very slow permeability, very slow surface runoff, and a high water table during the growing season. Lowton soils are non-eroded, non-stony, and moderately saline. They have high available water holding capacity, high organic matter content, and low natural fertility. Native vegetation includes native grasses, willows and sedges. The majority of these soils are currently under native vegetation.

In a representative profile the solum is approximately 20 cm thick. The profile is characterized by moderately decomposed LFH horizon, 1 to 5 cm thick, a very dark gray Ah horizon, 5 to 20 cm thick with carbonates, and a dark gray to olive gray Ckg horizon, with many mottles and carbonate concentrations. A typical profile also contains till at 1 to 2.5 m below the surface. Lowton soils occur in close association with Sigmond and Janick soils. They are similar to Landseer soils by having a Rego Humic Gleysol profile developed in clayey sediments but differ from them in having uniform textures throughout while Landseer soils are stratified at depth. Lowton soils were previously mapped as minor inclusions of the Oliver Association in the South-Central Manitoba (1943) reconnaissance soil survey.

Marringhurst Series (MRH)

The Marringhurst series consists of moderately well to well drained Calcareous Black Chernozem soil developed on moderately strongly to strongly calcareous, stratified, deep, sandy (CoS, S, LS) and sandy skeletal (GrS, GrCoS) glaciofluvial deposits. These soils occur in upper positions of very gentle slopes on rolling to irregular landscapes and have very rapid permeability, low surface runoff, and a low water table during the growing season. Marringhurst soils are often moderately eroded, non-stony, and non-saline. They have low available water holding capacity, low organic matter content, and low natural fertility. Native vegetation includes shrubs, bur oak, and prairie grasses. The majority of these soils are currently excavated for gravel or used for grazing.

In a representative profile soil the solum is approximately 25 cm thick. The profile is characterized by a very dark gray to very dark grayish brown Ah horizon, 14 to 18 cm thick, a dark brown to brown Bmk horizon, 10 to 18 cm thick, a Cca horizon, 20 to 30 cm thick with coarser gravelly strata and a Ck horizon.

The Marringhurst, shale gravel variant, MRH1, occurs in close association with normal Marringhurst soils and differs by having a dominantly shale derived gravel. Marringhurst soils occur in close association with Dorset, Dexter and Fortina soils. They are similar to Dorset soils by having a well drained profile in sandy skeletal deposits but differ from them in having a Bmk rather than Bm horizon. Marringhurst soils were mapped as the dominant associate of the Marringhurst in the Carberry (1957) soil report.

Marsden Series (MDN)

The Marsden series consists of poorly drained Rego Humic Gleysol carbonated soil developed on a sequence of strata consisting of a thin lacustrine mantle (25 to 60 cm) of moderately to strongly calcareous loamy sediments (VFSL to SiCL) over thin (10 to 40 cm) of medium sand to gravel strata over strongly calcareous loam to clay loam glacial till of shale, limestone and granitic origin. The topography is level to depressional; runoff is negligible, and permeability is restricted during periods when free water is at or near the surface.

The soils are characterized by a thin, moderately decomposed organic layer, 1 to 4 cm, a very dark gray Ah horizon, 12 to 18 cm and an olive brown AC frequently developed in the sand strata. The C horizon is olive gray with many prominent mottles and usually occurs at the till contact. Marsden soils were previously mapped as minor associates of the Heaslip complex in the Reconnaissance soil survey of South-Central Manitoba (1943).

Marsh Complex (MHC) or ($MH)

The Marsh complex consists of very poorly drained Rego Gleysol soils developed on lacustrine clay or thin mucky loam deposits over extremely calcareous till and/or moderately calcareous clay. These soils occur on level to depressional areas that are covered with water and are usually saturated for most of the year. The native vegetation consists entirely of reeds and sedges.

These soils have a thin surface layer of either muck or mineral material high in organic matter content and are underlain by strongly gleyed, olive gray mineral materials. A very thin Ahg horizon, less than 3 cm thick, may be present below the muck surface layer. Marsh soils are undifferentiated with respect to texture and composition of their parent material. They also are much more poorly drained than other Gleysolic soils.

Melland Series (MXT)

The Melland series consists of the imperfectly drained, Gleyed Rego Black Chernozem, carbonated soils developed on a sequence of materials consisting of a thin mantle (25 to 60 cm) of moderately to strongly calcareous loamy (VFSL to SiCL) sediment over a thin (10 to 40 cm) layer of medium sand to gravel strata over strongly calcareous loam to clay loam glacial till of shale, limestone, and granitic origin. Topography is level to gently sloping; runoff is moderately slow; permeability is moderate in the upper strata, but restricted above the till due to perched water conditions. Lateral flow of water occurs through the gravel strata during the spring or following heavy rains.

