Agriculture and Agri-Food Canada
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Rural Municipality of Wallace

Information Bulletin 96-14

Soils and Terrain

An introduction to the land resource

Land Resource Unit
Brandon Research Centre

Canada

Rural Municipality of Wallace

Information Bulletin 96-14

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PREFACE

This is one of a new series of information bulletins for individual rural municipalities of Manitoba. They serve to introduce the newly developed digital soil and terrain databases, and illustrate several typical derived map products for agricultural land use planning applications. The bulletins will also be available in diskette format for selected rural municipalities.

Information contained in this bulletin may be quoted and utilized with appropriate reference to the originating agencies. The authors and originating agencies assume no responsibility for the misuse, alteration, re-packaging, or re-interpretation of the information.

This information bulletin serves as an introduction to the land resource information available for the municipality. More detailed information, including copies of the primary soil and terrain maps at larger scales, may be obtained by contacting:

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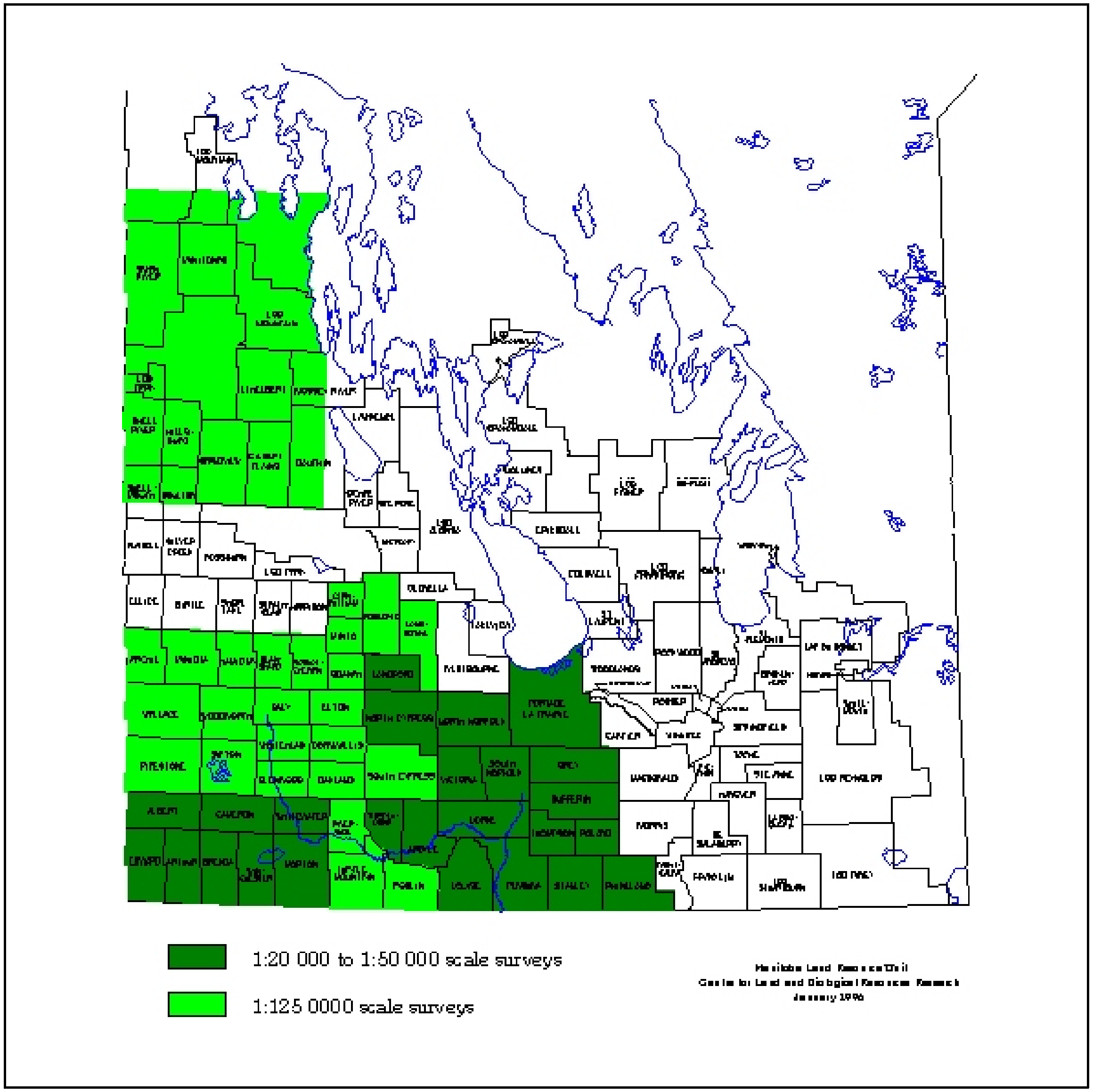


Figure 3. Rural municipalities in southern Manitoba with digital soil and terrain map information (1996).

INTRODUCTION

This information bulletin is one of a new series prepared for selected rural municipalities in southern Manitoba (Figure 1). A brief overview of the soil and terrain database information assembled for each municipality is presented, as well as a set of maps derived from the data for typical agricultural land use and planning applications.

The soil and terrain maps and databases were compiled and registered using the computerized Geographic Information System (GIS) facilities of the Manitoba Land Resource Unit. These GIS databases were used to create the generalized interpretive maps and statistics contained in this report.

LAND RESOURCE DATA

The soil and terrain (landscape) information were obtained as part of a larger project to provide a uniform level of land resource information for agricultural and regional planning purposes throughout Agro-Manitoba. This information was compiled and analyzed in digital form, using Geographic Information System (GIS) techniques. Three distinct layers of information were used, as shown in Figure 2.

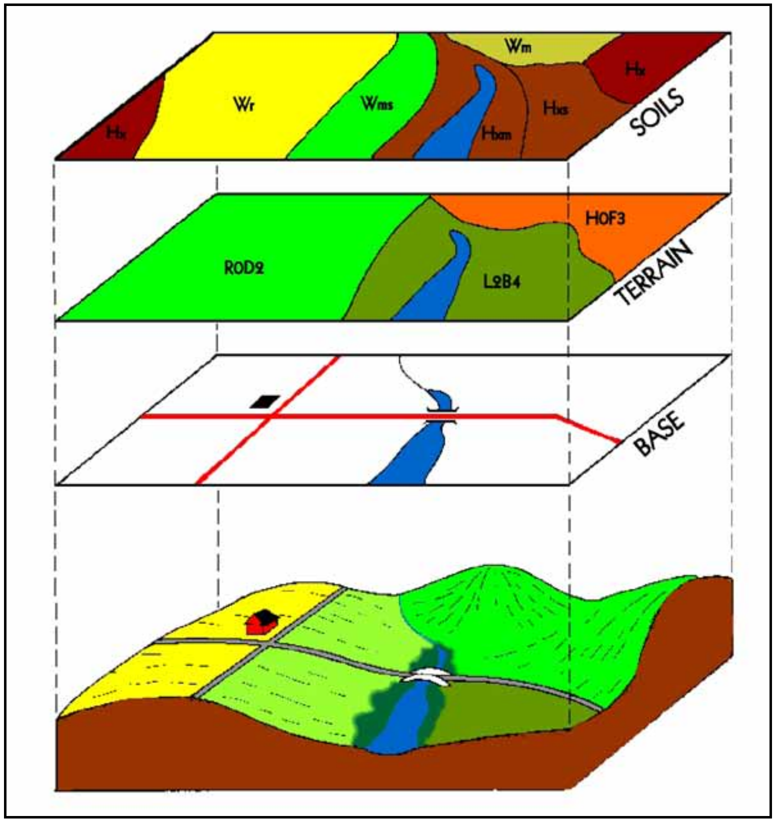


Figure 2. Soil, Terrain, and Base Map data.

