Soil Survey of the County of Forty Mile No. 8, Alberta

Alberta Soil Survey Report No. 54

ALBERTA RESEARCH COUNCIL
Environmental Research and Engineering

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R. L. McNeil, R. W. Howitt, I. R. Whitson and A. G. Chartier

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1994

Alberta Research Council, Environmental Research and Engineering Department
Edmonton, Alberta, Canada 1994

How To Use This Soil Survey Report

The soil survey report for the County of Forty Mile consists of four main parts, nine appendices and eight 1:50 000 scale (1 cm = 1/2 km) soil maps.

The four main parts contain the following information:

Part 1 Provides a general description of the county and summarizes the 28 land systems.

Part 2 Provides a general description of the soils and mapping methods.

Part 3 Describes the soils in the County of Forty Mile and provides a framework for the detailed legend (Appendix I).

Part 4 Provides interpretations of land capability for dryland agriculture, irrigation capability, grazing capability, wind erosion risk, and water erosion risk. This part also discusses soil degradation.

The nine appendices include:

A. A brief description of the climate of the county.

B. A brief description of the native vegetation.

C. A brief description of the physiography and drainage of the area.

D. A description of the surficial materials.

E. A description of the bedrock formations, depth to bedrock, and hydrogeology.

F. A glossary of terms used in this report.

G. Detailed soil analytical data of soil series not provided in previous reports.

H. General information to assist the user with this soil survey.

I. Detailed soil map unit legend with descriptions of the integral components, and soil and landscape characteristics.

The following steps are guidelines to assist the user with this report:

1. **Locate the specific area on the appropriate map sheet.** Refer to the index map on the following page to determine the appropriate basemap for locating the area of interest.
   (eg. Section 21, Township 10, Range 8, West of the 4th Meridian is located on basemap 8)

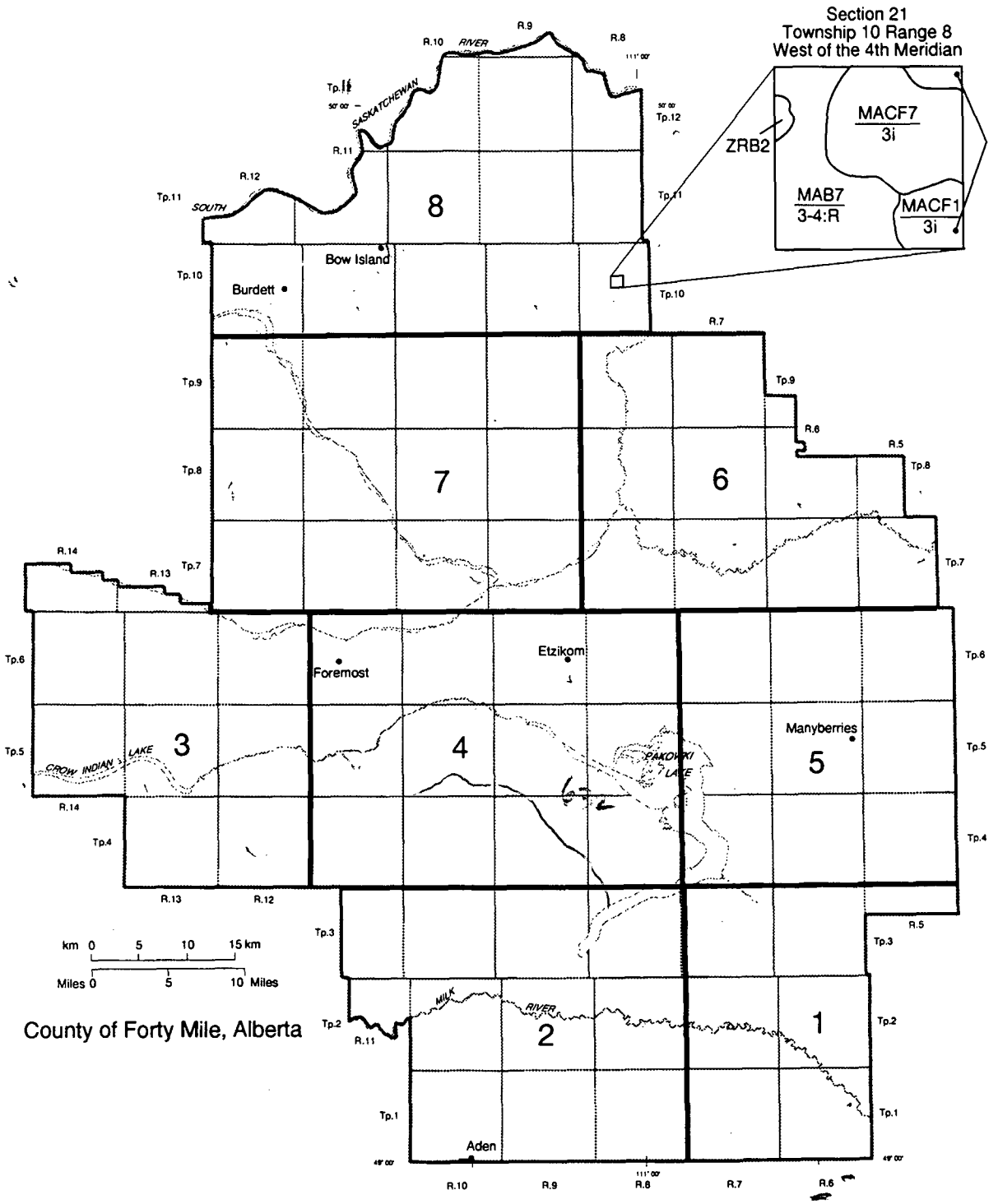
2. **Explanation of the map symbol.** For the noted example on the following page there are four soil map units symbolized as:

MAB7	MACF1	MACF7	ZRB2
3-4:R	3i	3i	

   These labels are described in further detail on page 62 of this report.

3. **Detailed description of the individual soil map units.** The soil map unit symbols appear alphabetically and numerically in the soil map unit legend (Appendix I beginning on page 64) where detailed descriptions of the parent material, surface form and soil drainage are provided. In addition, major and minor soil subgroups are identified with the commonly associated soil series (the building blocks of soil map units described in detail in Table 3 starting on page 15 of this report).

4. **Determine the soil interpretations.** Each soil map unit is interpreted for specified land use practices and erosive risk (Table 5 - Part 4 beginning on page 23). Also, a brief explanation is provided to describe the rationale of the various interpretive ratings.



County of Forty Mile, Alberta

Index for the County of Forty Mile Soil Survey Basemaps.

Preface

This report describes the soils and landforms in the County of Forty Mile. Mapping methods, soil map units, and soil properties are documented. Interpretations for dryland agriculture, irrigation, grazing, wind erosion risk, and water erosion risk are provided. Eight map sheets are included to show the types and distribution of soils.

The County is located in the Palliser triangle as recently documented by Wilson and Dijks (1993). Current land use includes dryland and irrigated agriculture, grazing, and forage crop production.

The majority of the County was mapped in the 1930's as part of the Milk River Sheet "to evaluate the soils and provide a guide for any future relocation of settlers or settlement due to proposed water development" (Wyatt et al. 1941). Lands had been abandoned by settlers because of adverse soil conditions combined with several years of drought. The soil survey map of the Milk River Sheet (Wyatt et al. 1941) provided an excellent insight into the soils of the area. Soil erosion and degradation were discussed at some length in the report. Soil conservation issues continue to be of concern in the Palliser triangle in the 1990's.

Previous soil survey information was also available for extreme northern portions of the County from the St. Mary River and Milk River Irrigation District report (Bowser et al. 1967) and the southwest Medicine Hat Sheet (Kjearsgaard and Pettapiece 1986). Soil map units and boundaries were correlated to the 1:50 000 Soil Survey of the County of Warner (Kjearsgaard et al. 1986) which occurs to the west. The Warner soil survey also provided an initial legend for direct application to this soil survey.

This soil survey is designed for regional multi-use and is targeted for farm and ranch conservation planning needs identified by the County (Schlachter 1992). The County of Forty Mile Soil Survey provides more detail than previous reports and takes advantage of significant developments in soil classification and mapping techniques. Two mapping techniques were used to complete the soil survey. Field work was initiated in 1990 and completed in 1993.

Acknowledgments

The soil survey of the County of Forty Mile was conducted by the Environmental Research and Engineering Department of the Alberta Research Council, Edmonton with field project management by Contract Pedology Services Ltd., Medicine Hat. Funding for the project was provided by the Alberta Research Council, Agriculture Canada (National Soil Conservation Program) and Alberta Agriculture, Food and Rural Development.

The authors wish to acknowledge the following persons and organizations for their contributions to this project.

- Mapping assistance and soil sampling was provided by C.V. Qualizza, S. C. H. Brookes, A. Bergen, R.J. Delorme and B. DeJong.

- Contributions to provincial correlation were provided by J.A. Brierley, W.W. Pettapiece and G.M. Coen; all of the Land Resources Unit, Centre for Land and Biological Resources Research, Agriculture Canada, Edmonton. J. A. Brierley provided valuable assistance throughout the project in developing soil map unit concepts, refining the soil map legend and providing useful dialog. In addition, correlation help from beyond provincial boundaries was provided by J.A. Shields, Western Correlator of Agriculture Canada; H B. Stonehouse of the Saskatchewan Soil Survey; and C. Gordon and R. Bandy of the USDA Soil Conservation Service in Montana.

- The authors thank the County of Forty Mile administration and staff for their assistance and liaison with landowners and lease holders. In particular, the services of Vern Arnold, Alan Schlachter, Shawn Geiger, Leonard Mitzel, Bill Gejdos and Brian Dillenbeck are noted.

- Assistance in interpreting the surficial geology was provided by M.M. Fenton[1] , L.D. Andriashek[1] and J.G. Pawlowicz[1], and by J. Kulig and N. Rutter of the Geology Department, University of Alberta.

- Standard aerial photography was obtained from Maps Alberta. Specialized aerial photographs were provided by Public Land Management Branch; Alberta Agriculture, Food and Rural Development, Edmonton (D. Brierley) and the University of Alberta (J. Kulig). L. Bradley prepared the working copy basemaps of the county.

- Final digital map production was provided by B.J. Sawyer[1], L.W. Turchenek[1] and M.R. Johnson[1].

- B.J. Sawyer[1] and L.W. Turchenek[1] provided technical review, final editing, and compilation of the report. J. Mathie, Alberta Geological Survey, Alberta Research Council, Edmonton, provided graphic support for figures in the report.

- Typing of the report manuscript and related documents was provided by J. Piercey[1], L. Payne[1], T. Miller[1] and B. Riley[1].

- Alberta Agriculture, Food and Rural Development, Public Land Management Branch [B. Adams (Lethbridge), T. Hood, B. Cairns and N. Boutilier (Medicine Hat) and D. Brierley (Edmonton)] and Alberta Environmental Protection, Public Lands, E. Karpuk (Edmonton) provided ongoing assistance for the completion of the soil survey. The Land Evaluation and Reclamation Branch of Alberta Agriculture, Lethbridge provided information on drill logs, soil analytical files and land classification maps for available Level 2 and Level 3 land irrigability inventories. S. J. Rodvang researched and reviewed information for the hydrogeology section (Appendix E) and reviewed this report.

