Agriculture and Agri-Food Canada
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Rural Municipality of Cornwallis

Information Bulletin 96-9

Soils and Terrain

An introduction to the land resource

Land Resource Unit
Brandon Research Centre

Canada

Rural Municipality of Cornwallis

Information Bulletin 96-9

Prepared by:

Manitoba Land Resource Unit,
Centre for Land and Biological Resources Research,
Agriculture and Agri-Food Canada.

Department of Soil Science, University of Manitoba.

Manitoba Soil Resource Section,
Soils and Crops Branch, Manitoba Agriculture.

Agriculture and Agri-Food Canada Research Branch

Faculty of Agriculture and Food Science

Manitoba Agriculture

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:

Manitoba Land Resource Unit
Room 360 Ellis Bldg, University of Manitoba,
Winnipeg, Manitoba R3T 2N2
Phone: 204-474-6118 FAX: 204-275-5817

CITATION

Manitoba Land Resource Unit, 1996. Soils and Terrain. An introduction to the land resource. Rural Municipality of Cornwallis, Information Bulletin 96-9, Ellis Bldg, University of Manitoba. Winnipeg.

ACKNOWLEDGEMENTS

This project was supported under the Canada-Manitoba Agreement of Agricultural Sustainability.

The following individuals and agencies contributed significantly to the compilation, interpretation, and derivation of the information contained in this report.

Managerial and administrative support was provided by:

R.G. Eilers, Head, Manitoba Land Resource Unit, CLBRR, Agriculture and Agri-Food Canada.
G.J. Racz, Head, Dept. of Soil Science, University of Manitoba.
F. Wilson, Manager, Manitoba Land and Soil Programs, PFRA, Agriculture and Agri-Food Canada.
G.F. Mills, Manitoba Soil Survey, Soils and Crops Branch, Manitoba Agriculture.
K.S. McGill, Chief, Land Utilization and Soil Survey, Soils and Crops Branch, Manitoba Agriculture.

Technical support was provided by:

L. Fuller and G.W. Lelyk, Manitoba Land Resource Unit, CLBRR, Agriculture and Agri-Food Canada.
J. Fitzmaurice, N. Lindberg, K. Gehman, A. Waddell and M. Fitzgerald, Dept. of Soil Science, University of Manitoba.
R. Lewis, PFRA, Agriculture and Agri-Food Canada.

Professional expertise for data conversion, correlation, and interpretation was provided by:

W.R. Fraser and W. Michalyna of the Manitoba Land Resource Unit, CLBRR, Agriculture and Agri-Food Canada.
P. Haluschak and G. Podolsky, Manitoba Soil Survey Unit, Soils and Crops Branch, Manitoba Agriculture.

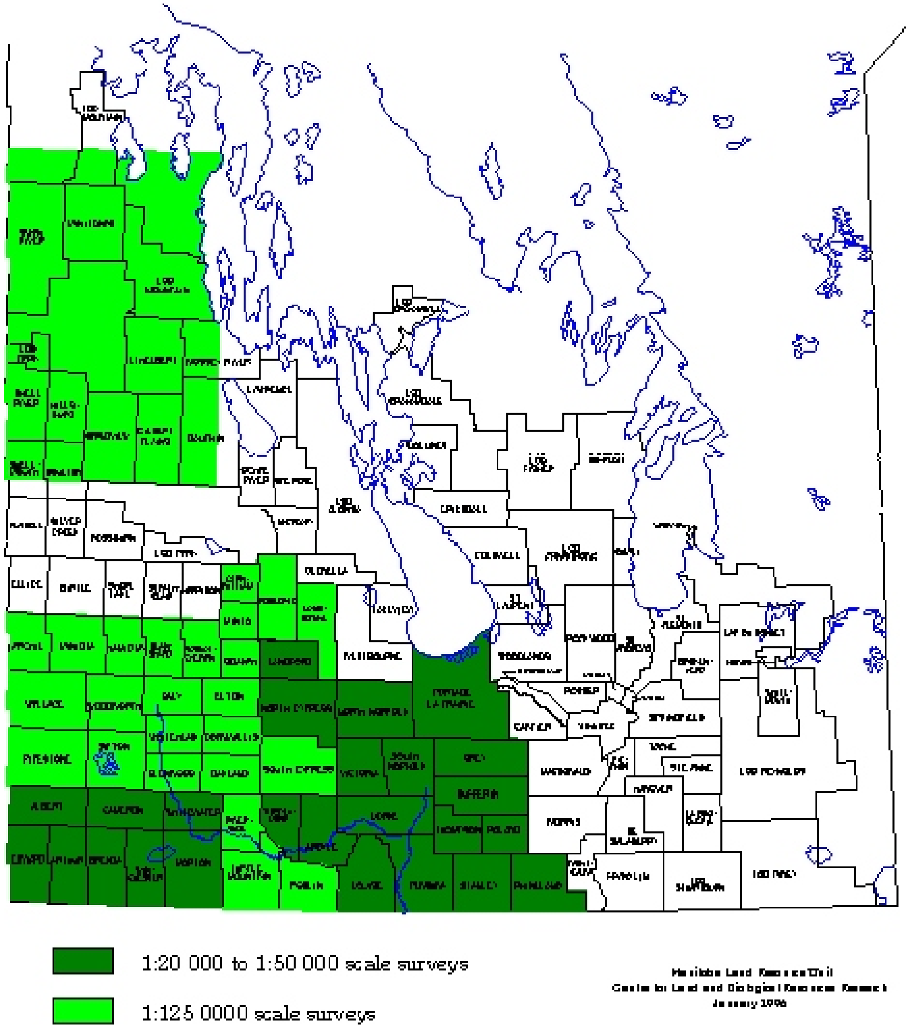


Figure 3. Rural municipalities in southern Manitoba with digital soil and terrain map information (1996).

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.