Base Layer

Digital base map information includes the municipality and Township boundaries, and major streams, roads and highways. The soil and terrain layers were added and aligned ("georeferenced") to the digital base map. Major rivers and lakes from the base layer were also used as common boundaries for the soil and terrain map layers. Water bodies larger than 25 ha in size were digitized as separate polygons.

Terrain Layer

A separate terrain layer was produced for municipalities for which only reconnaissance scale soil map coverage was available. This was compiled by aerial photo-interpretation techniques, using recent 1:50 000 scale stereo airphoto coverage. The terrain information was transferred from the photographs onto the standard RM base and digitized in the GIS. Where the soil and terrain boundaries coincided, such as along prominent escarpments and eroded stream channels, the new terrain line was used for both layers. The terrain line, delineated from modern airphoto interpretation, was considered more positionally accurate than the same boundary portrayed on the historical reconnaissance soil map. Each digital terrain polygon was assigned the following legend characteristics:

- Surface form
- Slope class
- Slope length class
- Percent wetlands
- Wetland size
- Erosional modifiers
- Extent of eroded knolls
- Polygon number

The first four legend fields are considered differentiating, that is, a change in any of these classes defines a new polygon.

Soil Layer

The most detailed soil information currently available was selected as the data source for the digital soil layer for each rural municipality.

Comprehensive detailed soil maps (1:20 000 to 1:50 000 scale) have been published for many rural municipalities. Where they were available, the individual soil map sheets were digitized and compiled as a single georeferenced layer to match the digital RM base. Map polygons have one or more soil series components, as well as slope and stoniness classes. Soil database information was produced for each polygon, to meet national standards (MacDonald and Valentine, 1992). Slope length classes were also added, based on photo-interpretation.

Older, reconnaissance scale soil maps (1:126 720 scale) represented the only available soil data source for many rural municipalities. These maps were compiled on a **soil association** basis, in which soil landscape patterns were identified with unique surficial geological deposits and textures. Each soil association consists of a range of different soils ("associates") each of which occurs in a repetitive position in the landscape. Each polygon digitized from the reconnaissance soil map was assigned the following legend characteristics:

Map symbol and modifier (overprinted symbol)
Soil Association or Complex name
Soil series and modifier codes
Polygon number

A modern soil series that best represents the soil association was identified for each soil polygon. The soil and modifier codes provide a link to additional databases of soil properties. In this way, both detailed and reconnaissance soil map polygons were related to soil drainage, surface texture, and other soil properties to produce various interpretive maps.

SOIL AND TERRAIN OVERVIEW

The Rural Municipality (RM) of Wallace covers 12 Townships (approximately 116 000 ha) in south western Manitoba. The Town of Virden is the largest population centre. Land use within the rural municipality is predominantly agriculture.

Soils in the Rural Municipality of Wallace have been mapped (1:126 720 scale) previously in the Reconnaissance Soil Survey of the Rossburn and Virden Map Sheet Areas (Ehrlich et al., 1956). More detailed soil information is provided at a 1:20 000 scale for the Virden townsite area (Podolsky, 1985).

Based on climatic data from Virden (Environment Canada, 1982), the mean annual temperature is 2.0°C; mean annual precipitation of 462 mm; frost-free period is 120 days; degree days above 5°C is 1702. The seasonal moisture deficit between May to September is 250 to 300 mm; effective growing degree days (EGDD) above 5°C for the same period is 1400 to 1500. This parameter provides an indication of heat energy available for crop growth (Agronomic Interpretations Working Group, 1995). Land use in the RM is mainly cereal, oilseed or forage crop production.

Two distinct physiographic areas occur in the municipality: the Souris Plain and the Pipestone Plain (Oxbow Till Plain in published soil reports) and the Antler River-Lake Souris Plain (Lake Souris Basin in published soil reports). The majority (approximately 90%) of the RM is in the Oxbow Till Plain. Elevations in this area vary from approximately 550 masl in the southwest to 460 m in the east. The land surface is mainly hummocky and undulating; relief is low, mainly less than 4 m and slopes are less than 9%. The Lake Souris Basin occupies a small area in the southeast corner of the RM. The average elevation in this level to gently undulating plain is about 435 masl. Local relief is low (generally less than 3 m) with slopes less than 5%. The Assiniboine Valley cuts across the extreme northeast corner of the RM. The land surface changes rapidly in this area as the valley bottom is eroded some 60 m into the till plain. Steep side slopes occur along the walls of this valley and along other waterways that cross the RM, such as Bosshill Creek, Gopher Creek, and Pipestone Creek.

The dominant soils in the RM are Orthic Black Chernozems in well drained positions with inclusions of Gleyed Black soil in lower landscape positions and Humic Gleysols in poorly drained depressional sites with high seasonal water tables.

Soils in the Oxbow Till Plain are developed on strongly calcareous loam to clay loam glacial till derived from local shale bedrock, limestone, and granitic materials. The land surface is marked by an irregular pattern of low knolls and ridges separated by shallow poorly drained depressions. Soils of the Oxbow Association are dominant in this area: well drained soils in upper and mid slope positions, inclusions of imperfectly drained soil in lower slopes and poorly drained soils in depressional areas. Agriculture capability of the Oxbow soils varies from class 2 to 3T with class 4T soils in areas of higher relief. Local areas of class 5 to 7 soil occur in areas of excessive slopes or wetness. Irrigation suitability is good in low relief areas, fair in areas of higher relief and poor in poorly drained areas. The potential for environmental impact under irrigation ranges from low to high. Risk of water erosion varies from negligible to severe, depending on degree of slope.

Soils of the Oxbow modified phase adjacent to the Assiniboine Valley are developed in a veneer of water worked till or shaly gravel overlying the regional till and are moderately well to imperfectly drained. Soil textures in the upper 30 to 50 cm vary from sandy loam to clay loam. Areas of low relief are rated in agriculture capability class 3 with class 5 or 6T soils on the steeper slopes. Irrigation suitability is fair and potential environmental impact under irrigation is moderate. The risk of water erosion varies, mainly due to topography.

Areas of Oxbow saline phase soils in the northern part of the RM are mainly imperfectly drained and often characterized by salinity or poor structure associated with Solonetzic soil features. These soils are rated in agriculture capability class 3 and the irrigation suitability is fair to poor, depending on topography and salinity. Water erosion risk is negligible to low, depending on topography.

Soils in the Lake Souris Basin are developed on fluvial and lacustrine deposits. They are grouped by texture in four soil associations; gravelly sands (Marringhurst Association), sandy sediments over medium to coarse sands (Miniota Association), sandy (Souris Association) and loam to clay loams (Carroll Association). The well drained Miniota and Marringhurst soils have very low water retention capacity and rapid permeability; they are rated as class 5M for agriculture capability and poor for irrigation suitability. The potential for environmental impact under irrigation is high.