- J. Beres[1], A. Schwarzer[1], and W.C. McKean of Agriculture Canada conducted the physical and chemical analyses of the soil samples.

- The authors thank Carolyn Luca, Donna Draber and Beverly Poapst for kindly renting housing to the Soil Survey field staff for the summer field seasons of 1990-92. Albert Kardash of Foremost provided vehicle service and maintenance as well as a smile to all the Soil Survey staff.

[1] Environmental Research and Engineering Department, Alberta Research Council, Edmonton.

Table of Contents

Figures

Tables

Part 1 - General Description Of The County

Location and Extent

The County of Forty Mile is located within the Palliser triangle region of the Canadian prairies in southeastern Alberta (Figure 1). The county borders with Montana of the United States of America on its south side at the 49th parallel. The northern boundary is the South Saskatchewan River from Township 11 Range 12 to Township 12 Range 8, West of the 4th Meridian. The easternmost portions lie from Township 3 Range 5 to Township 8 Range 5, West of the 4th Meridian. The western extremities lie in Township 5 Range 14 to Township 7 Range 14, West of the 4th Meridian (portions south of Chin Coulee).

Most of the County of Forty Mile occurs within the Foremost (72E) 1:250 000 National Topographic Series map sheet although a small portion lies within the Medicine Hat (72L) map sheet. The total area of the County, based on 1991 Statistics Canada data, is 731,684 ha (1,807,250 acres) of which approximately 217,000 ha, or 30% of the land base, is crown land and is used for livestock grazing. Individual dispositions (deeded land) constitute about 70% of the county on a total of 748 farms (C. Moroziuk, Statistics Branch, Alberta Agriculture, Edmonton, 1993, pers. comm.). Of this total, 207 farms report some level of irrigation which occurs on approximately 2% of the County land base (Alberta Agriculture 1991). The dominant land use is dryland agricultural cropping.

Statistics Canada reports a population of 3193, with most residents living in Bow Island, Foremost, and Burdett (Schlachter 1992). Other communities with over 100 residents include Etzikom and Manyberries.

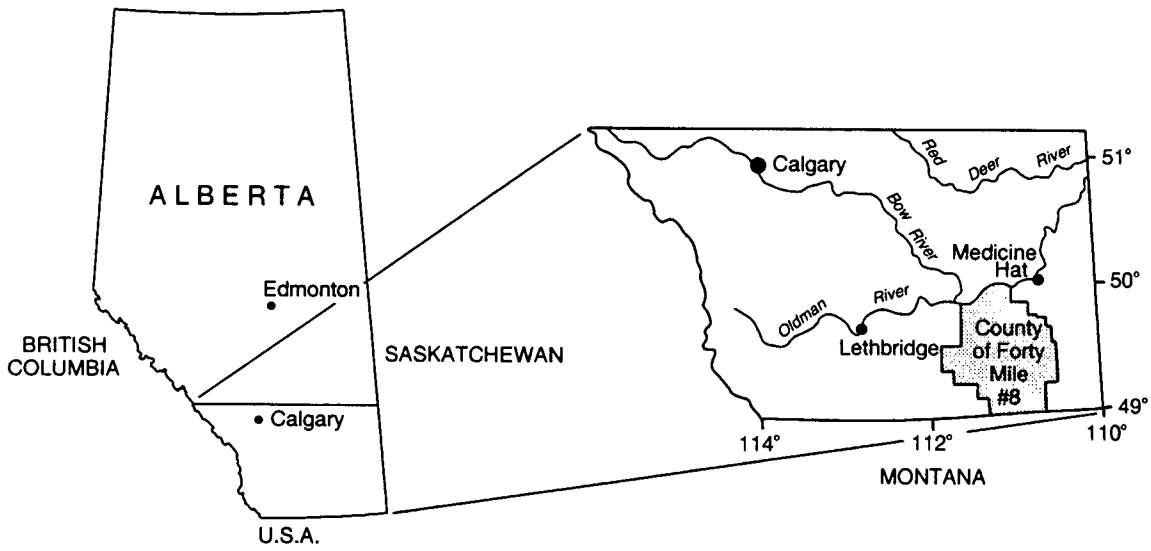


Figure 1. County of Forty Mile - Location and Extent.

Regional Setting

The majority of the County is characterized by undulating and rolling prairie landscapes. Landscapes of the County are described in more detail in Appendix C (Physiography and Drainage). Prominent geographic features in the County of Forty Mile include the west shoulder (dissected benchlands) of the Cypress Hills and the northern slopes of the Sweetgrass Upland. Other prominent features include the deeply incised valleys of the South Saskatchewan and Milk Rivers, and numerous coulees (glacial meltwater channels with characteristic misfit streams) including Chin, Etzikom, Forty Mile and Seven Persons. Pakowki Lake is a semi-permanent water body located in the east-central portion of the County near Orion and Manyberries.

Unique geographical features in the County include the Red Rock Coulee and Milk River Canyon (Beaty and Barendregt 1987; Brierley et al. 1989) which are natural areas protected by the Alberta Government. The Kennedy Coulee ecological reserve is characterized by ungrazed rangelands and is located in the southeastern part of the County. Other unique features include Black Butte (Township 1 Range 8) and Bull's Head Butte (Township 8 Range 7). The Forty Mile Regional Park, 20 km north of Foremost, includes an artificial lake in the Forty Mile Coulee. These geographic features provide recreational opportunities and scenic benefit to residents and visitors.

Land Systems

Land systems provide a framework for describing the distribution of soils and associated landscape characteristics. Land systems are designed to group features that can be applied to land use planning, such as the development of municipal conservation plans. Land systems of the County of Forty Mile were defined based on the approach of Brierley et al. (1992) in the County of Stettler. Land system definition was based on:

1) Agroclimatic and soil zones (Appendix A),

2) Parent material (Appendix D) and surface form (Appendix C), and

3) Soil taxonomic groups with the associated soil series (Part 3).

The original land systems approach emphasized soil series (Brierley et al. 1992). The soil survey in the County of Forty Mile used a slightly modified approach to recognize groups of soil series (soil map unit assemblages). The modified approach, based on soil mapping, resulted in the definition of 28 unique land systems (Figure 2; Table 1).

Three cross-sectional diagrams (Figure 3) show the distribution of soil map units associated with some of the land systems within the County. Other associated features, portrayed in the diagrams, include the presumed depth to bedrock and surface form characteristics.

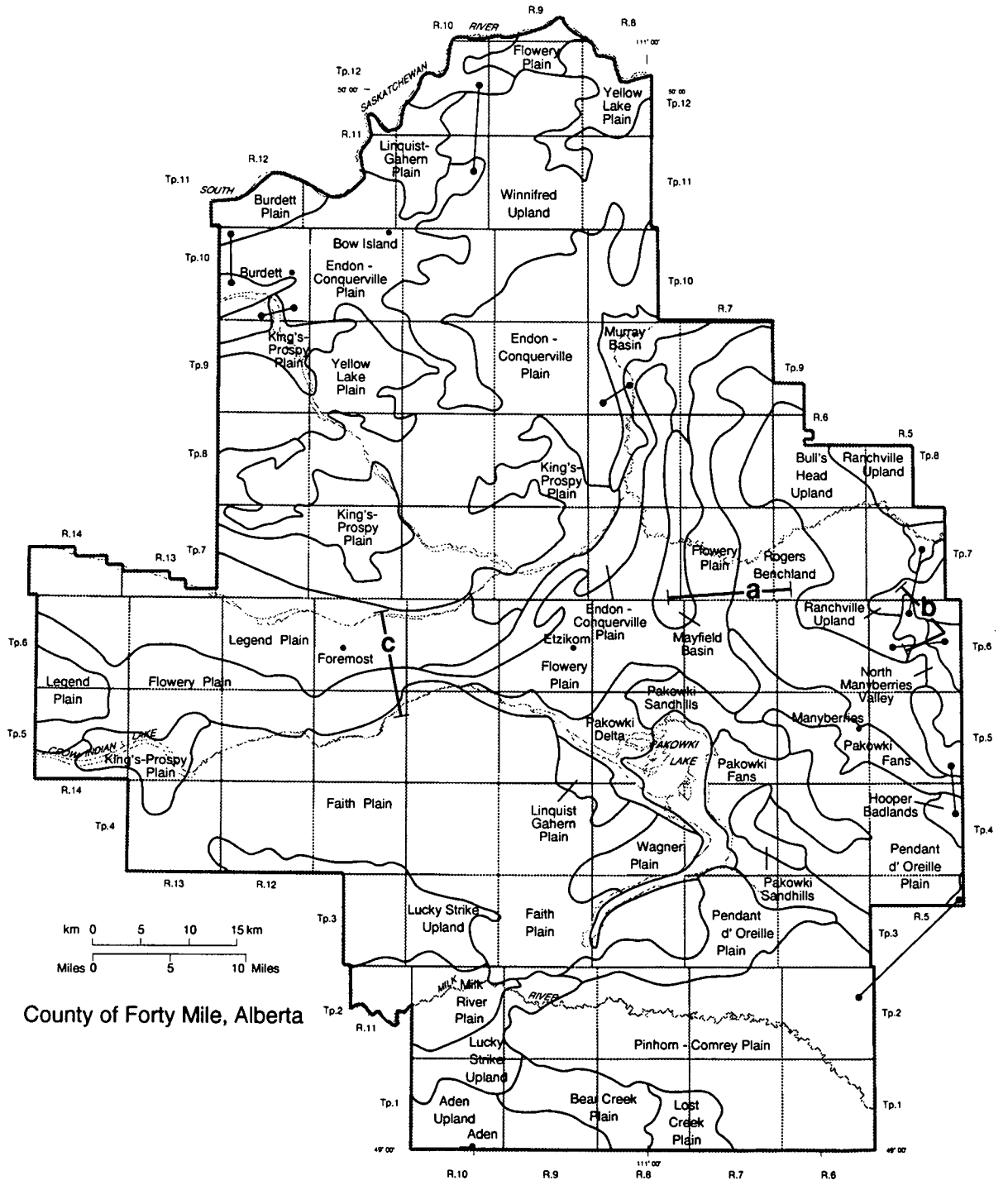


Figure 2. Land Systems of the County of Forty Mile (note that the Land System Cross Sections described in Figure 3 are illustrated on this diagram (a,b and c)).

Table 1. Land Systems of the County of Forty Mile.