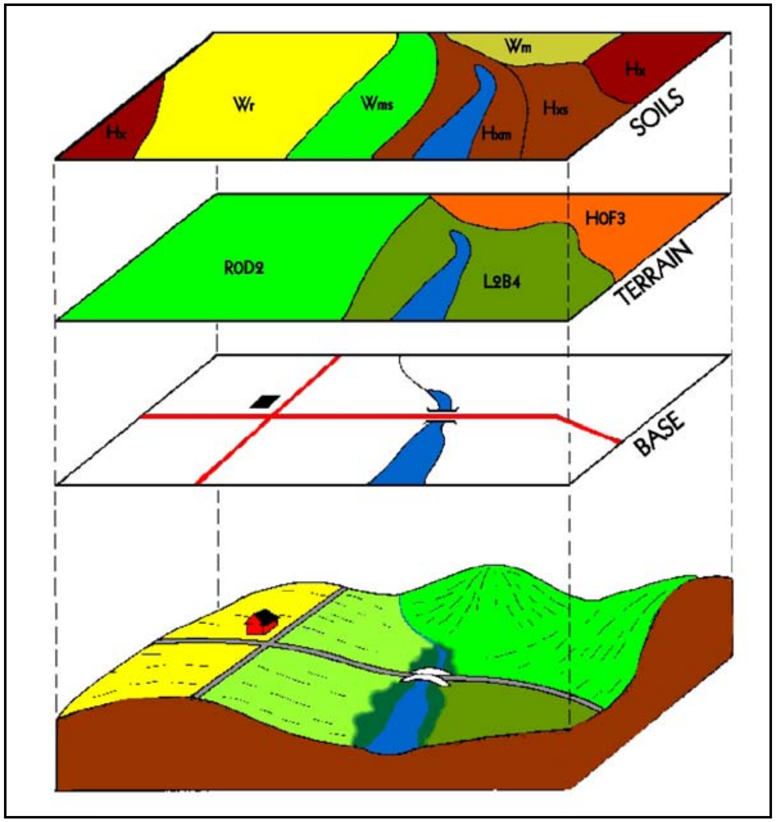


Figure 2. Soil, Terrain, and Base Map data.

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 knoll
- 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 Cornwallis covers 6.0 Townships (approximately 58 000 ha) in south-western Manitoba. The City of Brandon is the largest population centre in the municipality. Land use is predominantly agriculture.

Soils in the RM of Cornwallis have been mapped previously in the Reconnaissance Soil Survey of the Rossburn and Virden Map Sheet Areas (Ehrlich et al., 1956) and the Carberry Map Sheet Area (Ehrlich et al., 1957). More detailed information for part of the RM is reported in the Soils of the Brandon Region Study Area (Michalyna et al., 1976), and Soils of the City of Brandon Area (Podolsky, 1984).

Based on climatic data from Brandon Airport (Environment Canada, 1982) the mean annual temperature is 1.5°C; mean annual precipitation is 450 mm; frost-free period is 108 days; and degree days above 5ºC is 1642. The seasonal moisture deficit for the period May to September is 250 to 300 mm and effective growing degree days (EGDD) above 5ºC from seeding to first frost in fall is above 1500. This parameter provides an indication of heat energy available for crop growth (Agronomic Interpretations Working Group, 1995).

The municipality is situated within the Antler River-Lake Souris Plain (Lake Souris Basin in published soil reports), the Upper Assiniboine Delta and a small portion of the Brandon Lakes Plain. Two major physiographic features in the RM are the Assiniboine Valley and the Brandon Hills. The Assiniboine River traverses the municipality in a broad valley, 1.6 to 3.3 km wide and eroded some 35 m below the land surface in the west and about 15 m in the east. Elevations in the RM vary from 480 masl in the Brandon Hills in the southwest to about 350 m along the Assiniboine River Valley in the east. Surface deposits consist mainly of fluvial and lacustrine sediments ranging in texture from gravelly sands to clay loam. Areas of loamy textured glacial till occur in the Brandon Hills. Relief throughout the municipality is generally less than 3 m with slopes less than 5%. Steeper slopes are associated with hummocky and ridged surface forms in the Brandon Hills and along the valley walls of the Assiniboine River.

Dominant soils in the RM are Black Chernozems in well drained sites and imperfectly drained Black Chernozems in lower slope positions. Depressional areas are characterized by poorly drained Humic Gleysol soils with high seasonal water tables.

Soils in the Antler River-Lake Souris Plain and the Brandon Lakes Plain are in the Carroll Association (loam to clay loam lacustrine sediments) and the Souris and Stockton Associations (sandy lacustrine deposits). The Carroll soils are rated in agriculture capability class 1 to 2 on better drained sites in level to gently undulating terrain and class 3 or 4 on soils with steeper slopes or with appreciable erosion. Imperfectly drained soils are rated in class 2W to 3W (depending on the level of salinity), and poorly drained sites are rated in class 5W. Risk of water erosion is moderate to severe on the well drained sites depending upon topography. Irrigation suitability of these soils is good with a low potential for environmental impact.

Imperfectly drained soils of the Souris and Stockton Associations are rated in class 2M to 3M for agriculture due to periodic droughtiness; irrigation suitability is good to fair and the potential for environmental impact under irrigation is moderate. Moderately well to well drained soils are rated in class 4M for agriculture due to low water retention capacity and droughtiness. Land use is mainly cereal and forage production with some grazing. Associated poorly drained soils are utilized mainly for hay production and grazing; agriculture capability is 5W. Local areas of Stockton Duned Phase soils are class 5 to 6 for agriculture depending on the slope. These soils have a high risk of wind erosion if surface cover is removed.

The Assiniboine Delta in the eastern and north-central portion of the RM is characterized by soils of the Miniota and Marringhurst Associations. These soils are developed on well to moderately well drained sand and coarse sand to gravelly sand fluvial deposits with low water retention capacity and rapid permeability. Agriculture capability is 5M due to droughtiness; irrigation suitability is fair to poor and the potential for adverse environmental impact is high under irrigation. Risk of water erosion is low but the potential for erosion by wind is high if surface cover is minimal. Land use is mainly forage production and native grazing.