The sandy soils of the Souris Association are dominantly imperfectly drained and are rated in class 3 for agriculture due to periodic droughtiness and wetness. Land use includes production of cereal crops, forages and grazing. Irrigation suitability is good to poor and the potential environmental impact is high. These soils have a negligible risk of water erosion, but are very susceptible to erosion by wind if the soil surface is left bare. Poorly drained Souris soils are rated in class 5W. Land use is mainly forage production and grazing.

Soils of the Carroll Association, till substrate phase consist of dominantly well drained loam to clay loam textured lacustrine sediments underlain by stony till within a depth of 1 m. Agriculture capability is class 1 and 2; irrigation suitability is fair and potential environmental impact is low. Land use is mainly cereal crop production.

DERIVED AND INTERPRETIVE MAPS

A large variety of computer derived and interpretive maps can be generated, once the soil and terrain data are stored in digital format. These maps are based on selected combinations of database values and assumptions.

Derived maps show information that is given in one or more columns in the computer map legend (such as soil texture, drainage, stoniness, or slope class).

Interpretive maps portray a more complex evaluation of information presented in the legend which was combined in a unique way to arrive at an entirely new map.

Several examples of derived and interpretive maps are included in this information bulletin. The maps have all been reduced in size and generalized (simplified), in order to portray conditions for an entire rural municipality on one page. Only interpretations based on the dominant soil and terrain conditions in each polygon are shown at such reduced scales. These generalized maps provide a useful overview of conditions within a municipality, but are not intended to apply to site specific land parcels.

The digital databases may also contain more detailed information concerning significant inclusions of differing soil and slope conditions in each map polygon, particularly where they have been derived from modern detailed soil maps. This information can be portrayed at larger map scales.

Information concerning particular interpretive maps, and the primary soil and terrain map data, can be obtained by contacting the Manitoba Land Resource Unit.

Slope Map.

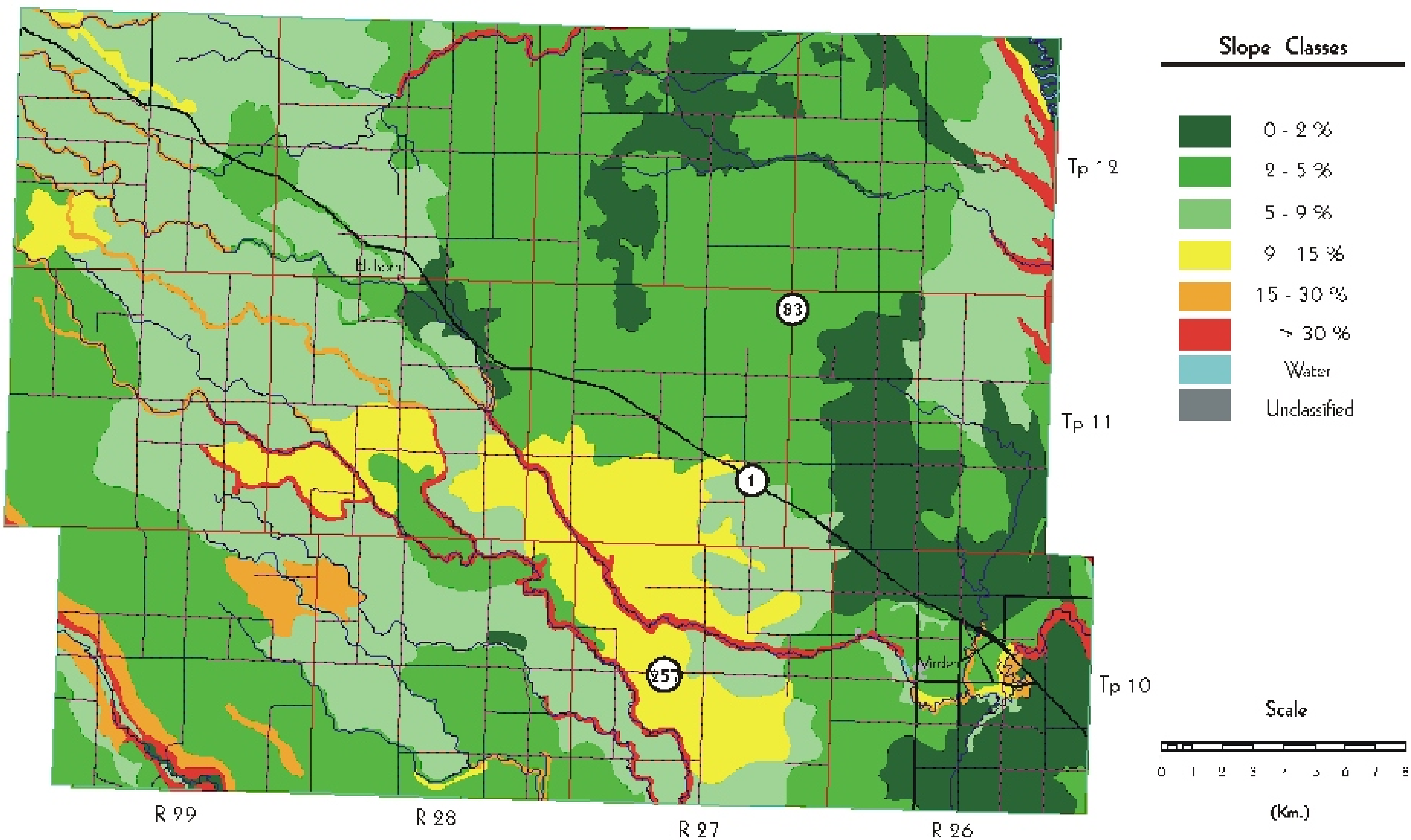
Slope describes the steepness of the landscape surface. The slope classes shown on this map are derived from the digital terrain layer database. Specific colours are used to indicate the most significant, limiting slope class for each terrain polygon in the RM. Additional slope classes can occur in each polygon area, but cannot be portrayed at this reduced map scale.

Table 1. Slope Classes[1]

Slope Class	Area (ha)	Percent of RM
0 - 2 %	14962	12.9
2 - 5 %	48272	41.5
5 - 9 %	36301	31.2
9 - 15 %	9977	8.6
15 - 30 %	3491	3.0
> 30 %	3210	2.8
Water	68	0.1
Unclassified	30	0.0
Total	116311	100.0

[1] Area has been assigned to the most significant limiting slope for each terrain polygon. Significant areas of lesser slope, and smaller areas of greater slope may occur in each terrain polygon.

Rural Municipality of Wallace Slope Map



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Surface Form Map.

Surface forms describe the overall shape of the earth's surface. The various surface forms may exhibit a regular (or irregular) pattern of convexities and concavities, and are commonly associated with characteristic ranges of slope gradients and slope lengths. They may also imply particular modes of origin. For example, scrolled and terraced surface forms are created by river and stream deposits, while undulating and hummocky surface forms are frequently associated with glacial moraines. A description of the various surface form classes are contained in a separate Soil and Terrain Classification System Manual (Manitoba Land Resource Unit, 1996).