Land System	Agro-climatic Zone[1]	Physio-graphic District[2]	Surficial Materials[3] (& Textures)[4]	Surface Form[4]	Dominant Soils by Great Group[4]	Dominant Soil Map Unit Assemblages[5]	Distinguishing Soil Map Unit(s)[6]	Comments
Aden Upland	2AH	Sweetgrass Upland	Morainal blanket to veneer over softrock (medium to moderately fine)	inclined to undulating	Dark Brown Chernozemic	PUR1, PUR4, PUR7, PULU9	PUR4/5-6d, PUR7/3i	Several bedrock controlled highs surrounded by morainal blanket. Includes the highest elevation in the county - 1196 m at Ike's Butte in SW5-1-9-W4.
Bear Creek Plain	2AH	Lost River Plain	Morainal blanket to veneer over softrock (medium to moderately fine)	undulating to ridged	Dark Brown Chernozemic	PUR7, PULU7, PULU9, PUPL7		Transitional land system between Aden Upland and Lost Creek Plain.
Bull's Head Upland	2AH	Elkwater Benchland	Morainal (moderately fine)	inclined and hummocky; dissected.	Dark Brown Chernozemic	TTH7, TTMH1	TTH7/4c, TTH7/3c	Transitional land system between Rogers Benchland and Ranchville Upland.
Burdett Plain	3A	Fincastle Plain	Glaciofluvial (moderately coarse & very coarse)	undulating to ridged	Brown Chernozemic	CVPL4, PLS4, CVD1, BVCF4, BVAN1	PLS4/4	Distinguishing unit also occurs in Pakowki Sandhills but in only one delineation.
Endon-Conquerville Plain	3A	Etzikom Plain	Morainal (medium to moderately fine) with discontinuous glaciolacustrine veneer	undulating	Brown Chernozemic	MACF4, MACF1, MAB		Ground moraine area of the northern portion of the County.
Faith Plain	3A	Etzikom Plain	Discontinuous glaciolacustrine veneer over morainal (medium to moderately fine)	ridged to undulating	Brown Chernozemic	MACF2, MACF4, MACF1		Similar to Endon-Conquerville but is a ridged recessional moraine while Endon-Conquerville is a ground moraine.
Flowery Plain	3A	Etzikom Plain	Morainal (medium to moderately fine)	hummocky to ridged	Brown Chernozemic	MAB4, MAB8	MAB8/5, MAB8/4	Lethbridge-Etzikom end moraine and associated hummocky stagnation moraine.
Hooper Badlands	2AH	Elkwater and McAlpine Benchlands	Residual softrock and morainal veneer over softrock (moderately fine to fine)	level to undulating plateaus with extensive steeply sloping rough broken areas	Dark Brown Solonetzic; Regosolic	ZRB3, ZCV, MNA1	MNA1/3, ZCV	Environmentally significant area with intensive oil and gas development.

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Table 1. Continued.

Land System	Agro-climatic Zone[1]	Physio-graphic District[2]	Surficial Materials[3] (& Textures)[4]	Surface Form[4]	Dominant Soils by Great Group[4]	Dominant Soil Map Unit Assemblages[5]	Distinguishing Soil Map Unit(s)[6]	Comments
Kings-Prospy Plain	3A	Etzikom Plain	Discontinuous glaciofluvial veneer to blanket over morainal (medium to coarse over medium)	undulating to ridged	Brown Chernozemic	BVAN1, RAPU1, CVD1, BVCF4, BVRI3, MACF6, MACF1	BVL6/4	Includes a mixture of glaciofluvial sands and gravels with till (morainal material).
Legend Plain	3A	Etzikom Plain	Discontinuous glaciolacustrine veneer over morainal (medium to moderately fine)	inclined to undulating	Brown Chernozemic	MACF1, CFD1	MACF1/2i	Includes Chin Coulee.
Linquist-Gahern Plain	3A	Etzikom Plain	Glaciofluvial (moderately coarse) and discontinuous glaciolacustrine veneer over morainal (medium to moderately fine)	undulating to level	Brown Chernozemic	BVAN4, BVCF4, CHCF1, CHN6, CFD1, MACF6, BVTA1/3		Similar land system to Kings-Prospy but does not have coarse (loamy sand) soil map units, such as CVD1; also has significant glaciolacustrine sediments.
Lost Creek Plain	2AH	Lost River Plain	Morainal veneer over softrock; Residual softrock (medium to moderately fine)	subparallel ridges with concavities	Dark Brown Chernozemic	PUPL1, CGW2, PUPL7, PLMN1	PLMN1/3-5	Surface form represents glacially contorted residual softrock.
Lucky Strike Upland	3A	Verdigris and Lost River Plains	Morainal blanket to veneer over softrock (medium to moderately fine)	inclined to undulating and ridged	Brown Chernozemic	MSN1, MSCF7, MSN7, MSCF1, MSN4	MSN1/3i:R, MSN7/3-4:R	Ridges (flutings) trend northwest to southeast.
Mayfield Basin	3A	Etzikom Plain	Glaciolacustrine (medium to fine)	level to undulating	Brown Solonetzic; Brown Chernozemic	TIPT1, PTSI1, CFD5	TIPT1/2-3	This land system follows the north-south trend of the preglacial Medicine Hat Valley (see Appendix E).
Milk River Plain	3A	Verdigris Plain	Discontinuous glaciolacustrine veneer over morainal (medium to moderately fine); glaciofluvial (moderately coarse to medium)	undulating and terraced	Brown Chernozemic	MSCF1, MSN1, RAM1, MKR1.	MKR1/3, MSCF1/3	Includes glaciofluvial sediments of modern-day Milk River and the morainal deposits of the pre-glacial Medicine Hat Valley (see Appendix E).

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Table 1. Continued.

Land System	Agro-climatic Zone[1]	Physio-graphic District[2]	Surficial Materials[3] (& Textures)[4]	Surface Form[4]	Dominant Soils by Great Group[4]	Dominant Soil Map Unit Assemblages[5]	Distinguishing Soil Map Unit(s)[6]	Comments
Murray Basin	3A	Etzikom Plain	Glaciofluvial (very coarse to moderately fine)	inclined to level (aprons) and undulating	Brown Chernozemic; Regosolic	ORBU9, BUT4, CVVS1, BVAN4		Includes Seven Persons Coulee, Murray Lake and the coarse glaciofluvial benchlands above Murray Lake.
North Manyberries Valley	2AH	Elkwater Benchland	Glaciofluvial veneer to blanket over morainal (moderately fine)	inclined (aprons) and undulating	Dark Brown Solonetzic; Dark Brown Chernozemic	CGW1, GNCG1. CGTT1, GNN1	GNCG4/3c	Glaciofluvial sediments derived from till uplands and Bearpaw shale exposures.
Pakowki Delta	3A	Pakowki Basin	Glaciofluvial (coarse and moderately coarse)	terraced and level to undulating	Brown Chernozemic	PUN5, CVPU5, RAPU1, RAM1	CVPU5/2-3	Glaciofluvial sediments of the Etzikom Coulee drainage into Pakowki Lake.
Pakowki Fans	3A	Pakowki Basin	Glaciofluvial (medium and moderately coarse)	inclined (aprons) and level	Brown Chernozemic; Brown Solonetzic	BUT, WDW, WTN3, ORWD3	BUT4/2a, BUT7/2a	Glaciofluvial sediments of the Fourways, Irrigation, Ketchum, Canal and South Manyberries Creeks derived from adjacent uplands.
Pakowki Lake	3A	Pakowki Basin	Glaciolacustrine (fine)	level	Gleysolic; Regosolic	GLS1, WTN1	GLS1/2n	GLS and WTN units only occur in coulee settings within other land systems.
Pakowki Sandhills	3A	Pakowki Basin	Eolian (very coarse)	ridged (duned)	Regosolic; Brown Chernozemic	VSAT1, CVVS1, VSCV:W1	VSAT1/4-5, VSCV:W1/2-3	Includes both active and stabilized dunes.
Pendant d'Oreille Plain	3A	Verdigris & Lost River Plains	Morainal blanket to veneer over softrock (medium to moderately fine)	ridged, undulating and inclined	Brown Solonetzic; Brown Chernozemic	HDRO, MAB	MAB7/3-4:R, HDRO1/3:R	High proportion of Solonetzic soils is directly related to thin till layer over sodic softrock.
Pinhorn-Comrey Plain	3A	Lost River Plain	Residual softrock and morainal veneer over softrock (medium to moderately coarse)	subparallel ridges with concavities; extensively dissected	Brown Chernozemic	PHMS, WDW, PHCM, CMSI4, ROSI1, ROSI4, ZRB2, ZRB3	PHMS6/3, PHCM7/3-4	Differs from Lost Creek Plain by Agroclimatic zone and greater % of soils developed on residual material. Includes Milk River Canyon and Lost River Badlands.

... continued

Table 1. Concluded.

Land System	Agro-climatic Zone[1]	Physio-graphic District[2]	Surficial Materials[3] (& Textures)[4]	Surface Form[4]	Dominant Soils by Great Group[4]	Dominant Soil Map Unit Assemblages[5]	Distinguishing Soil Map Unit(s)[6]	Comments
Ranchville Upland	2H	Elkwater Benchland	Morainal (moderately fine)	hummocky and inclined; dissected.	Dark Brown Chernozemic	WSPM7, WSM4, WSM1	WSM9/5	Highest elevation of the Cypress shoulder within the county.
Rogers Benchland	3A	McAlpine Benchland	Morainal (medium to moderately fine)	inclined	Brown Chernozemic; Brown Solonetzic	MACF7, MACF1, HDRO1, MACF4	MACF7/3i	Lower slopes of the Cypress shoulder. Solonetzic soils are co-dominant.
Wagner Plain	3A	Etzikom Plain	Morainal (medium to moderately fine)	hummocky	Brown Chernozemic	MAB9, MACF9		Differs from the Flowery Plain with the predominance of "9" units (significant gleyed, Gleysols and water with Solonetzic soils).
Winnifred Upland	3A	Etzikom Plain	Morainal blanket to veneer over softrock (medium)	ridged and undulating	Brown Chernozemic	MACF4, HMS1, MAB7	MACF4/3-4:R	Subdued bedrock - controlled upland dissected by numerous channels including the upper reaches of Stornham, Whitla, and Thirty Mile Coulees.
Yellow Lake Plain	3A	Etzikom Plain	Glaciolacustrine blanket to veneer over morainal (moderately coarse to moderately fine)	level to undulating	Brown Chernozemic	CHCF1, CHN6	CHCF1/2	Largely irrigated cropland; occurs both east and west of Forty Mile Coulee and in Rattlesnake Lake area.