Miniota sandy loam soils are developed on a variable thickness of fine sandy loam sediments grading to coarse sandy outwash deposits with depth. They have a low water retention capacity and are somewhat droughty; agriculture capability is 4M. Irrigation suitability is good and potential for environmental impact is low to moderate.

The steep side slopes of the Assiniboine Valley are mapped as the Eroded Slopes Complex. Agriculture capability is mainly class 6T and 7T; native woodland, wildlife habitat and limited natural grazing are the major land use. Soils on the valley terraces and bottom lands are mapped in the Assiniboine Association. These soils range in texture from sandy loam to clay; agriculture capability varies from class 2 to 4 and irrigation suitability ranges from good to poor depending on the frequency of flooding. Land use is mainly cereal and forage production.

Soils of the Tiger Hills and Hilton Associations in the Brandon Hills are rated in class 2T to 6T for agriculture, depending on the slope and degree of erosion, if cultivated. Steeper areas have a severe risk of water erosion and are generally poor for irrigation (classes 3 and 4), mainly due to topography.

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.

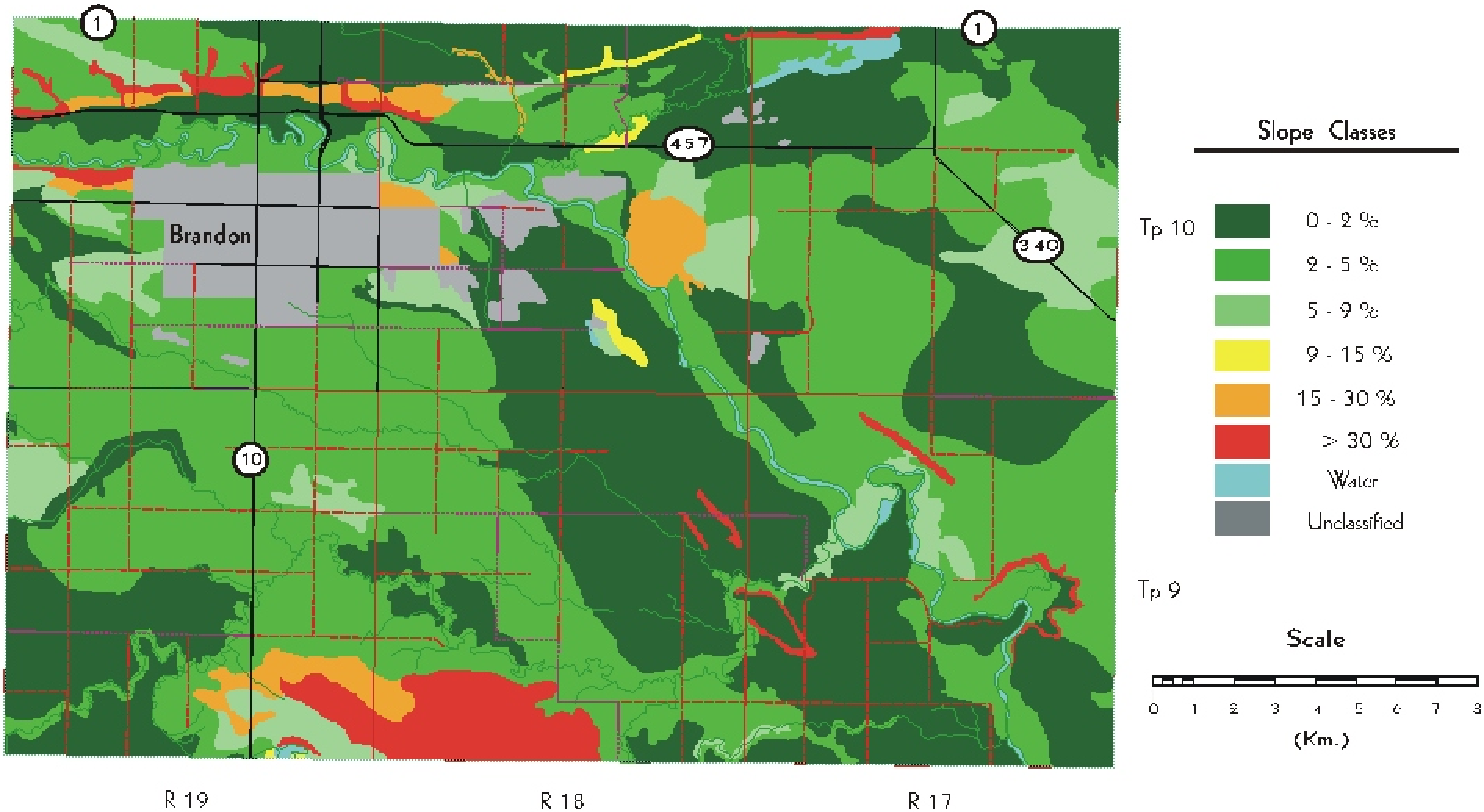
Slope describes the steepness of the landscape surface. The slope classes shown on this map are derived from the digital terrain layer database. Specific colours are used to indicate the most significant, limiting slope class for each terrain polygon in the RM. Additional slope classes can occur in each 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 %	21423	36.9
2 - 5 %	24959	43.0
5 - 9 %	4159	7.2
9 - 15 %	216	0.4
15 - 30 %	1406	2.4
> 30 %	2155	3.7
Water	732	1.3
Unclassified	3006	5.2
Total	58056	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 Cornwallis Slope Map



Manitoba Land Resource Unit
Centre for Land and Biological Resources Research
March 1996

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).