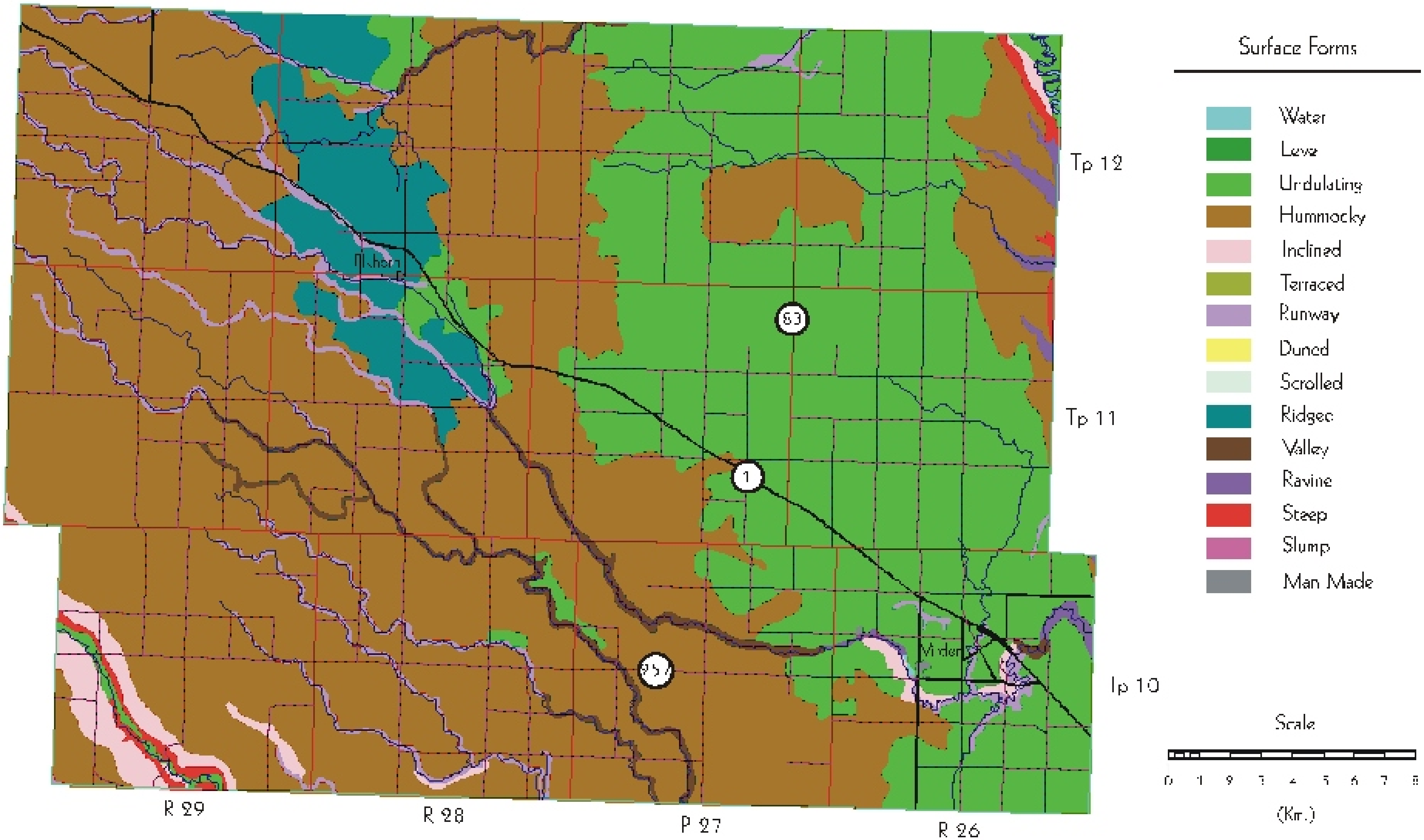
Surface form and slope class are two key features of the digital terrain map layer. Both of these characteristics are important controlling and influencing factors to consider for sustainable land use planning and management.

Table 2. Surface Form and Slope Classes[1]

Surface Form Slope Class	Area (ha)	Percent of RM
Hummocky	**63625**	**54.7**
C (2.0 to 5.0%)	28094	24.2
D (6.0 to 9.0%)	25020	21.5
E (10.0 to 15.0%)	9665	8.3
F (16.0 to 30.0%)	846	0.7
Inclined	**2058**	**1.8**
C (2.0 to 5.0%)	144	0.1
D (6.0 to 9.0%)	575	0.5
E (10.0 to 15.0%)	312	0.3
F (16.0 to 30.0%)	1028	0.9
Ravine	**629**	**0.5**
H (31.0 to 70.0%)	72	0.1
J (> 70.0%)	557	0.5
Man Made	**30**	**0.0**
Ridged	**5907**	**5.1**
C (2.0 to 5.0%)	187	0.2
D (6.0 to 9.0%)	5720	4.9
Steep	**637**	**0.5**
J (> 70.0%)	637	0.5
Undulating	**37803**	**32.5**
B (0.5 to 2.0%)	14962	12.9
C (2.0 to 5.0%)	18643	16.0
D (6.0 to 9.0%)	4198	3.6
Runway	**3611**	**3.1**
C (2.0 to 5.0%)	1205	1.0
D (6.0 to 9.0%)	788	0.7
F (16.0 to 30.0%)	1618	1.4
Valley	**1944**	**1.7**
H (31.0 to 70.0%)	426	0.4
J (> 70.0%)	1519	1.3
Water	**68**	**0.1**
Total	**116311**	**100.0**

[1] Area has been assigned to the most significant limiting slope for each terrain polygon. Significant areas of lesser slope, and smaller areas of greater slope may occur in each terrain polygon.

Rural Municipality of Wallace Surface Form Map



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Generalized Soil Map.

All soil polygons on the original published reconnaissance maps were digitized to create the soil layer. In some cases, areas of overprinted symbols on the original maps were delineated as additional new soil polygons.