1 Refer to Appendix A - Climate
2 Refer to Appendix C - Physiography and Drainage
3 Refer to Appendix D - Surficial Materials
4 Refer to Appendix H - Information to Assist the User with this Soil Survey Report
5 Refer to the Descriptive Legend in Part 3 - Soils and Appendix I - Detailed Legend
6 A unit that is unique to the described land system or occupies a greater area within the described land system than occurs elsewhere within the county

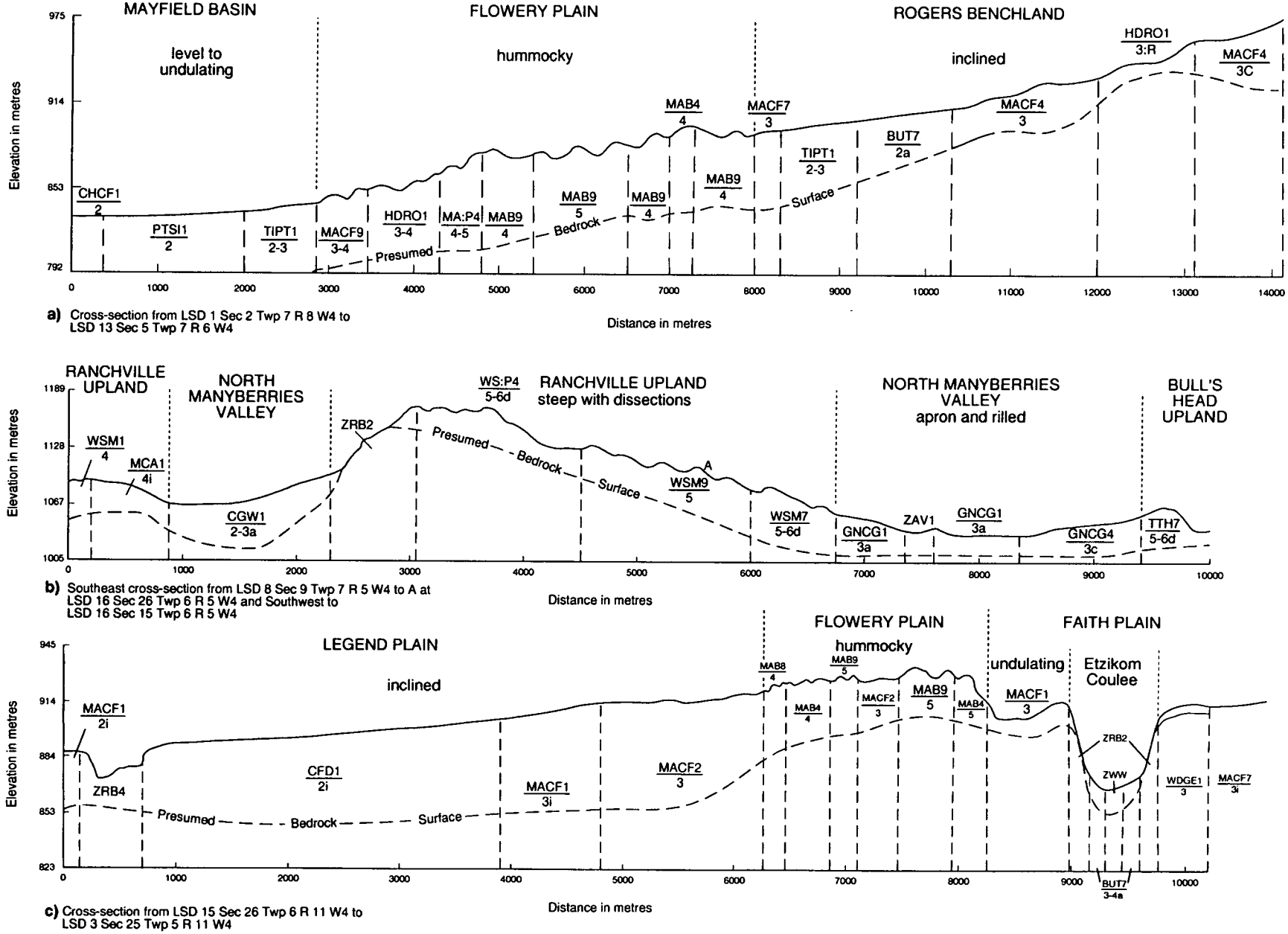

Figure 3. Schematic Cross-sectional Diagrams of Selected Land Systems within the County of Forty Mile (see Figure 2 for locations in the County).

Part 2 - Soils and Mapping Methods

Introduction

During the course of this soil survey, the landscape was systematically subdivided into repeating soil map units based on soil characteristics and topography. Soils were examined to a 1 m depth using a shovel and hand auger to characterize each location. The soils were classified according to the Canadian System of Soil Classification (Expert Committee on Soil Survey (ECSS) 1987) and assigned soil names (Alberta Soil Series Working Group 1993) for identification. Landscapes with similar combinations of soils on similar slope classes were delineated and labeled on aerial photographs. The aerial photographic and field information was compiled on eight basemaps which are provided with this report. Soil samples were collected and analyzed to characterize soil properties.

The Soil Profile

Soils are recognized and classified by identifying the horizons of the soil profile. Each soil horizon differs from adjacent horizons in properties such as texture, structure, consistence, depth, color, and in chemical, biological and mineralogical composition. Soil profile characteristics are the result of the integrated effects of the soil forming factors: climate, parent material, biota, topography, and time.

Three main horizons are recognized in the profiles of mineral soils. The A horizon, the uppermost layer in the profile, is the part of soil in which organic matter is most plentiful. The organic matter is principally derived from the decay of plant roots. Mixing of organic and mineral material by soil fauna results in the formation of stable aggregates in the topsoil, a feature typical of grassland soils. The B horizon, when present, lies immediately beneath the A horizon and has been altered to give a change in color, structure or texture. B horizons affected by sodicity are dense and hard and almost impenetrable by plant roots or water. The C horizon is the lowest recognized horizon in the profile and usually represents the parent material of the soil. The C horizon usually contains an accumulation of calcium or magnesium carbonates and may also have soluble salts.

Soil Correlation Areas

The Soil Correlation Area (SCA) concept is a framework for depicting the distribution of soil series names within Alberta (Alberta Soil Series Working Group 1993). Soil Correlation Areas (SCAs) are defined in terms of soil zones as well as ecological and agroclimatic factors. Thus, SCA boundaries generally coincide with ecoregion lines (Strong and Leggat 1992) and agroclimatic zones (Alberta Soils Advisory Committee (ASAC) 1987) within broad soil zone concepts.

The soil survey of the County of Forty Mile utilized the SCA framework. Within the County two SCAs were recognized and the boundary between them coincides with the Brown/Dark Brown soil zone. The characteristics of these two SCAs are as follows:

SCA 1 Brown Soil Zone of South - Eastern Alberta
- Dry Mixed Grass Ecoregion
- Agroclimate 3A* (moderate moisture limitation)

SCA 2 Dark Brown Highlands of Southern Alberta
- Mixed Grass Ecoregion
- Agroclimate 2AH* (slight aridity and heat limitations)
- 2H* (slight heat limitation)

* Appendix A.

Mapping Methods

Two mapping methods were used in the County of Forty Mile: SIL3 1:50 000 (Mapping Systems Working Group (MSWG) 1981) and extrapolatory mapping as developed by R.L. McNeil and documented by Fawcett et al. (1993). SIL3 1:50 000 mapping was used in 1990 to initiate the soil survey and in the subsequent years of 1991 and 1992 to characterize strategic townships (Figure 4). Extrapolatory mapping expedited the soil survey process by reducing field time and was found as equally reliable as the SIL3 1:50 000 in a comparison of the two methods (Fawcett et al. 1993).

SIL3 1:50 000 Method

The soil mapping program in Alberta evolved from reconnaissance mapping to SIL3 1:50 000 standards (MSWG 1981). This evolution was the result of a recognized need to update existing data and incorporate current knowledge into new data products.

The majority of existing SIL3 1:50 000 soil surveys were developed for a generalized user audience addressing concerns of grazing land management, soil conservation planning, and farmland assessment; as well, providing baseline information for deep plowing, pipeline right-of-ways and reclamation. The SIL3 1:50 000 method included office compilation of existing data, extensive field verification and final data compilation. Field work confirmed soil map unit composition and polygon boundaries. Field verification required 6 to 10 days per township.

The procedures used in the production of the SIL3 1:50 000 mapping method for the County of Forty Mile were as follows:

1. Definition of objectives, requirements and ongoing reviews.

2. Compilation of existing data, preliminary field studies and initial stratification.

   Information was collected on climate, surficial and bedrock geology, hydrogeology, hydrology, topography, vegetation, and soils. Compilation of the background information provided the soil surveyors with a regional overview of the area. This information was used to develop the land systems of the County.

3. Development of an initial mapping legend.

   The soil map legend was adapted from existing soil maps to save time and enhance correlation during the field work. Continued map legend development was based on field observations.

4. Field mapping.

   Mapping was conducted using black and white, and color infrared aerial photographs. All passable roads and trails were traversed during field soil mapping. Occasional traverses were made on foot to verify soil and landscape properties where necessary. Soils were examined to a depth of 1 m using a shovel and hand auger. Soil inspections were conducted at approximately one location per 80 ha (200 acres). Supplemental inspections and observations were conducted at many sites to confirm and verify soil map unit composition and boundaries.

5. Correlation and consolidation of soil map units.

   Each mapped township was compared, checked and correlated with adjacent townships. Correlation provided consistency in matching polygon boundaries and ensured that soil map unit concepts were applied consistently across the project area.

   Soil map unit concepts were consolidated to achieve a balance between cartographic simplicity and landscape detail (Hole and Campbell 1985). Soil map unit consolidation reduced the number of soil map units initially developed in the survey by amalgamating similar soil map units possessing similar interpretations. The consolidation process occasionally resulted in the redefinition of soil map units.

   SIL3 1:50 000 soil maps were produced in conjunction with this report. The basemap was derived from the 1:20 000 digital base files distributed by the Land Information Services Division, Alberta Environmental Protection and portrayed at a scale of 1:50 000.

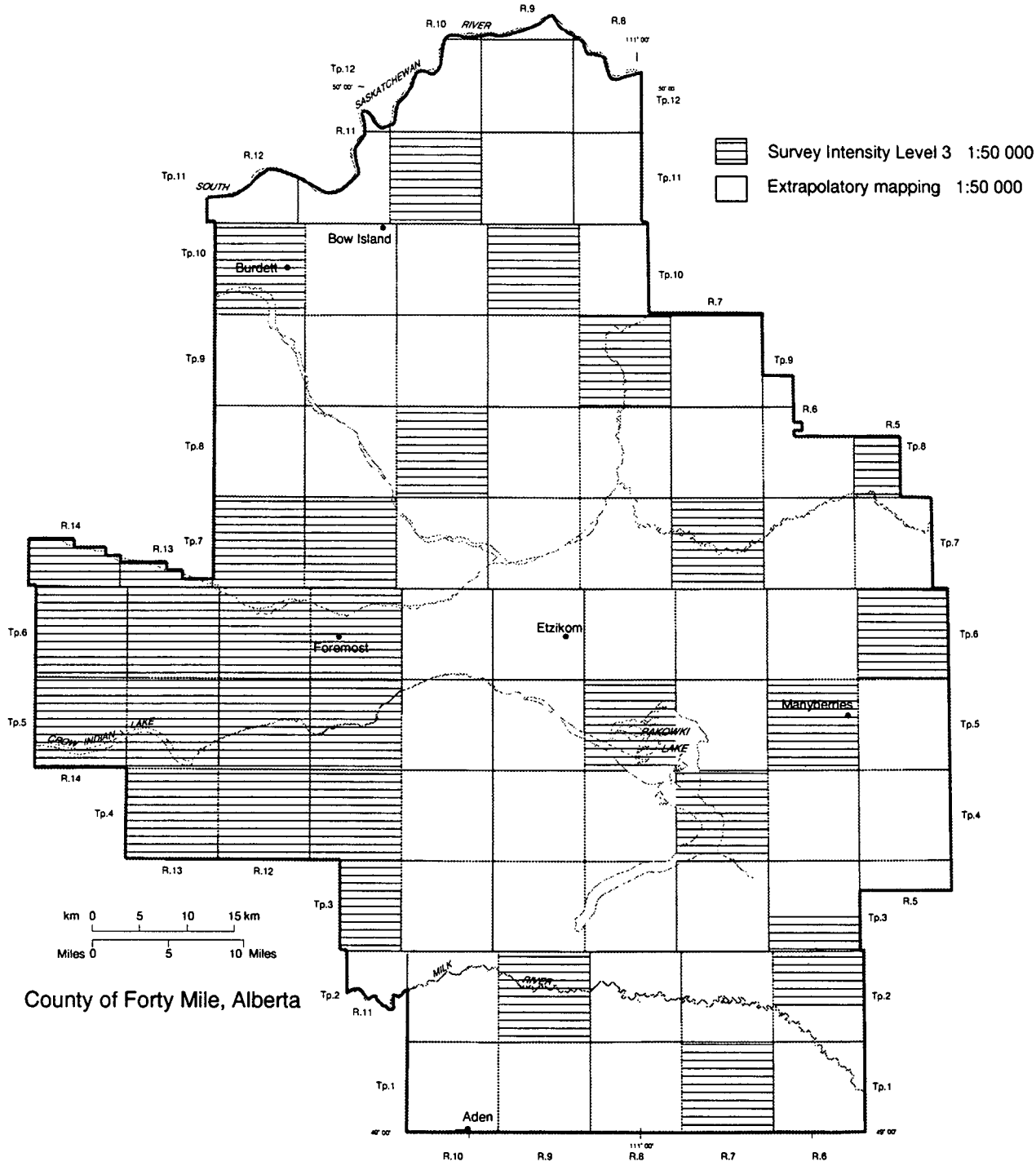

Figure 4. Soil Mapping Procedures in the County.