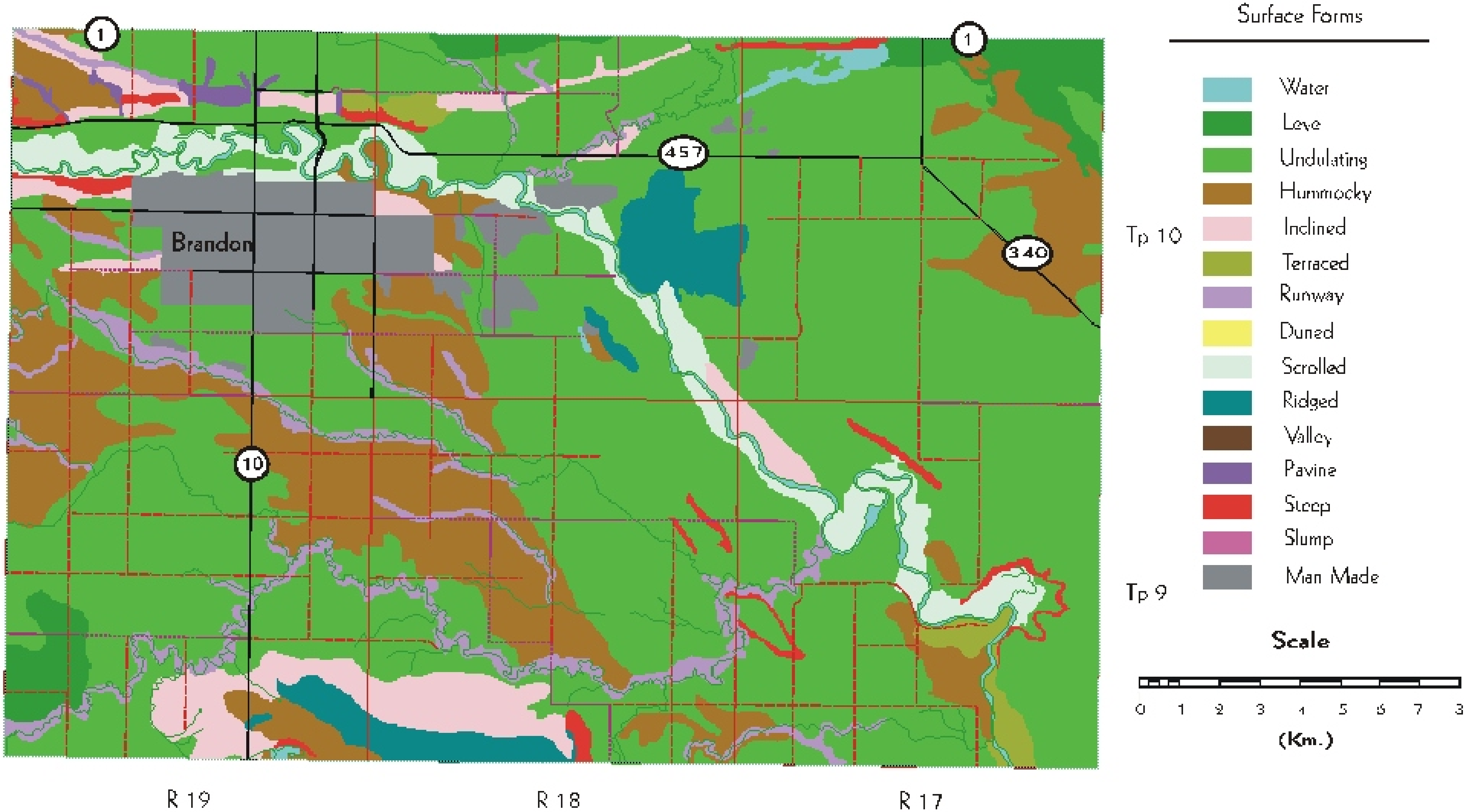
Surface form and slope class are two key features of the digital terrain map layer. Both of these characteristics are important controlling and influencing factors to consider for sustainable land use planning and management.

Table 2. Surface Form and Slope Classes[1]

Surface Form Slope Class	Area (ha)	Percent of RM
Scrolled	**2327**	**4.0**
C (2.0 to 5.0%)	2017	3.5
D (6.0 to 9.0%)	310	0.5
Hummocky	**8604**	**14.8**
C (2.0 to 5.0%)	5867	10.1
D (6.0 to 9.0%)	2724	4.7
E (10.0 to 15.0%)	13	0.0
Inclined	**2586**	**4.5**
C (2.0 to 5.0%)	580	1.0
D (6.0 to 9.0%)	479	0.8
E (10.0 to 15.0%)	127	0.2
F (16.0 to 30.0%)	778	1.3
H (31.0 to 70.0%)	622	1.1
Level	**1583**	**2.7**
B (0.5 to 2.0%)	1583	2.7
Ravine	**195**	**0.3**
H (31.0 to 70.0%)	166	0.3
J (> 70.0%)	30	0.1
Man Made	**3006**	**5.2**
Ridged	**1590**	**2.7**
D (6.0 to 9.0%)	425	0.7
E (10.0 to 15.0%)	77	0.1
F (16.0 to 30.0%)	430	0.7
H (31.0 to 70.0%)	648	1.1
J (> 70.0%)	11	0.0
Steep	679	1.2
J (> 70.0%)	679	1.2
Terraced	**530**	**0.9**
B (0.5 to 2.0%)	199	0.3
C (2.0 to 5.0%)	178	0.3
F (16.0 to 30.0%)	154	0.3
Undulating	**33804**	**58.2**
B (0.5 to 2.0%)	19642	33.8
C (2.0 to 5.0%)	14161	24.4
Runway	**2427**	**4.2**
C (2.0 to 5.0%)	2156	3.7
D (6.0 to 9.0%)	226	0.4
F (16.0 to 30.0%)	44	0.1
Water	**727**	**1.3**
Total	**58056**	**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 Cornwallis Surface Form Map



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March 1996

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.