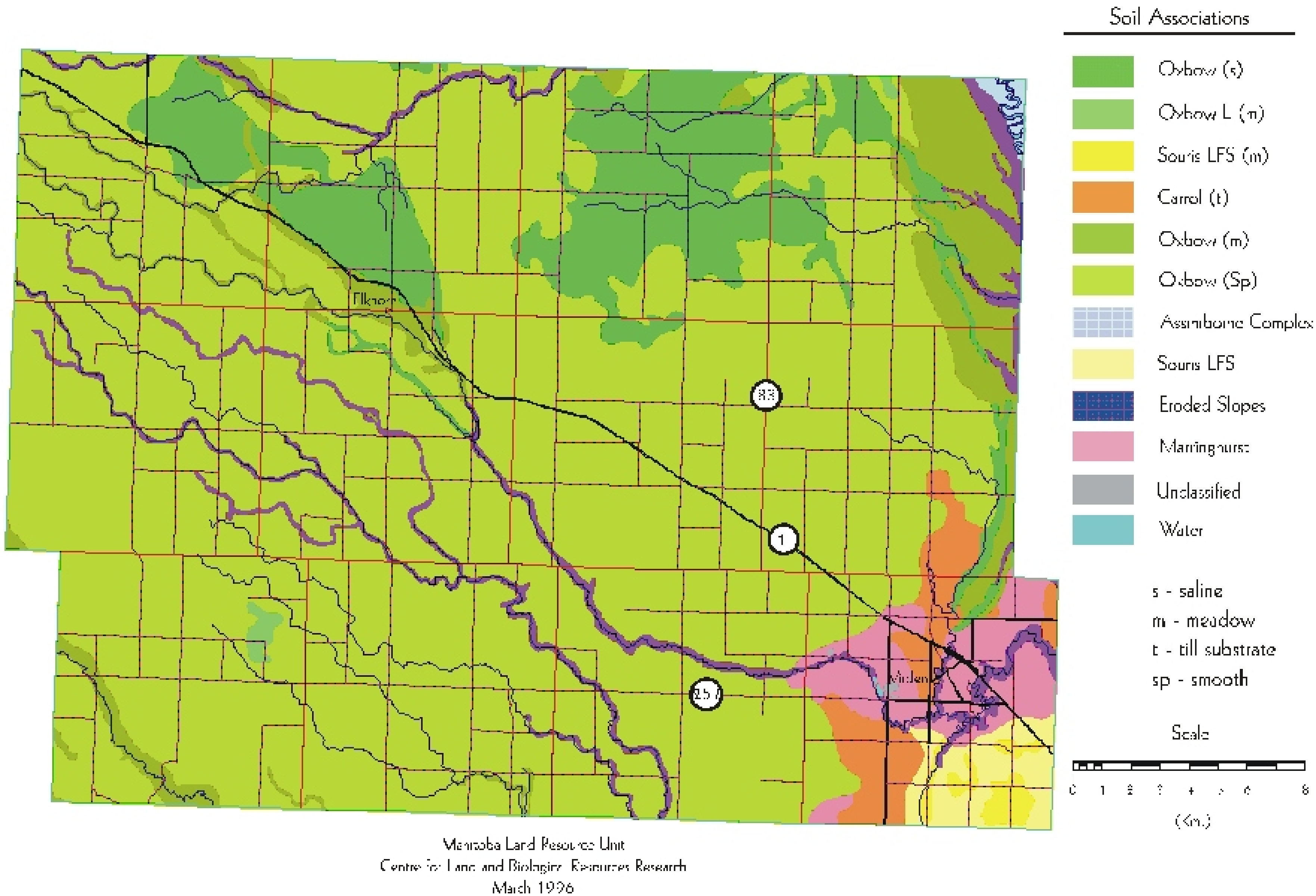
This generalized soil map has been reduced in size and simplified by grouping the original soil association polygons. The groups have been colour themed according to similar modes of origin, texture, and soil drainage. Soils derived from glacial till deposits (typically loam to clay loam in texture) have been assigned blue and green colours. Soils developed from glacial lake deposits are coloured yellow (sandy), orange (loam), or brown (clay). Sand and gravel deposits are coloured in pink.

The groups have been named after the dominant soil association, and the statistics for each the groups have been summarized (in bold). The original reconnaissance map symbol types and their areal extent in the municipality are shown within each group.

Table 3. Generalized Soil Association Groups

Association Group Associate	Area (ha)	Percent of RM
Oxbow (s)	**12806**	**11.0**
Om (degraded)	248	0.2
Om (meadow)	868	0.7
Osa	11691	10.1
Oxbow (l - m)	**250**	**0.2**
Ol (meadow)	250	0.2
Souris (LFS - m)	**593**	**0.5**
Slfs (meadow)	593	0.5
Carroll (CL/t)	**2597**	**2.2**
Ccl/t	2460	2.1
Ec	137	0.1
Oxbow (modified)	**7074**	**6.1**
Om	7074	6.1
Oxbow (smooth)	**83626**	**71.9**
Ol	67415	58.0
Osp	16212	13.9
Assiniboine Complex	**233**	**0.2**
As	233	0.2
Souris (LFS)	**1563**	**1.3**
Slfs	1563	1.3
Eroded Slopes	**4285**	**3.7**
Er	4285	3.7
Marringhurst	**3188**	**2.7**
M	2552	2.2
Ma	637	0.5
Man Made	**30**	**0.0**
Water	**68**	**0.1**
Total	**116311**	**100.0**

Rural Municipality of Wallace Generalized Soil Map



Agricultural Capability Map.

This evaluation utilizes the 7 class Canada Land Inventory system (CLI, 1965). Classes 1 to 3 represent the prime agricultural land, classes 4 and 5 represent marginal lands, and classes 6 and 7 are considered unsuitable for dryland agriculture.

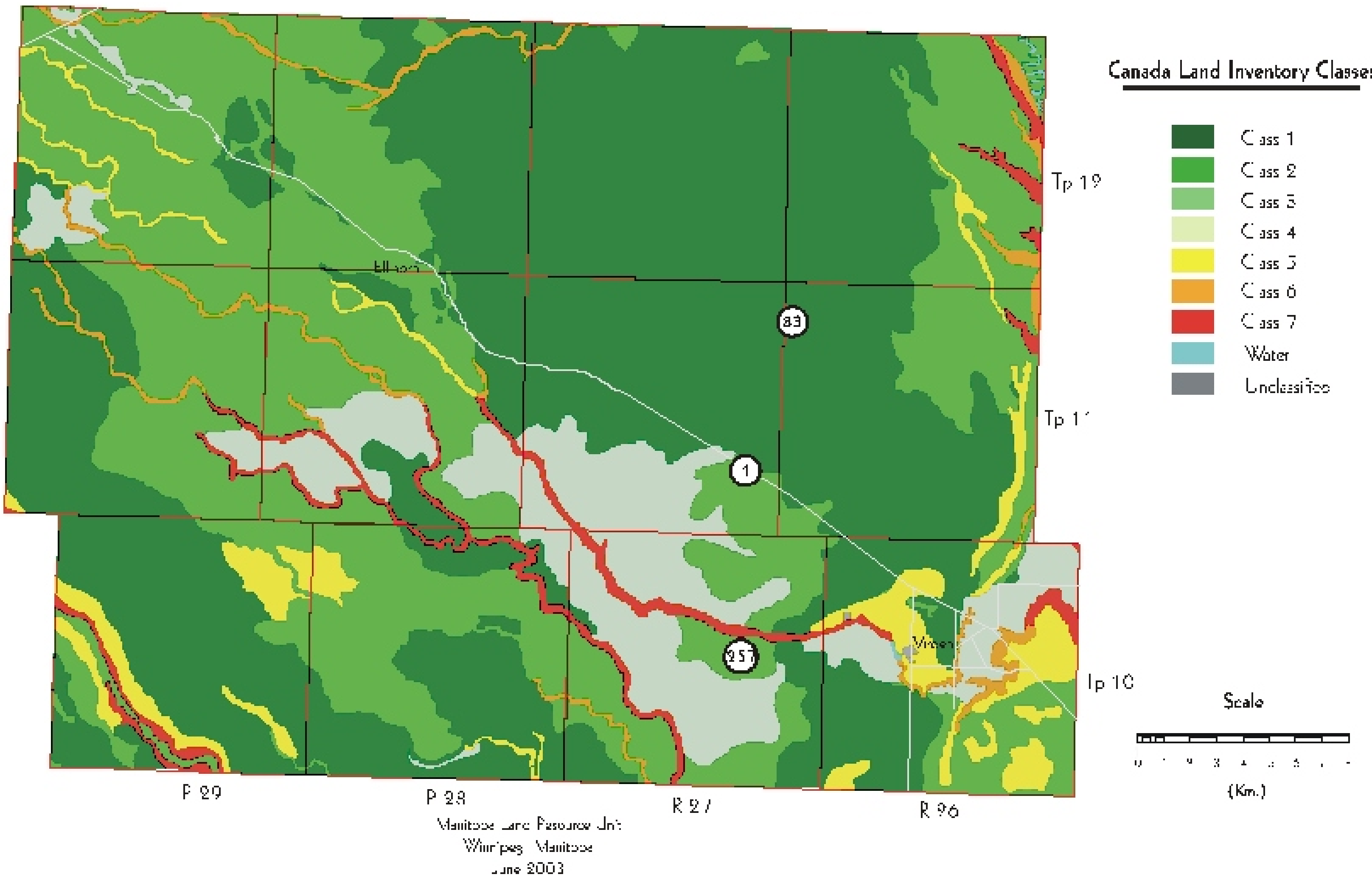
This generalized interpretive map is based on the dominant modern soil type for the soil polygon, in combination with the dominant slope class identified from the terrain polygon layer. The nature of the CLI subclass limitations and the classification of subdominant components cannot be portrayed at this generalized map scale.