SIL3 1:50 000 mapping was conducted in strategically selected townships with varying land systems to facilitate mapping by the extrapolatory method.

Extrapolatory Method

The extrapolatory method made use of the strong and consistent relationship between soils and landscapes. The SIL3 1:50 000 method was used to develop soil map unit concepts in several representative areas. The concepts were used to build a detailed soil map unit legend which was extrapolated to adjacent areas of similar landscapes using a much lower intensity of time-consuming ground truth observations. Field site examinations were reduced from 90 to 150 sites per township using the SIL3 1:50 000 mapping method, to less than 20 sites in extrapolatory townships. Therefore, field work was reduced from six to ten days per township, to two to four days per township.

The procedures used in the production of extrapolatory mapping for the County of Forty Mile were as follows:

1. The County was sub-divided into land systems (Part 1) on the basis of agroclimatic zone, dominant surface form, parent material, and associated soil series. Existing information including climate, surficial and bedrock geology, hydrogeology, hydrology, topography, vegetation and soils was collected to differentiate land systems.

2. Conceptual models of soil-landscape relationships (preliminary soil map units) were developed through a review of information from existing surveys and aerial photo interpretation.

3. Representative areas within the various land systems were selected for SIL3 1:50 000 mapping to test and revise soil map unit concepts.

4. A working legend with soil-landscape concepts (soil map units) was developed.

5. The soil-landscape models were extrapolated to adjacent areas to delineate strongly and moderately contrasting polygons.

6. Initial soil map unit symbols were assigned to all polygons in extrapolatory areas and descriptions were developed for these soil map units.

7. Areas of undescribed or uncertain soil landscape models were identified for field investigation.

8. Extrapolatory areas were checked by the project leader to verify soil map unit boundaries, define map legend concepts and identify specific soil properties.

9. Polygon boundaries, soil map unit names and soil map unit descriptions were finalized using aerial photo interpretation and field verification notes. This differs from the SIL3 1:50 000 method which tends to separate the mapping and correlation components.

Both mapping methods used in this project provided reliable soil information and were consistent with current soil mapping technologies. The extrapolatory method proved to be as effective and more efficient than the standard SIL3 1:50 000 mapping (Fawcett et al. 1993). The opportunity to compare and contrast mapping methods confirmed that the extrapolatory approach is applicable for use in future soil survey projects.

Part 3 - Soils in The County of Forty Mile

Four soil orders of the Canadian System of Soil Classification (ECSS 1987) (Table 2) were found in the County. They were: Chernozemic, Solonetzic, Gleysolic, and Regosolic soils. The most common soils found were Brown Chernozemics which formed on a variety of parent materials resulting from the melting of the glacial ice (deglaciation) that covered northern North America approximately 12,000 years ago. Dark Brown Chernozemics were mapped at higher elevations on the Cypress Shoulder and on the Sweetgrass Arch (Appendix C). Solonetzic soils commonly occurred in the southeastern part of the County but also occurred sporadically in most land systems (Part 1). Gleysolic and Regosolic soils were mapped throughout most of the defined land systems.

Chernozemic soils formed on non-saline or weakly saline parent materials with carbonate rich horizons frequently occurring at 40 to 70 cm beneath the surface. The most common Chernozemic soil series include: Maleb, Cranford, Chin, Tothill, Wisdom, and Purescape. Chernozemic soils occur in virtually all land systems. The majority of these soils are cultivated for dryland or irrigated agriculture because of their inherent fertility, ease of management, and organic matter content (generally 2-5%).

Solonetzic soils formed on saline and sodic parent materials (softrock and thin till over softrock) and in regions prone to groundwater discharge. The most common Solonetzic soil series include: Halliday, Hemaruka, and Duchess. Solonetzic soils commonly occur in conjunction with Chernozemic soil series. Areas of Solonetzic soils that are not cultivated are characterized by blowout pits (shallow depressions where the topsoil has been eroded) with sparse vegetation. Cultivated areas of Solonetzic soils usually exhibit an uneven crop height producing a wavy appearance. Annual cropping requires timely soil management to ensure seedling germination and continued growth. Special management techniques include ripping and deep plowing. Solonetzic soils occur in most land systems but are especially prevalent in the Hooper Badlands, Mayfield Basin, North Manyberries Valley, Pakowki Fans, Pendant d'Oreille Plain, and Rogers Benchland.

Regosolic soils formed on steep-sided river valleys, coulees, active sand dunes, recent floodplains and saline discharge areas. The main soil series used were Antelope and Weston but there are undifferentiated Regosols throughout most land systems in minor amounts. These soils are weakly developed, generally non-arable, but have a limited capacity for grazing.

Gleysolic soils formed in areas of surface water collection or groundwater discharge. Gleysols are often saline due to their location in the landscape. These soils are typically dull coloured or strongly mottled because of saturation by water. The main soil series used were Gleddies, Skiff, and Walsh but there are undifferentiated Gleysols throughout most land systems in variable amounts. The Pakowki Lake basin is characterized by the Gleddies series because of a high water table and or standing water during parts of the year. Gleysols are mapped as significant or co-dominant with other series in most land systems (e.g. MAB2, SKMA1). These soils are generally non-arable with limited capacity for grazing or forage production.

There were 77 soil series identified in this soil survey (Table 3). The major differences among the series identified were attributed to soil classification (Table 2), soil parent material (Appendix D) and climatic differences due to elevation and local climate (Appendix A).

Table 2. Soil Orders and Great Groups mapped in the County of Forty Mile.

Order	Great Group	Distinguishing Characteristics
Chernozemic (Surface horizons darkened by accumulation of organic matter from decomposition of grassland vegetation).	Brown Dark Brown	Brownish Ah, subarid to semiarid climate Dark Brown Ah, semiarid climate
Gleysolic (Features indicative of periodic or prolonged water saturation, and reducing conditions - mottling and gleying).	Humic Gleysol Gleysol Luvic Gleysol	Ah≥10 cm, no Bt Ah≤10 cm, no Bt Has a Btg, usually has an Ahe or an Aeg
Regosolic (Development too weak to meet requirements of any other order).	Regosol Humic Regosol	Ah<10 cm, Bm absent or <5 cm Ah≥10 cm, Bm absent or <5 cm
Solonetzic (Solonetzic B horizon - Bn or Bnt - columnar or prismatic structure, hard to extremely hard when dry, exchangeable Ca/Na≤10).	Solonetz Solodized Solonetz Solod	Lack a continuous Ae≥2 cm Ae≥2 cm, intact columnar Bnt or Bn Ae≥2 cm, distinct AB or BA (disintegrating Bnt)

Source: ECSS 1987.

Table 3. Soil Series Key.

Series Name	Symbol	Agro-climate[1]	Classification[2]	Parent Material 1 (surface to 30 cm or greater)		Parent Material 2 (occurring within 30-100 cm)		Comments
				Texture[2]	Type[3]	Texture[2]	Type[3]	
ANTELOPE	ATP	3A	Orthic Regosol	Very Coarse	Eolian			Active dunes common. Typical texture is sand.
ANTONIO	ANO	3A	Orthic Brown	Moderately Coarse	Glaciofluvial	Moderately Fine	Till	Sandy loam veneer over till.
BINGVILLE	BVL	3A	Orthic Brown	Moderately Coarse	Glaciofluvial			Sandy loam blanket.
BULLPOUND	BLP	3A	Brown Solonetz	Moderately Fine	Glaciolacustrine			Loam to silt loam, but may be finer such as silty clay loam to silty clay.
BUNTON	BUT	3A	Orthic Brown	Medium	Glaciofluvial			Sediments typically deposited as fan or aprons.
CAVENDISH	CVD	3A	Orthic Brown	Very Coarse	Fluvioeolian			Typically loamy sand texture.
CHIN	CHN	3A	Orthic Brown	Medium	Glaciolacustrine			Generally 25-35% clay.
CHINZ	CHZ	3A	Solonetzic Brown	Medium	Glaciolacustrine			Distinguished from the Tilley series by lack of Ae horizon.
CLARINDA	CLR	3A	Rego Brown	Moderately Fine	Till			Used with Masinasin till on Lucky Strike Upland and Sweetgrass Arch.
COMREY	CMR	3A	Orthic Brown	Moderately Coarse	Residual			No veneer of till; soil developed in Cretaceous sandstone of the Judith River Formation.
CRAIGOWER	CGW	2AH	Dark Brown Solodized Solonetz	Moderately Fine	Glaciolacustrine			Sediments typically deposited as fans or aprons.
CRANFORD	CFD	3A	Orthic Brown	Medium	Glaciolacustrine	Moderately Fine	Till	
DISHPAN	DHP	3A	Rego Gleysol-saline	Moderately Fine	Lacustrine			Depressional areas.
DUCHESS	DHS	3A	Brown Solodized Solonetz	Medium	Glaciolacustrine	Moderately Fine	Till	
ETZIKOM	EZM	3A	Orthic Regosol	Gravelly Very Coarse	Glaciofluvial			Found on the Etzikom delta of the Pakowki Basin.
EXPANSE	EXP	3A	Calcareous Brown	Medium	Glaciolacustrine			
FOREMOST	FMT	3A	Orthic Brown	Medium	Till			Modified till with sand lenses.
GEM	GEM	3A	Brown Solod	Medium	Glaciolacustrine	Moderately Fine	Till	
GLEDDIES	GLS	3A	Rego Gleysol-saline	Fine	Lacustrine			Depressional areas in coulee bottoms and Pakowki Basin.
GLENBANNER	GNN	2AH	Orthic Dark Brown	Moderately Fine	Glaciolacustrine			Sediments typically deposited as fans or aprons.
GRUDGE	GRG	2AH	Dark Brown Solodized Solonetz	Moderately Fine	Till			Occurs on the Sweetgrass Arch.

...continued

Table 3. Continued.