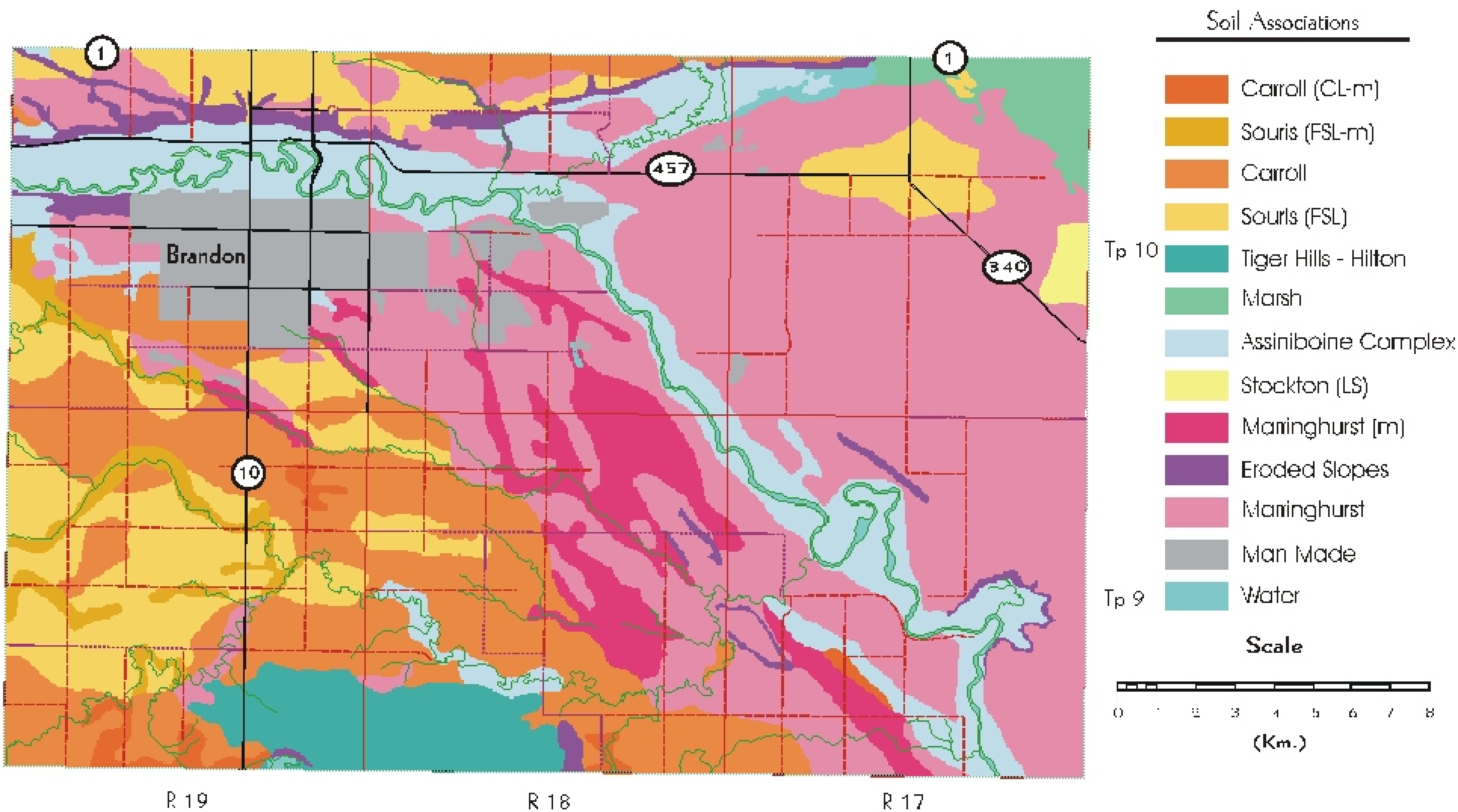
This generalized soil map has been reduced in size and simplified by grouping the original soil association polygons. The groups have been colour themed according to similar modes of origin, texture, and soil drainage. Soils derived from glacial till deposits (typically loam to clay loam in texture) 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
Carroll (CL-m)	**543**	**0.9**
Ccl (meadow)	385	0.7
Ccl (saline)	158	0.3
Souris (FSL - m)	**1185**	**2.0**
Sfsl (meadow)	1185	2.0
Carroll	**9585**	**16.5**
Bd	41	0.1
Ccl	9039	15.6
Ccl (saline)	505	0.9
Souris (FSL)	**6785**	**11.7**
Cl	702	1.2
Sfsl	5166	8.9
Snfsl	918	1.6
Tiger Hills - Hilton	**2099**	**3.6**
T	1758	3.0
T-Hn	341	0.6
Marsh	**894**	**1.5**
Mh	894	1.5
Assiniboine	**6739**	**11.6**
As	5770	9.9
As (meadow)	510	0.9
Bcx	458	0.8
Stockton (LS)	**233**	**0.4**
Snls	233	0.4
Marringhurst (m)	**3146**	**5.4**
M (meadow)	1095	1.9
Ma (meadow)	2051	3.5
Eroded Slopes	**1394**	**2.4**
Er	1394	2.4
Marringhurst	**21716**	**37.4**
M	2540	4.4
Ma	9649	16.6
Ms	9527	16.4
Man Made	**3006**	**5.2**
Water	**732**	**1.3**
Total	**58056**	**100.0**

Rural Municipality of Cornwallis Generalized Soil Map



Manitoba Land Resource Unit
Centre for Land and Biological Resources Research
March 1996

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.