The soil is characterized by a very dark gray Ah horizon 18 to 25 cm thick, and a dark gray to grayish brown AC horizon, 10 to 15 cm thick. A lime accumulation (Cca) horizon is usually present at the transition from loamy to gravel strata. Melland soils are more permeable than the very similar, finer textured Beresford series.

Miniota Series (MXI)

The Miniota series consists of moderately well to well drained Orthic Black Chernozem soils developed on a thin mantle (<1 m) of moderately to strongly calcareous very fine sand to fine sandy loam textured sediments over moderately to strongly calcareous, medium sand to gravelly textured deposits. The topography varies from gently sloping to irregular, moderately rolling. Runoff is moderate to moderately rapid, and permeability is rapid in the sandy strata and very rapid in the lower coarser strata. They occur in close association with the imperfectly drained Wytonville and Kilmury soils and the poorly drained Bornett series.

The soil is characterized by a very dark gray to very dark grayish brown Ah horizon, 12 to 20 cm thick, a dark brown to brown Bm horizon, 10 to 18 cm thick, and a pale brown BC horizon. The depth of solum varies with the depth of the sandy strata; the lime accumulation (Cca) horizon usually occurs at the transition from sandy to coarser sediments. Miniota soils are less permeable and less droughty than the very similar coarser textured Wheatland and Dorset soils. The similar, finer textured Croyon soils are less droughty.

Moore Park Series (MPK)

The Moore Park series is characterized by a Gleyed Black Chernozem (carbonated) solum on moderately to strongly calcareous, loamy (L, CL) morainal till of limestone, granite and shale origin. These soils are imperfectly drained and occur in the lower slope positions of undulating to hummocky landscapes in close association with Varcoe soils. They receive runoff from the upper slopes, and in some landscapes, may be influenced by seepage. Permeability is slow and may be restricted during periods of subsoil saturation.

Newdale Series (NDL)

The Newdale series is characterized by an Orthic Black Chernozem solum on moderately to strongly calcareous, loamy (L, CL) morainal till of limestone, granitic and shale origin. These soils are moderately well to well drained and occur in mid to upper slope positions of undulating to hummocky landscapes. Surface runoff is moderate to moderately rapid; permeability is moderately slow. Most of these soils are presently cultivated; they have formed under intermixed aspen grove and grassland vegetation.

The Newdale solum has a very dark gray Ah horizon, commonly 25 cm thick and ranging from 15 to 35 cm, a dark brown Bm horizon, 10 to 30 cm thick, and a transitional BC horizon, 3 to 15 cm thick. A lime carbonate horizon, 10 to 15 cm thick is often present in shallower soils but is not evident in deeper profiles. Its solum depth averages 58 cm and ranges from 25 to 90 cm. Minor amounts of well drained Eluviated Black Chernozem soils are included within the Newdale mapping units. They have solum thickness ranging from 75 cm to greater than 1 m. They also have thicker A (combined Ah, Ahe) horizons, 30 to 60 cm and Bt horizons that are 40 cm thick.

The Newdale soils differ from Erickson soils in being less strongly leached and having less distinct and shallower solum. Newdale soils, on the other hand, differ from the very similar Rufford and Cordova soils in being more strongly leached, deeper and free of lime carbonate in the A and B horizons.

Penrith Series (PEN)

The Penrith series is a Humic Luvic Gleysol solum developed on moderately to strongly calcareous, loamy (L, CL) morainal till of limestone, granitic and shale rock origin. These soils are poorly drained and occur in depressional positions of undulating to hummocky landscapes. These soils are ponded for a variable period in the spring and early summer; they usually are free of water in the summer and fall, unless replenished by heavy rains and runoff. Permeability is very slow within the solum and moderately slow in the subsoil. Vegetation consists of sedge and willow.

The solum of the Penrith series commonly has a moderately to strongly decomposed organic layer, 4 to 8 cm thick, a dark gray to gray Ahe horizon, 6 to 10 cm thick, a light gray, platy Aeg horizon, 6 to 10 cm thick, a dark gray to gray Btg horizon, 35 to 45 cm thick, and a gray transitional BC, 15 to 25 cm thick. The A horizon thickness averages 22 cm and ranges from 5 to 45 cm; the average solum depth is 77 cm and ranges from 30 to 105 cm. These soils differ from the Drokan soils in being more strongly leached and having more distinct and thicker horizons.