Series Name	Symbol	Agro-climate[1]	Classification[2]	Parent Material 1 (surface to 30 cm or greater)		Parent Material 2 (occurring within 30-100 cm)		Comments
				Texture[2]	Type[3]	Texture[2]	Type[3]	
HALLIDAY	HDY	3A	Brown Solod	Moderately Fine	Till			Associated with the Bearpaw Formation or marine partings of the Judith River Formation.
HELMSDALE	HMS	3A	Rego Brown	Moderately Fine	Till			Used with the Maleb series.
HEMARUKA	HUK	3A	Brown Solodized Solonetz	Moderately Fine	Till			Associated with the Bearpaw Formation or marine partings of the Judith River Formation.
ILLINGWORTH	IWT	3A	Orthic Gleysol	Moderately Fine	Fluviolacustrine			Typically loam to silt loam; depressional areas.
ISLANDS	INS	3A	Rego Gleysol	Very Coarse	Fluvioeolian			Depressional areas in sand dunes with high watertable and surface water collection.
KANGAROO	KGO	3A	Orthic Brown	Gravelly Coarse	Glaciofluvial			20-50% gravel and cobbles by volume.
KARLSBAD	KBD	3A	Brown Solod	Moderately Fine	Glaciolacustrine			Typically loam to silty clay loam
KITSIM	KTM	3A	Rego Gleysol-saline	Moderately Fine	Till			Occurs in depressional areas in till , often where the Bearpaw Formation is close to the surface.
LILYDALE	LLD	3A	Orthic Brown-saline	Medium	Fluvial			Sometimes occurs on medium textured lacustrine and slopewash derived materials.
LUPEN	LUP	2AH	Orthic Dark Brown	Medium	Glaciolacustrine	Moderately Fine	Till	Occurs on the Sweetgrass Arch. Clay content typically varies from 25-35%.
MAHER	MHR	2AH	Dark Brown Solodized Solonetz	Moderately Fine	Till			Used with the Tothill series.
MALEB	MAB	3A	Orthic Brown	Moderately Fine	Till			
MASINASIN	MSN	3A	Orthic Brown	Moderately Fine	Till			Mapped on the Lucky Strike Upland and Sweetgrass Arch.
MCALPINE	MCA	2H	Dark Brown Solodized Solonetz	Moderately Fine	Till			Mapped above 1110 m on the Cypress Shoulder.
MCNAB	MCN	3A	Orthic Regosol-saline	Medium	Fluvial			
MEACHIN	MHN	3A	Gleyed Brown	Medium	Glaciolacustrine			
MILK RIVER	MKR	3A	Cumulic Regosol	Moderately Coarse	Fluvial			Recent fluvial sediments on floodplains.

...continued

Table 3. Continued.

Series Name	Symbol	Agro-climate[1]	Classification[2]	Parent Material 1 (surface to 30 cm or greater)		Parent Material 2 (occurring within 30-100 cm)		Comments
				Texture[2]	Type[3]	Texture[2]	Type[3]	
MILLICENT	MCT	3A	Solonetzic Brown	Fine	Glaciolacustrine			Has an eluvial (Ae) horizon. Usually occurs in lake basins.
MINDA	MNA	2AH	Dark Brown Solodized Solonetz	Moderately Fine	Till	Fine	Residual	Till veneer over saline and/or sodic Cretaceous residual. Gradational boundary between till and residual. Mapped on the Cypress Shoulder and Sweetgrass Arch.
ORION	ORN	3A	Orthic Regosol	Medium	Glaciofluvial			Sediments typically deposited as fans or aprons.
PATRICIA	PTA	3A	Brown Solodized Solonetz	Fine	Glaciolacustrine			Usually occurs in lake basins.
PEMUKAN	PUN	3A	Orthic Brown	Very Gravelly, Very Coarse	Glaciofluvial			May have up to 30 cms of material with less than 20% gravels overlying material with greater than 50% gravels.
PHILP	PLP	2AH	Orthic Dark Brown	Medium	Till	Medium	Residual	Mapped on the Sweetgrass Arch typically above 1025 m.
PINHORN	PHN	3A	Orthic Brown	Medium	Residual			
PLUME	PME	2H	Rego Dark Brown	Moderately Fine	Till			Used with the Wisdom series.
PURESCAPE	PUR	2AH	Orthic Dark Brown	Moderately Fine	Till			Mapped on the Sweetgrass Arch typically above 1025 m.
PURPLE SPRINGS	PLS	3A	Orthic Brown	Very Coarse	Fluvioeolian	Moderately Fine	Till	Loamy sand veneer over till.
RAINIER	RIR	3A	Orthic Brown	Moderately Coarse	Glaciofluvial	Moderately Fine	Glacio-lacustrine	Sandy loam veneer over loam to silty clay loam.
RAMILLIES	RAM	3A	Orthic Brown	Medium	Glaciofluvial	Very gravelly, Very Coarse	Glaciofluvial	Loam to silt loam veneer over material with greater than 50% gravels.
ROLLING HILLS	RHS	3A	Brown Solodized Solonetz	Very Coarse	Fluvioeolian	Moderately Fine	Glacio-lacustrine	Bnt typically occurs in the second parent material.
RONALAINE	ROL	3A	Solonetzic Brown	Moderately Fine	Till			Eluvial (Ae) horizon not present.
ROSEMARY	RMR	3A	Brown Solod	Fine	Glaciolacustrine			Occurs in lake basins.
SCOTFIELD	SFD	3A	Gleyed Regosol-saline	Moderately Fine	Glaciolacustrine			Depressional areas with saline discharge.
SEVEN PERSONS	SPS	3A	Orthic Brown	Fine	Glaciolacustrine			Usually occurs in lake basins.
SEXTON-AA[4]	aaSXT	3A	Orthic Humic Regosol	Moderately Coarse	Fluvial			Typical location is the Dark Brown Plains (Soil Correlation Area 3).
SKIFF	SKF	3A	Orthic Luvic Gleysol	Moderately Fine	Glaciolacustrine	Moderately Fine	Till	

...continued

Table 3. Concluded.

Series Name	Symbol	Agro-climate[1]	Classification[2]	Parent Material 1 (surface to 30 cm or greater)		Parent Material 2 (occurring within 30-100 cm)		Comments
				Texture[2]	Type[3]	Texture[2]	Type[3]	
SLOUGHAY	SLY	3A	Rego Humic Gleysol	Moderately Fine	Glaciolacustrine			
STERLING	SIG	3A	Brown Solonetz	Fine	Glaciolacustrine			Usually occurs in lake basins.
STEVEVILLE	SIL	3A	Brown Solodized Solonetz	Medium	Till	Medium	Residual	Mainly developed on Bearpaw Formation; textures range from sandy loam to silty clay.
TABER	TAB	3A	Orthic Brown	Medium	Glaciolacustrine	Very Coarse	Glacio-fluvial	Formerly Chin (CHN) over sand.
TEMPEST	TEP	3A	Humic Luvic Gleysol	Moderately Fine	Glaciolacustrine			Usually occurs in depressional areas.
TILLEY	TIY	3A	Solonetzic Brown	Medium	Glaciolacustrine			Formerly classified as a Solodic or Eluviated Brown; has an Ae horizon.
TIMKO	TIK	3A	Solonetzic Brown	Medium	Glaciolacustrine	Moderately Fine	Till	Formerly classified as a Solodic or Eluviated Brown; an eluvial (Ae) horizon is present.
TOTHILL	TTH	2AH	Orthic Dark Brown	Moderately Fine	Till			1025 to 1110 metre zone on the Cypress Shoulder.
TRAVERS	TVS	3A	Calcareous Brown	Moderately Fine	Till			Used with the Maleb series.
VENDISANT	VST	3A	Rego Brown	Very Coarse	Fluvioeolian			Generally occurs on stabilized sand dunes.
VENTRE	VET	3A	Rego Gleysol	Moderately Fine	Fluviolacustrine			Occurs in depressional areas.
VERDIGRIS	VGR	3A	Cumulic Regosol	Moderately Fine	Fluvial			Recent fluvial sediments often with variable texture. Found on floodplains
WALSH	WLH	3A	Rego Gleysol	Fine	Lacustrine			Occurs in depressional areas.
WARDLOW	WDW	3A	Brown Solodized Solonetz	Moderately Fine	Glaciolacustrine			Mapped in lake basins and on fans or aprons.
WESTON-AA[4]	aaWTN	3A	Orthic Regosol	Fine	Glaciolacustrine			Typical location is the Dark Brown Plains (Soil Correlation Area 3).
WILDA	WID	2AH	Rego Dark Brown	Moderately Fine	Till			Used with the Purescape series on the Sweetgrass Arch.
WISDOM	WSM	2H	Orthic Dark Brown	Moderately Fine	Till			Above 1110 m on the Cypress Shoulder.
WOOL-CHESTER	WCR	2AH	Rego Dark Brown	Moderately Fine	Till			Used with the Tothill series.
YARNLEY	YNY	3A	Brown Solodized Solonetz	Very Coarse	Fluvioeolian			Found on beach deposits along the edges of Pakowki Lake.
YOUNGSTOWN	YTW	3A	Brown Solodized Solonetz	Moderately Coarse	Glaciofluvial			

1 Appendix A
2 Appendix H
3 Appendix D
4 Not in modal SCA

PART 4 - INTERPRETATIONS

Land Capability for Dryland Agriculture

Interpretations for dryland agriculture capability (Table 5) were determined using the procedures of Land Capability Classification (LCC) for Arable Agriculture in Alberta (ASAC 1987).

The LCC system retains a similarity to the older Canadian Land Inventory (CLI) soil capability for agriculture system. The LCC system attempts to be more quantitative with a range of index points assigned to each class. The CLI for the Foremost (72E) sheet was compiled by Peters (1970).

The LCC system is based on climate, landscape and soil properties. There are seven land capability classes, with class 7 being the most severely limiting. The class indicates the relative degree of limitations for the soil map unit while the subclasses identify the dominant limitations. In soil map units with strongly contrasting soils, such as those with a component of poorly drained soils, two classes are assigned along with an estimated proportion of each component. The LCC classes and subclasses are defined as follows:

Land Capability Classes and Descriptions

Class 1 These lands have no significant limitations for crop production.

Class 2 These lands have slight limitations that restrict the range of crops or require modified management practices.

Class 3 These lands have moderate limitations that restrict the range of crops or require special management practices.

Class 4 These lands have severe limitations that restrict the range of crops that can be grown or require special management practices or both.

Class 5 These lands have very severe limitations for sustained arable agriculture. Annual cultivation using common cropping practices is not recommended.

Class 6 These lands have such severe limitations for arable agriculture that cropping is not feasible even on an occasional basis.

Class 7 These lands have no capability for arable agriculture.

Subclasses of Limiting Factors:

A moisture
D structure and consistence
E depth of Ah or Ap horizon
J pattern of obstacles, field shape
M texture and water holding capacity; depth to gravel
P surface stoniness
R depth to lithic and paralithic material
S salinity
T slope gradient or slope length
W drainage

LCC classes, for the County, range from 3 to 7. The best rating is class 3 for Dark Brown soils and class 4 for Brown soils.

Irrigation Capability

Soil map units were evaluated for their suitability for irrigation (Table 5) using the Land Classification for Irrigation in Alberta criteria (Alberta Agriculture 1992). Irrigation suitability was determined for all soil map units by assessing the most limiting soil and landscape components. Soil limitations were related to water movement and the potential for salinization. Landscape factors were related to the delivery and application of water.