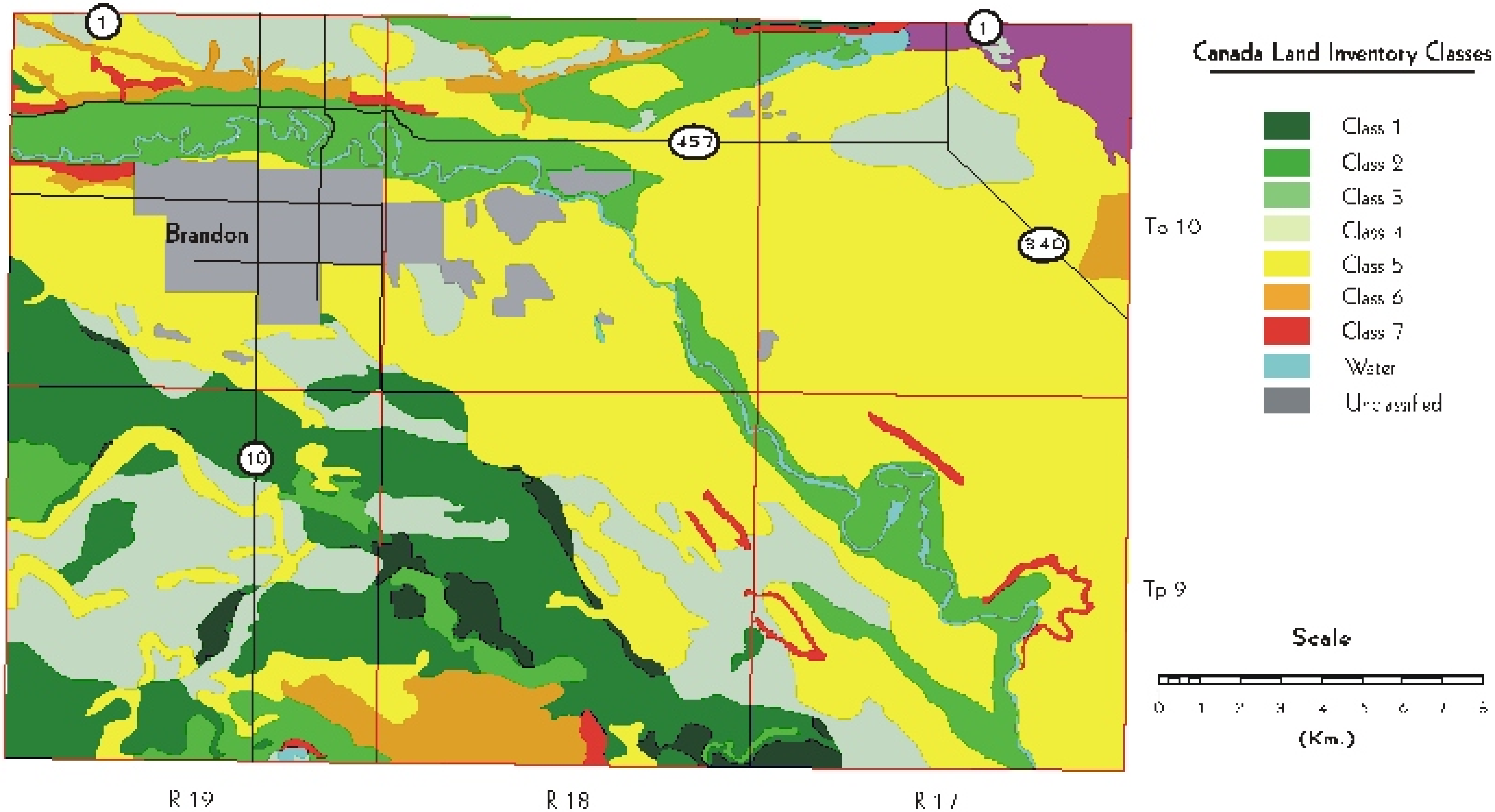
This generalized interpretive map is based on the dominant modern soil type for the soil polygon, in combination with the dominant slope class identified from the terrain polygon layer. The nature of the CLI subclass limitations and the classification of subdominant components cannot be portrayed at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

Table 4. Agricultural Capability[1]

Class / Subclass	Area (ha)	Percent of RM
1	**956**	**1.6**
2	**7618**	**13.1**
2T	6130	10.5
2TW	577	1.0
2W	764	1.3
2X	147	0.3
3	**7181**	**12.3**
3	451	0.8
3I	5155	8.9
3N	647	1.1
3T	921	1.6
3TN	8	0.0
4	**8590**	**14.8**
4	25	0.0
4M	8555	14.7
4T	10	0.0
5	**26283**	**45.2**
5	146	0.3
5EM	633	1.1
5M	19263	33.1
5MT	513	0.9
5T	561	1.0
5W	4657	8.0
5WI	510	0.9
6	**2179**	**3.7**
6M	232	0.4
6T	1947	3.3
7	**724**	**1.2**
7	0	0.0
7T	724	1.2
Unclassified	**3006**	**5.2**
Water	**733**	**1.3**
Organic	**894**	**1.5**
Total	**58163**	**100.0**

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

Rural Municipality of Cornwallis Agriculture Capability Map



Manitoba Land Resource Unit
Winnipeg, Manitoba
June 2003

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.