Rufford Series (RUF)

The Rufford series is characterized by a Rego Black Chernozem solum on moderately to strongly calcareous, loamy (L, CL) morainal till of limestone, granite and shale origin. These soils are moderately well to well drained and occur on the upper slopes and knoll positions in undulating to hummocky landscapes in close association with Cordova and Newdale soils. Runoff is moderately rapid to rapid; permeability is moderately slow.

Rufford profiles have a very dark gray to very dark grayish brown Ah horizon, 12 to 18 cm thick and a thin AC horizon, 6 to 10 cm thick. A carbonate accumulation (Cca) layer, 5 to 15 cm thick, is usually present. In the Russell area, the A horizon averages 28 cm and ranges from 10 to 50 cm; the solum depth averages 37 cm and ranges from 20 to 55 cm. Rufford soils differ from Cordova soils in being less leached and having thinner, less distinct horizons. Both Rufford and Cordova differ from Newdale in being less leached and having free lime carbonate in their A and B horizons.

Tadpole Series (TDP)

The Tadpole series is a Rego Humic Gleysol, developed on poorly drained, strongly to very strongly calcareous, fine loamy (CL, SiCL), lacustrine sediments. These soils occur in level to depressional positions of gently sloping to undulating topography in association with Carroll, Firdale, Charman and Danlin soils. Surface runoff is very slow and permeability is restricted. Free water occurs at or near the surface for a considerable part of the year. In areas where seepage water contains appreciable soluble salt; a sufficient salt accumulation can occur to inhibit or retard the growth of normal hydrophytic vegetation.

The Tadpole soil profile has a moderately decomposed organic layer, 2 to 6 cm thick; a very dark gray Ah horizon, 10 to 18 cm thick; a dark gray AC horizon, 4 to 6 cm thick; a Cca horizon, 10 to 15 cm thick, and an olive to olive gray Ckg horizon with distinct yellowish brown mottles. In areas affected by salts, white pseudomycelia are common in the surface horizons. Tadpole soils are finer textured and less permeable than the very similar and more coarse textured Vordas, Poolex and sandy Mockry and Sewell soils. The similar Carvey soils have coarser textured sandy to gravelly subsurface layers that are much more rapidly permeable than the Tadpole soils.

Varcoe Series (VRC)

The Varcoe series is characterized by a Gleyed Rego Black Chernozem (carbonated) solum on moderately to strongly calcareous, loamy (L, CL) morainal till of limestone, granite and shale origin. These soils are imperfectly drained and occur in the lower slope positions of undulating to hummocky landscapes in close association with Angusville soils. They receive runoff from the upper slopes, and in some landscapes, may be influenced by seepage. Permeability is slow and may be restricted during periods of subsoil saturation. In areas where upward groundwater or seepage waters contain appreciable salts, accumulation of salts may occur within the soil.

Varcoe profiles average 42 cm in thickness and range from 20 to 60 cm. The A horizon is usually 28 cm thick and ranges from 20 to 50 cm; very dark gray in color and is underlain by a dark gray transitional AC horizon, 4 to 8 cm thick. A carbonate accumulation horizon (Cca) is commonly present, but may be discontinuous. Gypsum crystals are usually present below and within the carbonate accumulation layer. Varcoe soils containing significant soluble salts in the A horizon as well as gypsum, have been identified as the saline phase of the series.

Vodroff Series (VFF)

The Vodroff series consists of poorly drained Rego Humic Gleysol soils developed on a thin mantle (<1 m) of loamy (L, CL, SiCL) lacustrine sediments over a strongly calcareous loam to clay loam glacial till of shale, limestone and granitic origin. These soils have free water at or near the surface for a considerable period of the year. The topography is level to depressional; runoff is negligible; permeability is restricted during periods of free water within a metre. In areas where the inflowing waters contain appreciable soluble salts, the salt may accumulate in the soil in sufficient amount to affect the growth of normal hydrophytic vegetation.

The soil is characterized by a moderately decomposed organic layer, 2 to 5 cm thick, a very dark gray Ah horizon, 10 to 18 cm thick, a mottled dark gray AC horizon, 4 to 8 cm thick and a carbonate accumulation horizon, 8 to 12 cm thick. The Ckg horizon is olive to pale olive and usually contains yellowish brown mottles.

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