The system consists of six irrigation capability classes with the possible subclasses, defined as follows:

Irrigability Classes
Class 1 Irrigable - excellent
Class 2 Irrigable - good
Class 3 Irrigable - fair
Class 4 Irrigable with restrictions
Class 5 Non-irrigable pending more detailed investigation and/or reclamation measures
Class 6 Non-irrigable

Irrigability Subclasses:

D low permeability /undesirable structure
E erosion damage
G steep slopes
I periodic flooding
J field size, shape
K shallow profile development
M low moisture holding capacity
N sodicity
P stoniness
R shallowness to lithic and paralithic materials
RB rough broken (a combination of steep slopes and complex soils)
S salinity
U earth-moving requirement
W excessive wetness

Within the County of Forty Mile, the irrigation capability ratings of soil map units varied from classes 2 to 6.

Capability for Grazing

Grazing interpretations provide an estimate of the potential forage productivity of range sites and assist range specialists and ranchers in setting stocking rates (Wroe et al. 1988). Range type, soil and climate information (Cannon and Nielsen 1984) were used to estimate grazing capability classes (Table 4). Range conditions and site characteristics (Wroe et al. 1988) are critical factors for optimizing the productive capacity (expressed as stocking rates) of rangelands. The relationships between soil characteristics and forage productivity (Adams et al. 1986) were modified using data from benchmark sites in southern Alberta (Adams and Hood, Public Land Services Branch, Food and Rural Development, Alberta Agriculture, Lethbridge, 1993, pers. comm.). Final grazing land ratings for each soil map unit (Table 5) were substantiated through consultation with rangelands specialists.

Stocking rates were determined with the following assumptions:

1) The Needle and Thread / Blue Grama subtype (Appendix B) was used to represent the rangelands in the Brown soil zone.

2) The Wheatgrass / June grass subtype was used to represent the rangelands in the Dark Brown soil zone.

3) The soil map unit meets the criteria for a good range condition (Wroe et al. 1988).

4) Plant carryover is maintained at 50% of annual production (Adams and Hood, Public Land Services Branch, Food and Rural Development, Alberta Agriculture, Lethbridge, 1993, pers. comm.).

5) Sound management and maintenance practices are applied to the soil map unit.

Table 4. Grazing Classes based on Stocking Rates.

Class	ha/AUY*	acres/AUY
1	< 5	<12
2	5-10	12-24
3	10-16	24-38
4	16-24	38-58
5	24-36	58-86
6	36-60	86-144
7	>60	>144

* (AUY) Animal Unit Year: the grazing required to support an animal unit for twelve months. An animal unit, defined by Adams et al. (1986) is a 450 kg (1000 lb) cow with or without an unweaned calf at side, or equivalent.

Each soil map unit may have limitations due to drainage, topography, salinity, topsoil depth, rooting zone depth, and water holding capacity. The following limitations were used in rating soil map units:

C limitations due to climate
D solonetzic soils
K low inherent fertility
M low water holding capacity
R soils formed on lithic or paralithic materials
S limitations due to soil salinity
T limitations due to topography
W limitations due to excess water

Within the County of Forty Mile, grazing classes of 3 to 7 were used. Class 3 only occurs in Agroclimate 2H (Appendix A).

Wind Erosion Risk

The calculation of wind erosion risk was based on soil texture, soil moisture regime, and soil map unit composition (Alberta Agriculture 1985). The risk ratings (Table 5) were based on the assumption of "an isolated, level, smooth, unsheltered, wide and bare (cultivated, no trash cover) field with a non-crusted surface". Soil texture is considered to be the most important factor used to determine wind erosion risk. The four categories, associated textures and potential soil loss are:

Wind Erosion Risk	Texture	Potential Soil Loss (T/ha/yr)
Low	Si,SiCL,CL	<80
Medium	L,CL,SL,SCL,SiL,SC,C	120
High	SL,LS,SC,C,HC	220
Extreme	S,LS,HC	>320

All four wind erosion risk categories were used to describe the soil map units of the county.

Water Erosion Risk

The water erosion risk for soil map units in the County of Forty Mile was calculated using a modified Universal Soil Loss Equation (USLE) (Tajek et al. 1985) as follows:

$$A = R_T K LS C P$$

where A = annual soil loss
R_T = total precipitation factor
K= inherent soil erodibility
LS = topography
C = cover
P = conservation practices

Water erosion risk (Table 5) was calculated assuming bare soil conditions with the R_T, K, and LS factors. The R_T factors of 475 and 550 were assigned to the Brown and Dark Brown soil zones respectively. The K factors ranged from 0.007 to 0.072 based on measured soil properties. Solonetzic, Regosolic and fine textured soils have the highest K factors. The LS factors were modified from Tajek et al. (1985) to account for variable topographic and surface form classes as follows:

LS Factor	Topography and Surface Form (Appendix H)
0.2	2
0.3	2-3a, 2c and 2i
0.4	3
0.6	3a
0.75	3c and 3i
1.25	4
1.3	3-4i
2.9	4-5i
3.4	5
5.8	5d
7.6	5-6d

The water erosion risk classes and their potential soil loss values are:

Water Erosion Risk Class	Potential Soil Loss (T/ha/yr)
negligible	< 6
slight	6-11
moderate	11-22
severe	22-33
very severe	33-55
extreme	> 55

The values for water erosion risk classes are taken as a general guideline and are applicable for soils with greater than 10 cm of topsoil. All six water erosion risk classes were used to describe the soil map units of the county.

Soil Degradation

Captain John Palliser made strong and controversial comments about the implementation of agriculture in the Canadian Prairies region in the 1860's (Wilson and Dijks 1993). Rapid agricultural settlement in the early 1900's, coupled with the drought of the 1930's, caused extensive soil degradation problems. The original soil survey of the area (Wyatt et al. 1941) identified soil degradation to be a significant concern in terms of wind erosion, water erosion and salinity.

The results of the current soil survey indicate that soil degradation continues to be a concern for soil conservation specialists and farmers. Soil erosion and soil salinity were observed and documented during the soil survey. Numerous publications document wind erosion and salinity, for example

Alberta Agriculture and Agriculture Canada (1991), but water erosion is generally overlooked although it continues to be a persistent problem in Southern Alberta. In addition, organic matter loss from Southern Alberta soils is a concern.

Water Erosion

Water erosion results from short duration high intensity events such as summer thunderstorms and spring melt. In the county, both rill and gully erosion were observed. Specific landscape types were identified as highly susceptible to soil loss by water erosion. These include: inclined, rilled, fan and apron soil map units (Appendix F); and soil map units with slope classes 4, 5, and 6 (Appendix H). Soil management and land surface form are key elements in understanding and minimizing soil loss from water erosion.

The term soil loss is overused. Soil redistribution is a more appropriate term because most of the soil removed from one part of the landscape is deposited on other portions of the landscape (Howitt 1991). Soil loss only occurs when the soil is transported to the surface water system.

There are a number of indices or ratings available for predicting water erosion (the USLE being the most common). These indices provide a relative estimate to compare susceptibility of soil map units. These indices do not take into account short duration, high intensity events in relation to current soil conditions and management practices (e.g. fallow vs. crop, spring vs fall, soil moisture conditions). The indices (Table 5) should be used as relative estimates to compare the susceptibility of soil map units to these forces of water erosion.

Wind Erosion

Wind erosion is a persistent problem in southern Alberta. Virtually all soil map units are prone to wind erosion. Certain soil map units are particularly prone to wind erosion because of soil properties, land surface form and soil management. These include: coarse and medium textured soil map units (eg. BVAN, CVPL, MACF (Appendix I), and tops of knolls in hummocky topography.

Wind erosion risk ratings (Table 5) should be used as relative indices to compare soil map units rather than as measures to predict actual erosion. The term soil loss is more appropriate for wind erosion as compared to water erosion. Soil particles, including organic matter and nutrients, can be carried for great distances by the wind and hence lost from agricultural production.

Salinity

Soil salinity reduces crop growth. Salinity occurs when soil water with dissolved salts evaporates at the soil surface or migrates to the soil surface. Dry weather results in the occurrence of salt crusts whereas wet weather tends to dissolve and flush the salts downward or laterally. Soil salinity can occur in a number of landscape positions. The most common surface forms where salts accumulate include concave landscapes, valleys and coulees.

Salt affected and potentially salt affected areas were identified during the course of the soil survey. For example, saline areas are common on the lower slopes of the Lucky Strike Upland due to local groundwater flow over shallow bedrock.

Organic Matter Loss

The importance of organic matter lies in nutrient supply, soil water holding capacity and soil tilth. Organic matter loss can result from a variety of processes including biological degradation, wind and water erosion, and loss by tillage operations. Soil micro-organisms use oxygen and nitrogen for the metabolism of organic matter. Tillage operations introduce oxygen into the topsoil which increases the rate of biological degradation of soil organic matter. The consequences of organic matter loss are increased fertilizer use, poor soil structure and reduced crop productivity.

Table 5. Interpretations by Soil Map Unit.

Soil Map Unit	Land Capability Classification	Irrigability Rating	Grazing Land Rating	Wind Erosion Risk	Water Erosion Risk
BUT1/3 a	4 M	2U	5 C	medium	moderate
BUT4/2 a	5 EM	2 E	5 KM	medium	slight
BUT7/2 a	4 D	2 D	5 D	medium	slight
BUT7/3-4 a	4 DMT	2 D	5 D	medium	severe
BVAN1/3	5 M	2 M	5 M	medium	negligible
BVAN4/3	5 ME	2 ME	5 MK	medium	negligible
BVCF4/3	5 ME	2 ME	5 MK	medium	slight
BVL6/4	6 M	2 ME	6 MK	medium	slight
BVRI3/3	5 MS	5 SM	5 MS	medium	negligible
BVTA1/3	5 M	2 M	5 M	medium	slight
CFD1/2 i	4 M	2 U	4-5 C	medium	moderate
CFD1/3	4 M	2 U	4-5 C	medium	slight
CFD2/2-3 n	$4\ M^{8}\ 6\ W^{2}$	5 WJ	4-5 W	medium	negligible
CFD3/3 n	5 S	5 S	5 S	medium	slight
CFD5/3	4 M	2 U	4-5 C	medium	slight
CFD7/2-3	4 D	3 D	5 D	medium	negligible
CFD9/3 n	$4\ D^{8}\ 7\ W^{2}$	5 WJ	5 DW	medium	slight
CFGE1/3 c	5 D	3 D	5-6 D	medium	severe
CGTT1/3	4 D	3 D	4-5 D	medium	moderate
CGW1/2-3 a	5 DE	6 D	5 D	medium	moderate
CGW2/2-3 n	5 DW	6 DWJ	5 D	medium	slight
CHCF1/2	4 M	1	4-5 C	medium	negligible
CHN6/2-3	4 M	2 M	5 M	medium	negligible
CMSI4/3-5	7 RDE	6 RDE	6 DKR	medium	severe
CMR1/3	6 RM	6 RM	5 RM	medium	negligible
CVD1/3	6 M	3 M	5-6 M	high	negligible
CVPL4/3	6 ME	6 ME	5-6 MK	high	negligible
CVPU5/2-3	7 MP	3 M	6 M	high	negligible
CVVS1/3	7 ME	3 ME	6 M	high	negligible
CVVS1/4	7 ME	3 ME	6 M	high	negligible
DHRO1/3	5 D	3 D	5-6 D	medium	slight
GLS1/2 n	7 WS	5 IS	6 SKW	low	negligible
GNCG1/3 a	4 D	3 D	4-5 D	low	moderate
GNCG4/3 c	4 DE	3 DE	4-5 DK	low	severe
GNN1/3 a	3 M	2 U	4 C	low	moderate
HDRO1/3-4	5 D	3 D	5-6 D	medium	moderate
HDRO1/3:R	5 D	6 DR	5-6 D	medium	moderate
HDRO1/3i:R	5 D	6 DR	5-6 D	medium	moderate
HDRO1/4:R	5 D	6 DR	5-6 D	medium	very severe
HDRO1/4 c:R	5 DT	6 DR	5-6 D	medium	extreme
HDRO2/3-4	5 DW	5WD	5-6 DW	medium	moderate
HDTI2/2-3	5 DW	5 DW	5-6 DW	medium	slight
HMCF1/3	5 E	2 E	5 K	medium	moderate
HMS1/4-5	5 ET	4 GE	5 K	medium	very severe
HUHD1/3-4 i:R	6 DT	6 DR	6 D	medium	very severe
LLD1/2-3 n	6 S	5 S	6 S	medium	negligible
MA:P2/5	6 PTW	5 WJG	5 W	medium	extreme

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Table 5. Continued.