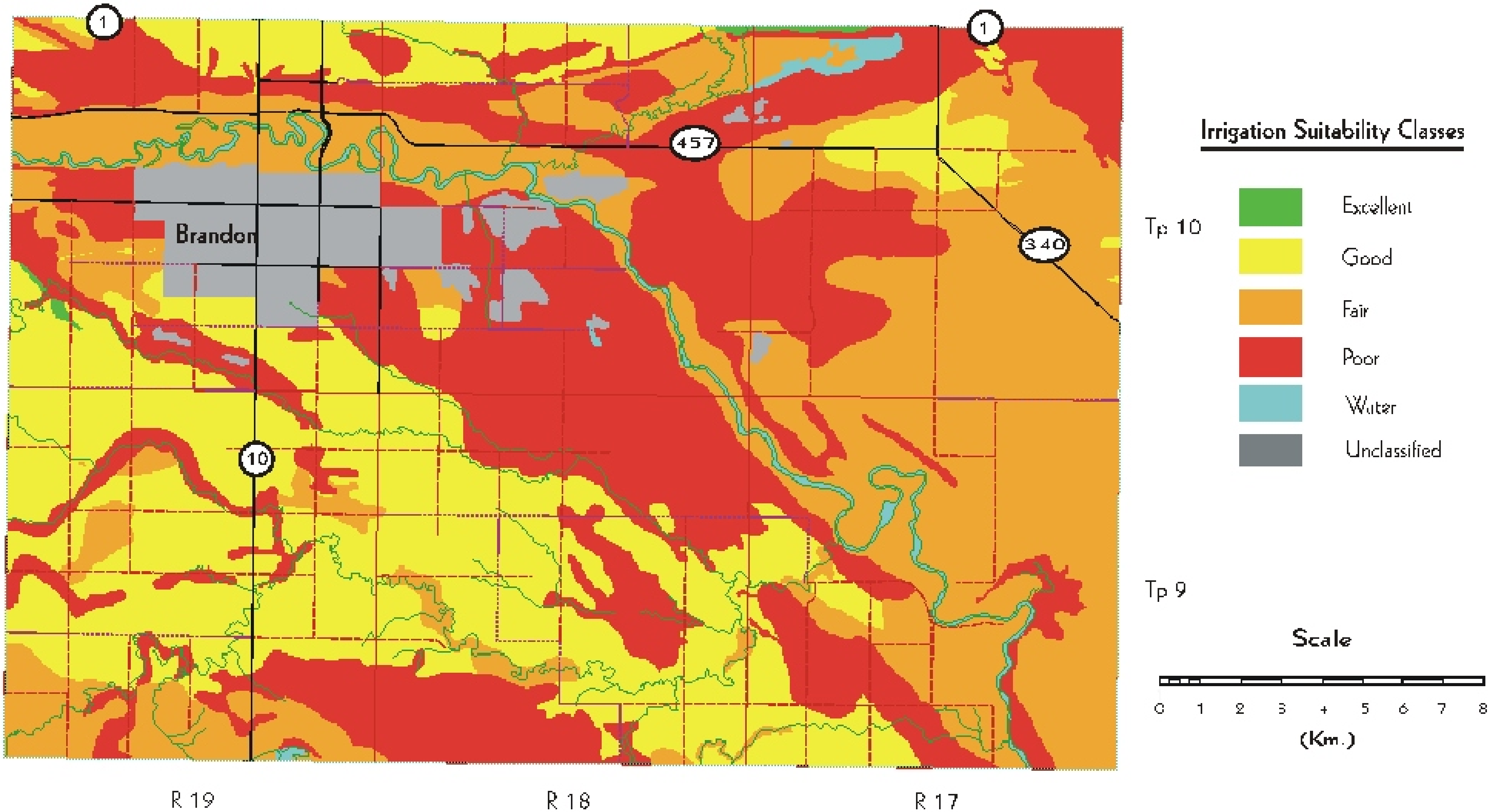
This generalized interpretive map is based on the dominant soil series for each soil polygon, in combination with the dominant slope class from the terrain layer database. The nature of the subclass limitations, and the classification of subdominant components is not shown at this generalized map scale.

Table 5. Irrigation Suitability[1]

Class	Area (ha)	Percent of RM
Excellent	109	0.2
Good	16532	28.5
Fair	18611	32.1
Poor	19067	32.8
Organic	0	0.0
Water	732	1.3
Unclassified	3006	5.2
Total	58056	100.0

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

Rural Municipality of Cornwallis 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.

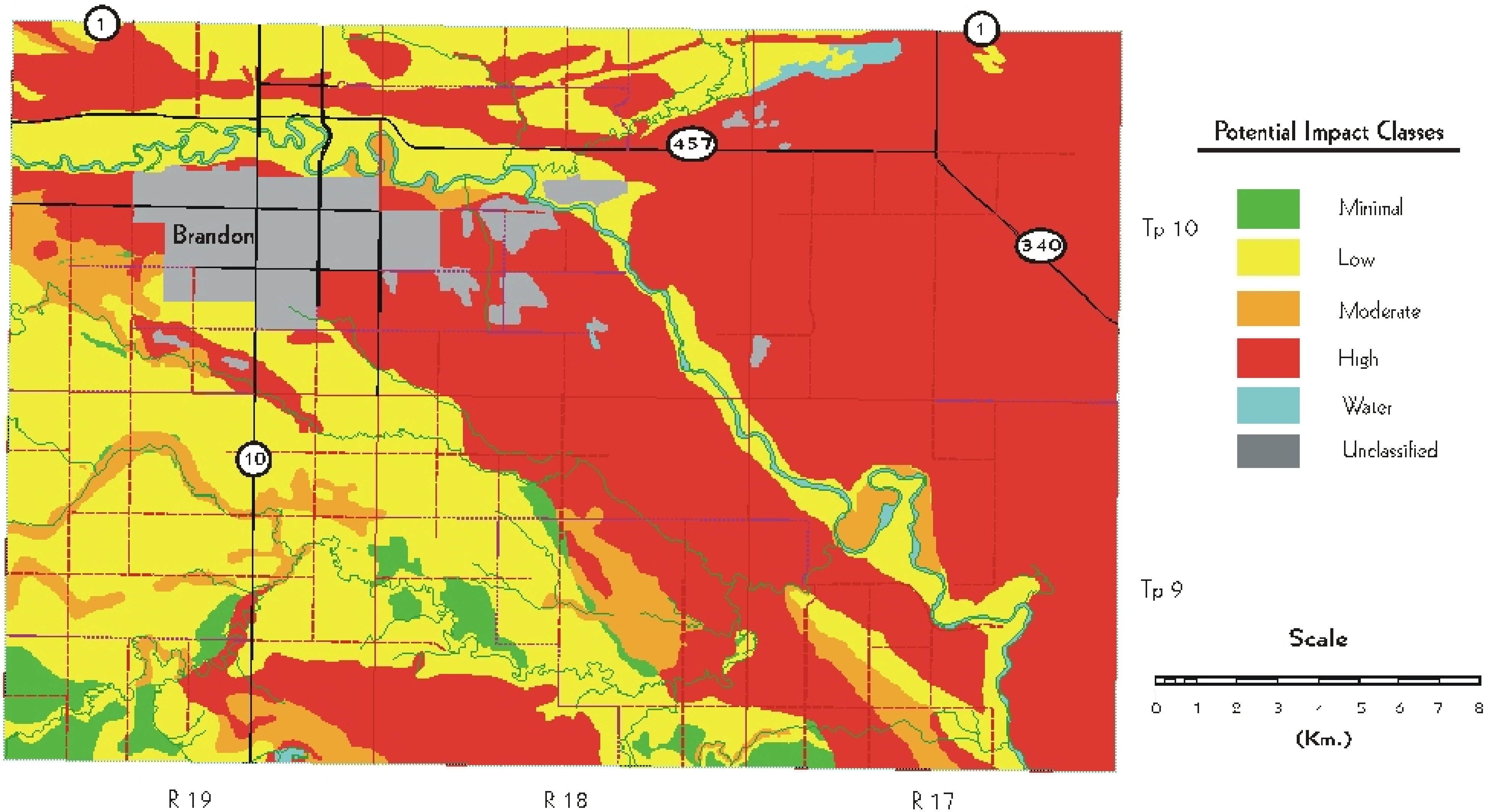
This generalized interpretive map is based on the dominant soil series for each soil polygon, in combination with the dominant slope class from the terrain layer database. The nature of the subclass limitations, and the classification of subdominant components is not shown at this generalized map scale.