Table 4. Agricultural Capability[1]

Class Subclass	Area (ha)	Percent of RM
2	**54473**	**46.8**
2T	44435	38.2
2X	10038	8.6
3	**40220**	**34.5**
3I	232	0.2
3M	4414	3.8
3MT	3547	3.0
3T	32028	27.5
4	**11443**	**9.8**
4M	1459	1.3
4MT	103	0.1
4R	138	0.1
4T	9743	8.4
5	**5520**	**4.7**
5	250	0.2
5M	1616	1.4
5T	2451	2.1
5W	1203	1.0
6	**1947**	**1.7**
6T	1947	1.7
7	**2718**	**2.3**
7	378	0.3
7T	2339	2.0
Unclassified	**30**	**0.0**
Water	**69**	**0.1**
Total	**116420**	**100.0**

[1] Based on **dominant** soil and slope of the respective soil and terrain maps.

Rural Municipality of Wallace Agriculture Capability Map



Irrigation Suitability Map.

Irrigation suitability is a four class rating system. Classes are **Excellent, Good, Fair, and Poor**. Irrigation ratings are based on an assessment of the most limiting combination of soil and landscape conditions. Soils in the same class have a similar relative suitability or degree of limitation for irrigation use, although the specific limiting factors may differ. These limiting factors are described by subclass symbols at detailed map scales. The irrigation rating system does not consider water availability, method of application, water quality, or economics of irrigated land use.

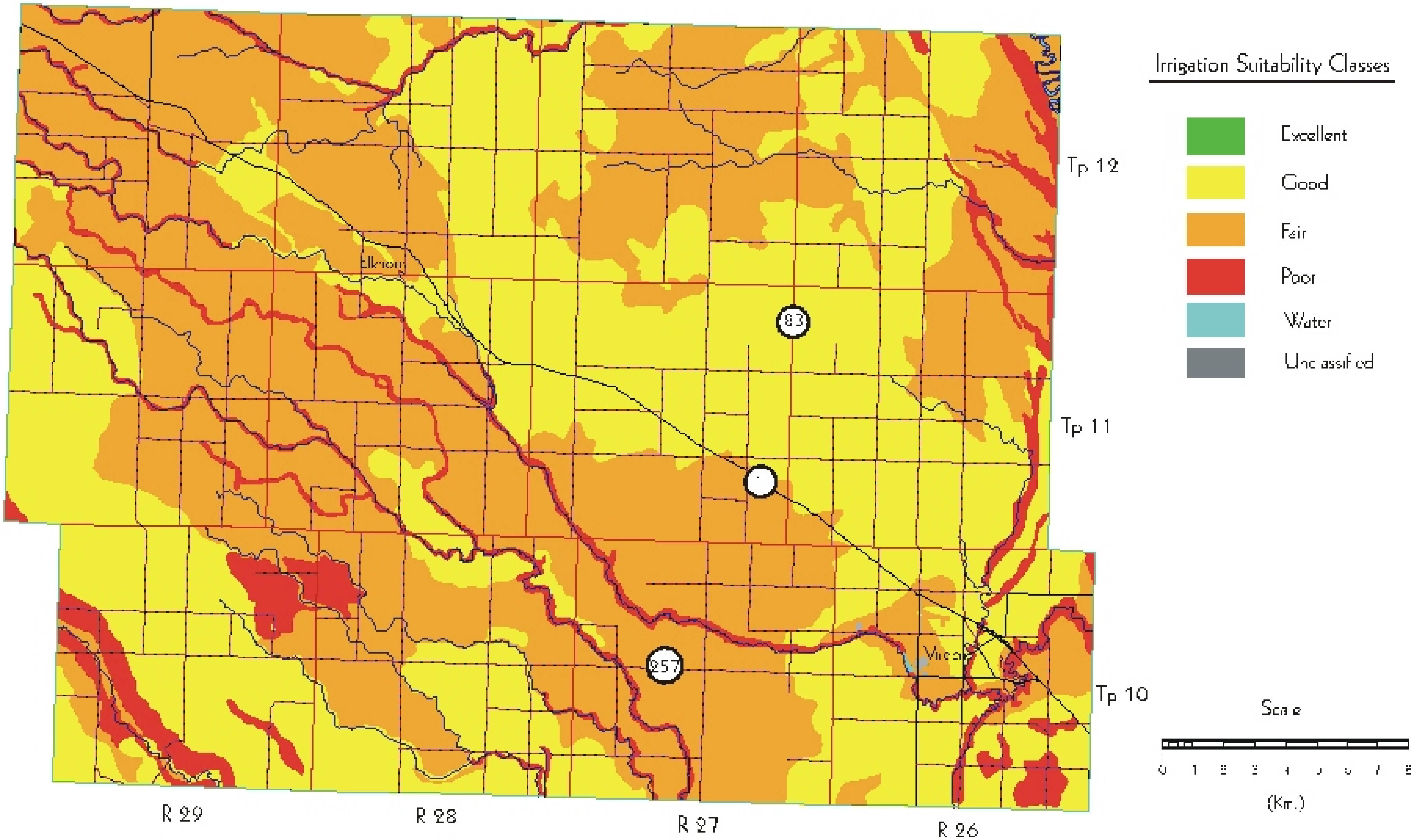
This generalized interpretive map is based on the dominant soil series for each soil polygon, in combination with the dominant slope class from the terrain layer database. The nature of the subclass limitations, and the classification of subdominant components is not shown at this generalized map scale.

Table 5. Irrigation Suitability[1]

Class	Area (ha)	Percent of RM
Excellent	0	0.0
Good	51357	44.2
Fair	56158	48.3
Poor	8699	7.5
Organic	0	0.0
Water	68	0.1
Unclassified	30	0.0
Total	116311	100.0

[1] Based on **dominant** soil and slope of the respective soil and terrain maps.

Rural Municipality of Wallace Irrigation Suitability Map



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March 1996

Potential Environmental Impact Under Irrigation.

A major concern for land under irrigated crop production is the possibility that surface and/or groundwater may be impacted. The potential environmental impact assessment provides a relative rating of land into 4 classes (minimal, low, moderate and high) based on an evaluation of specific soil factors and landscape conditions that determine the impact potential.

Soil factors considered are those properties that determine water retention and movement through the soil; topographic features are those that affect runoff and redistribution of moisture in the landscape. Specifically considered are: soil texture, hydraulic conductivity, salinity, geological uniformity, depth to watertable and topography. The risk of altering surface and subsurface soil drainage regimes, soil salinity or the potential for runoff, erosion or flooding is determined by specific criteria for each property.

Use of this rating is intended to serve as a warning of potential environmental concern. It may be possible to design and/or give special consideration to soil-water-crop management practices that will mitigate any adverse impact.

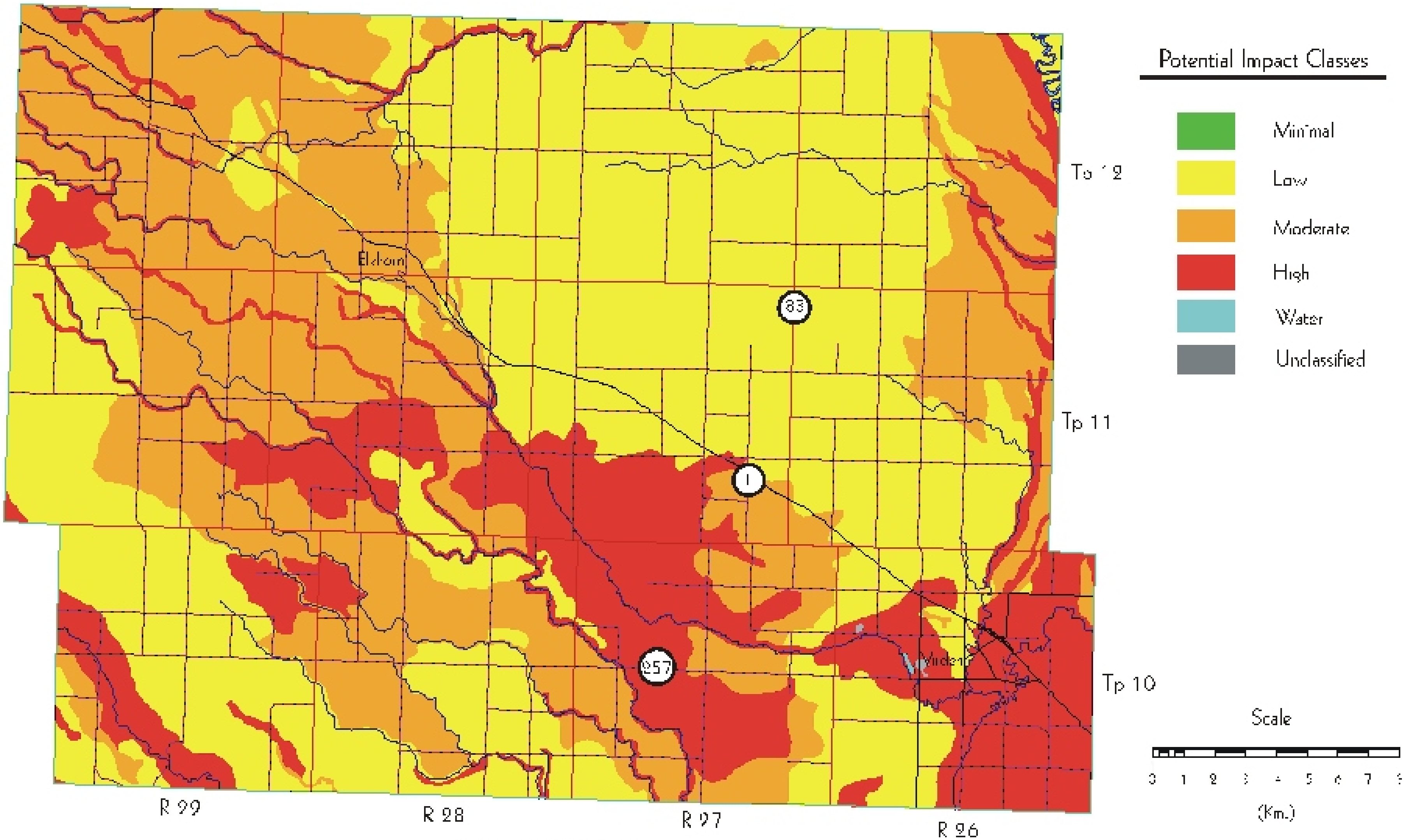
This generalized interpretive map is based on the dominant soil series for each soil polygon, in combination with the dominant slope class from the terrain layer database. The nature of the subclass limitations, and the classification of subdominant components is not shown at this generalized map scale.

Table 6. Potential Environmental Impact Under Irrigation[1]

Class	Area (ha)	Percent of RM
Minimal	0	0.0
Low	54797	47.1
Moderate	38031	32.7
High	23386	20.1
Organic	0	0.0
Water	68	0.1
Unclassified	30	0.0
Total	116311	100.0

[1] Based on **dominant** soil, slope gradient, and slope length of the respective soil and terrain maps.

Rural Municipality of Wallace Potential Environmental Impact Under Irrigation



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March 1996

Water Erosion Risk Map.

The risk of water erosion was estimated using the universal soil loss equation (USLE) developed by Wischmeier and Smith (1965). The map shows 5 classes of soil erosion risk based on bare unprotected soil:

- negligible
- low
- moderate
- high
- severe

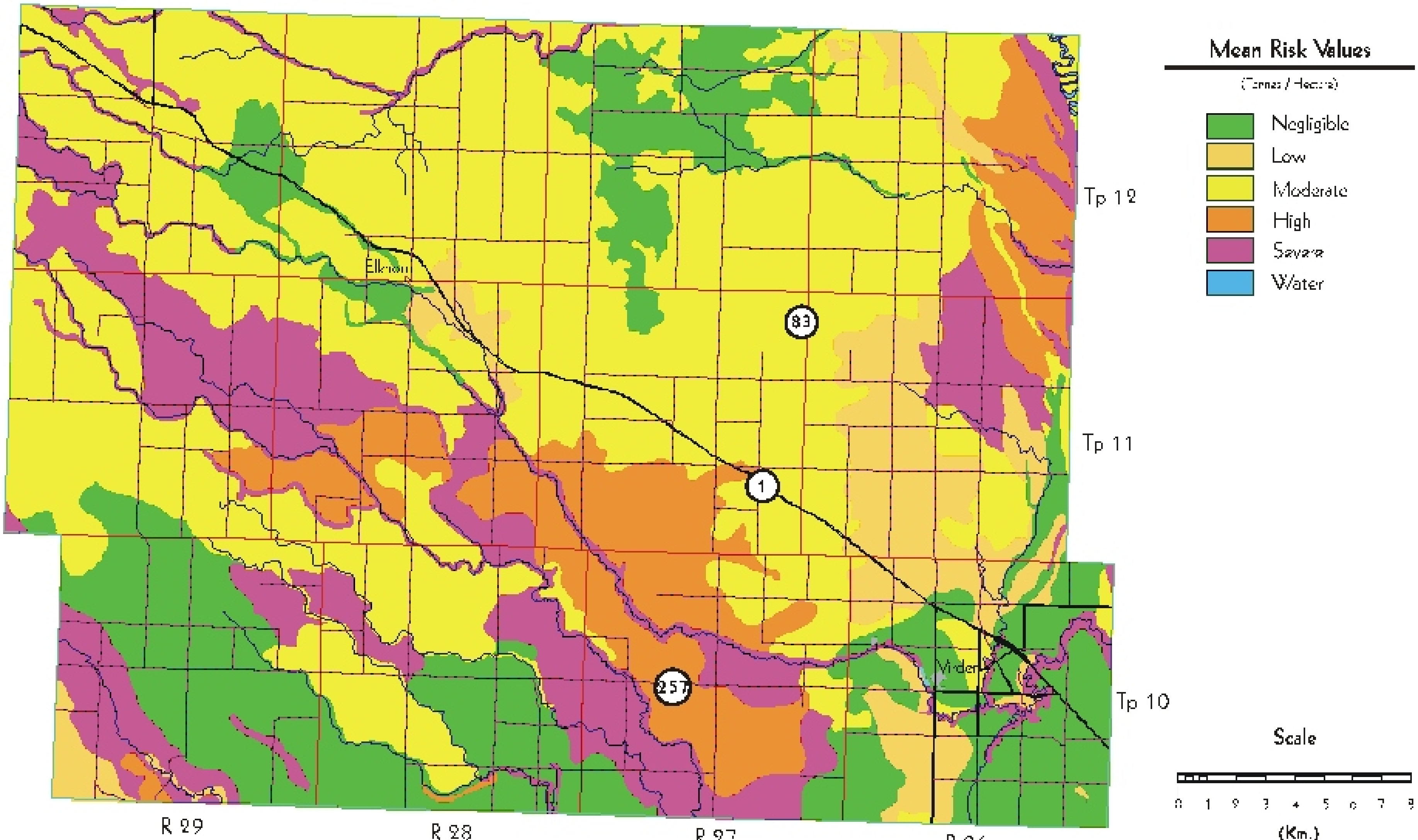
Cropping and management practices will significantly reduce this risk depending on crop rotation program, soil type, and landscape features.