Table 6. Potential Environmental Impact Under Irrigation[1]

Class	Area (ha)	Percent of RM
Minimal	1657	2.9
Low	18852	32.5
Moderate	3896	6.7
High	29914	51.5
Organic	0	0.0
Water	732	1.3
Unclassified	3006	5.2
Total	58056	100.0

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

Rural Municipality of Cornwallis **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

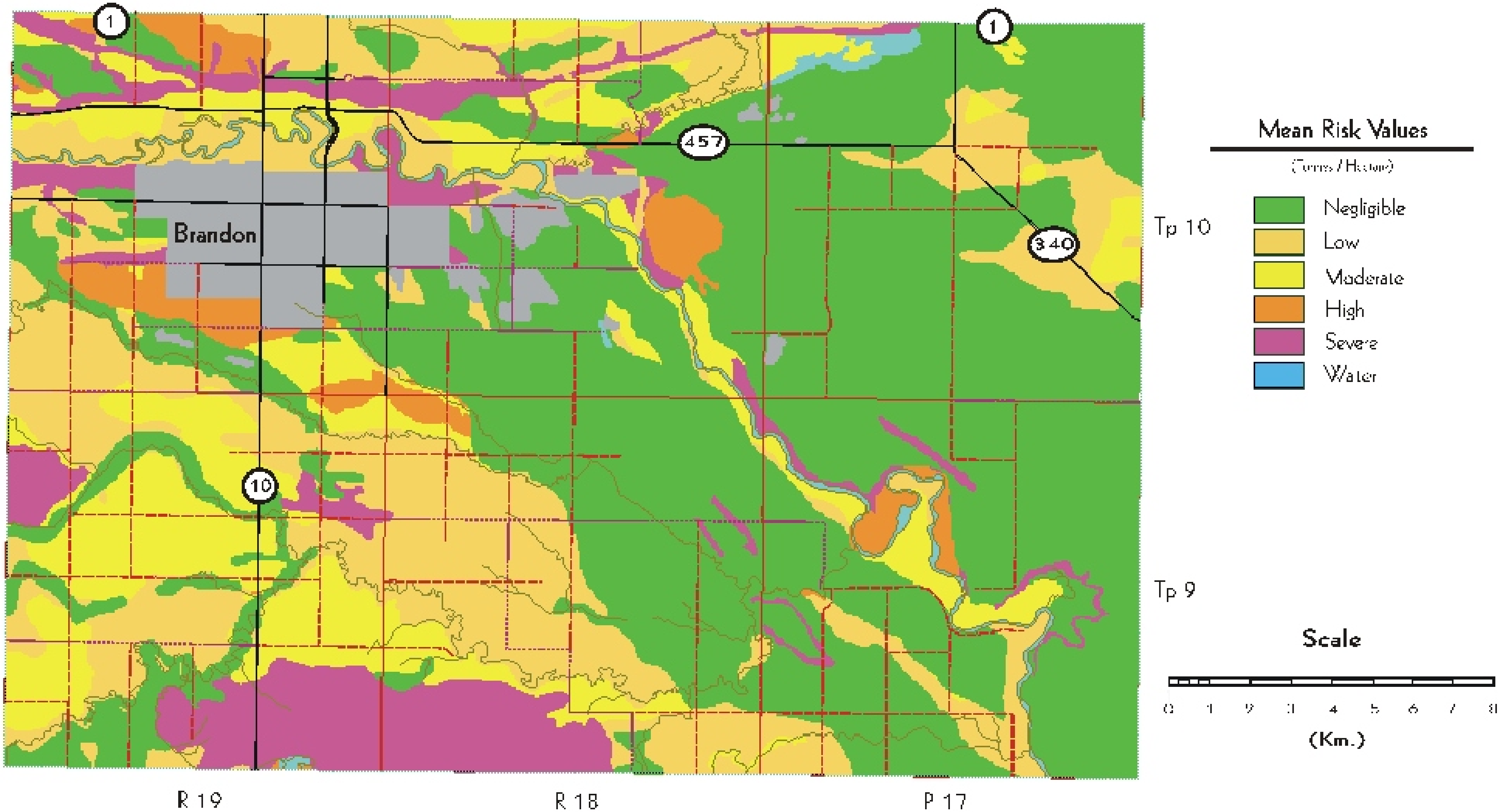
Cropping and management practices will significantly reduce this risk depending on crop rotation program, soil type, and landscape features.

Table 7. Water Erosion Risk[1]

Class	Area (ha)	Percent of RM
Negligible	26805	46.2
Low	12537	21.6
Moderate	7786	13.4
High	1884	3.2
Severe	5307	9.1
Water	732	1.3
Unclassified	3006	5.2
Total	58056	100.0

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

Rural Municipality of Cornwallis Water Erosion Risk Map



Manitoba Land Resource Unit
Centre for Land and Biological Resources Research
March 1996

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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.

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	23328	48.0
Forage	2950	6.1
Grasslands	20157	34.4
Trees	4574	9.4
Wetlands	2344	4.8
Water	760	1.6
Urban and Transportation	4470	9.2
Total	58583	100.0

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

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