Table 7. Water Erosion Risk[1]

Class	Area (ha)	Percent of RM
Negligible	5442	4.7
Low	25308	21.8
Moderate	54711	47.0
High	119	0.1
Severe	30635	26.3
Water	68	0.1
Unclassified	30	0.0
Total	116311	100.0

[1] Based on **dominant** soil, slope gradient, and slope length of the respective soil and terrain maps.

Rural Municipality of Wallace Water Erosion Risk Map



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ADDENDUM

Land Use Map.

The land use classification of the RM has been interpreted from LANDSAT satellite imagery, using supervised computer classification techniques. Many individual spectral signatures were classified and grouped into the seven general land use classes shown here. Although land use changes over time, and some land use practices on individual parcels may occasionally result in similar spectral signatures, this map provides a general representation of the current land use in the RM.

The following is a brief description of the land use classes are:

Annual Crop Land - land that is normally cultivated on an annual basis.

Forage - perennial forages, generally alfalfa or clover with blends of tame grasses.

Grasslands - areas of native or tame grasses, may contain scattered stands of shrubs.

Trees - lands that are primarily in tree cover.

Wetlands - areas that are wet, often with sedges, cattails, and rushes.

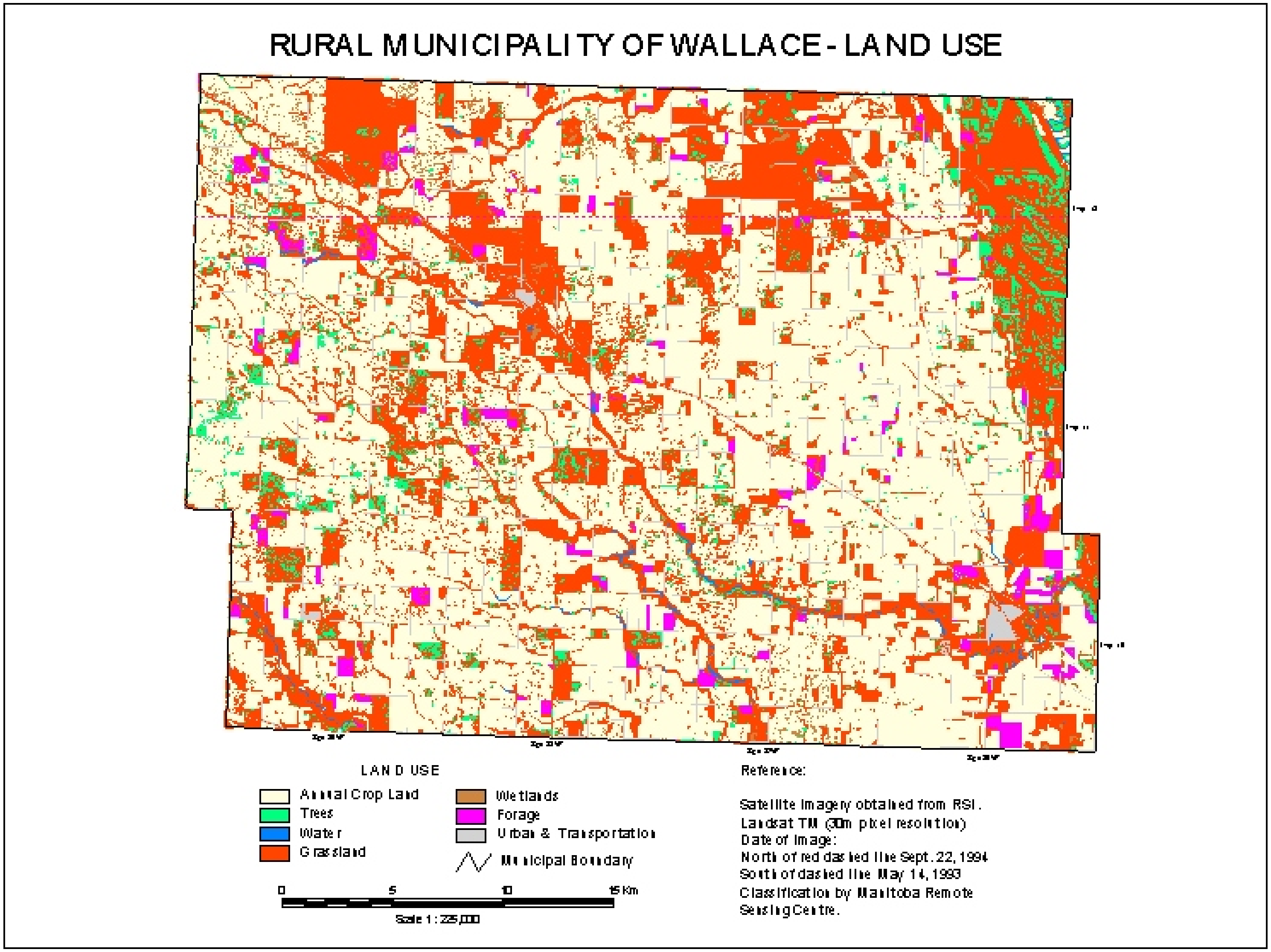
Water - open water-lakes, rivers streams, ponds, and lagoons.

Urban and Transportation - towns, roads, railways, quarries.

Table 10. Land Use[1]

Class	Area (ha)	Percent of RM
Annual Crop Land	70050	59.8
Forage	2451	2.1
Grasslands	34593	29.5
Trees	4511	3.8
Wetlands	1361	1.2
Water	413	0.4
Urban and Transportation	3801	3.2
Total	117180	100.0

[1] Land use information (1995) and map supplied by Prairie Farm Rehabilitation Administration. Total area may vary from previous maps due to differences in analytical procedures.


RURAL MUNICIPALITY OF WALLACE - LAND USE
LAND USE
Annual Crop Land
Trees
Water
Grassland
Wetlands
Forage
Urban & Transportation
Municipal Boundary
0
5
10
15 Km
Scale 1 : 225,000
Reference:
Satellite Imagery obtained from RSI.
Landsat TM (30m pixel resolution)
Date of Image:
North of red dashed line Sept. 22, 1994
South of dashed line May 14, 1993
Classification by Manitoba Remote
Sensing Centre.