Soil Map Unit	Land Capability Classification	Irrigability Rating	Grazing Land Rating	Wind Erosion Risk	Water Erosion Risk
MA:P4/4-5	5 PTE	4 GP	5 K	medium	very severe
MA:P7/4	5 PD	2 PD	5 D	medium	severe
MAB1/3-4	4 M	2 U	4-5 C	medium	moderate
MAB2/3	4 M^8 6 W^2	5 WJ	4-5 W	medium	slight
MAB2/4	4 M^8 6 W^2	5 WJ	4-5 W	medium	severe
MAB4/4	4 E	2 E	5 K	medium	severe
MAB4/4 c	4 ET	2 E	5 K	medium	extreme
MAB4/4-5 d	4 TEJ	6 GJ	5 K	medium	extreme
MAB4/5	4 ET	4 GE	5 K	medium	extreme
MAB6/4	4 ME	2 ME	5 M	medium	moderate
MAB7/3-4:R	4 D	5 DR	5 D	medium	moderate
MAB7/4	4 D	2 D	5 D	medium	severe
MAB8/4	4 E^8 6 W^2	5 WJE	5 KW	medium	severe
MAB8/5	4 ET^8 6W^2	5 WJE	5 KW	medium	extreme
MAB9/4	4 M^8 7 WD^2	5 WJD	5 DW	medium	severe
MAB9/5	4 MT^8 7 WD^2	5 WJD	5 DW	medium	extreme
MACF1/2	4 M	2 U	4-5 C	medium	negligible
MACF1/2 i	4 M	2 U	4-5 C	medium	slight
MACF1/3	4 M	2 U	4-5 C	medium	negligible
MACF1/3 c	4 M	2 U	5 C	medium	moderate
MACF1/3 i	4 M	2 U	4-5 C	medium	moderate
MACF2/2-3 n	4 M^8 6 W^2	5 WJ	4-5 W	medium	negligible
MACF2/3	4 M^8 6 W^2	5 WJ	4-5 W	medium	slight
MACF3/2-3	5 S	5 S	5 S	medium	negligible
MACF4/3	4 E	2 E	5 K	medium	slight
MACF4/3 c	4 E	2 E	5 K	medium	moderate
MACF4/3-4:R	4 E	5 RE	5 K	medium	moderate
MACF4/4	4 E	2 E	5 K	medium	severe
MACF6/3	4 M	2 M	5 M	medium	slight
MACF7/3	4 D	2 D	5 D	medium	moderate
MACF7/3 i	4 D	2 D	5 D	medium	moderate
MACF8/3	4 E^8 6 W^2	5 WJE	5 KW	medium	slight
MACF8/4	4 E^8 6 W^2	5 WJE	5 KW	medium	severe
MACF9/3-4	4 D^8 7 WD^2	5 WJD	5 DW	medium	moderate
MALL6/3-4	5 SEM	5 SM	5 SM	medium	moderate
MCA1/4 i	4 D	6 D	4-5 D	low	extreme
MHR1/4 i	5 DT	6 D	5 D	low	extreme
MKR1/3	6 ME	3 M	5-6 KM	medium	slight
MNA1/3	5 RD	6 RD	5 D	low	moderate
MS:P4/5:R	6 TPE	5 RGP	5 K	medium	extreme
MSCF1/3	4 M	2 U	4-5 C	medium	slight
MSCF1/3 i	4 M	2 U	4-5 C	medium	moderate
MSCF2/3	4 M^8 6 W^2	5 WJ	4-5 W	medium	slight
MSCF4/3	4 E	2 E	5 K	medium	slight
MSCF7/3	4 D	2 D	5 D	medium	moderate
MSCF7/3 i	4 D	2 D	5 D	medium	moderate
MSN1/3	4 M	2 U	4-5 C	medium	slight

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Table 5. Continued.

Soil Map Unit	Land Capability Classification	Irrigability Rating	Grazing Land Rating	Wind Erosion Risk	Water Erosion Risk
MSN1/3i:R	4 M	5 R	4-5 C	medium	moderate
MSN1/4	4 M	2 U	4-5 C	medium	severe
MSN1/4i:R	4 MT	5 R	4-5 C	medium	very severe
MSN4/3-4:R	4 E	5 RE	5 K	medium	moderate
MSN4/4	4 E	2 E	5 K	medium	severe
MSN4/4 c	4 ET	2 E	5 K	medium	extreme
MSN4/5	4 ET	4 GE	5 K	medium	extreme
MSN6/5	4 MET	4 GM	5 M	medium	extreme
MSN7/3-4:R	4 D	5 RD	5 D	medium	moderate
MSN7/4-5:R	4 DT	5 RDG	5 D	medium	extreme
MSN7/5 d	5 TJD	6 JGD	5 D	medium	extreme
ORBU9/2 a	6 EDW	3 ED	5-6 KDM	medium	slight
ORSI4/3-5	7 EDR	6 RED	6 KDR	medium	very severe
ORWD3/2-3 a	7 EDS	6 DS	6 KDS	medium	moderate
PHCM4/4	6 REM	6 REM	5 RMK	medium	moderate
PHCM7/3-4	6 RDM	6 RMD	5 RDM	medium	moderate
PHMS6/3	5 RM	6 RM	5 RM	medium	slight
PHMS7/3-4	5 RD	6 RD	5 RD	medium	moderate
PHMS7/3 i	5 RD	6 RD	5 RD	medium	severe
PHMS7/4-5	5 RDT	6 RDG	5 RD	medium	very severe
PLMN1/3-5	5 RDT	6 RDG	4-5 DR	medium	very severe
PLS4/4	6 ME	6 ME	5-6 MK	high	negligible
PTSI1/2	7 D	6 D	6 D	high	slight
PUGR1/3-4:R	4 D	6 DR	4-5 D	medium	severe
PUGR2/4:R	4 D^{8} 6 WD^{2}	6 DRW	4-5 DW	low	very severe
PULU3/3	4 S	5 S	4 S	medium	moderate
PULU7/3	3 D	2 D	4 D	medium	moderate
PULU9/3 n	3 M^{8} 6 WD^{2}	5 W	4 DW	medium	moderate
PUN5/4-5	7 MTP	6 MG	6 M	high	slight
PUPL1/3-4	4 R	6 R	4 R	medium	moderate
PUPL7/3-4	4 RD	6 RD	4 RD	medium	severe
PUR1/3	3 M	2 U	4 C	medium	moderate
PUR4/3-4 c	3 ET	2 E	4 K	medium	very severe
PUR4/4	3 E	2 E	4 K	medium	very severe
PUR4/4-5 c:R	4 TE	5 RE	4 K	medium	extreme
PUR4/4:R	3 E	5 RE	4 K	medium	very severe
PUR4/5-6 d	5 TJE	6 GJE	4-5 K	medium	extreme
PUR7/3-4:R	3 D	5 RD	4 D	medium	severe
PUR7/3 i	3 D	2 D	4 D	medium	severe
PUR7/4	3 D	2 D	4 D	medium	very severe
PUR7/4 c	3 DT	2 D	4 D	medium	extreme
PUR7/4d:R	4 TJD	5RDJ	4 D	medium	extreme
PUR7/5	3 DT	4 GD	4 D	medium	extreme
RAM1/2-3	5 M	4 M	5 M	medium	negligible
RAM2/2-3 n	5 M	3 M	5 M	medium	negligible
RAPU1/2-3	7 MP	6 M	5-6 M	high	negligible
ROSI1/3-4	6 DR	6 RD	5-6 RD	medium	severe

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Table 5. Concluded.

Soil Map Unit	Land Capability Classification	Irrigability Rating	Grazing Land Rating	Wind Erosion Risk	Water Erosion Risk
ROSI4/5-6	6 DET	6 RGD	6 RDK	medium	extreme
SIPH1/2-3	6 D	6 RD	5-6 RD	medium	slight
SIPH1/3-4	6 D	6 RD	5-6 RD	medium	severe
SKF7/2 n	7 WD	5 ID	4 DW	low	negligible
SKMA1/2-3 n	4 M^5 6 W^5	5 WJ	4 W	low	negligible
TIPT1/2-3	5 D	3 D	5-6 D	high	slight
TTH1/3	3 M	2 U	4 C	medium	moderate
TTH1/4	3 M	2 U	4 C	medium	very severe
TTH4/4	3 E	2 E	4 K	medium	very severe
TTH4/4 d	4 TJE	5 JGE	4 K	medium	extreme
TTH4/5-6 d	5 TJE	6 JGE	4-5 K	medium	extreme
TTH7/3 c	4 D	3 D	4 D	medium	severe
TTH7/4	4 D	3 D	4 D	medium	very severe
TTH7/4 c	4 DT	3 D	4 D	medium	extreme
TTH7/5	4 DT	4 GD	4 D	medium	extreme
TTH7/5-6 d	5 TJD	6 JGD	4-5 D	medium	extreme
TTH9/3-4	3 D^8 7 WD^2	5 WJD	4 WD	low	severe
TTMH1/3	4 D	3 D	4-5 D	low	moderate
TTWC1/4 c	3 ET	2 E	4-5 K	medium	extreme
TTWC7/4	4 ED	2 ED	4-5 KD	medium	very severe
TTWC7/4 c	4 EDT	2 ED	4-5 KD	medium	extreme
VSAT1/4-5	7 MET	6 MG	6 MK	extreme	slight
VSCV:W1/2-3	7 W	5 W	4-5 WM	high	slight
WDGE1/3	6 D	6 D	6 D	medium	moderate
WDW2/2-3 n	6 DW	6 DWJ	6 DW	low	slight
WDW5/2-3 a	6 D	6 D	6 D	low	slight
WDW6/2-3 a	6 DM	6 DM	6 DM	low	slight
WLH7/2 n	7 WD	5 ID	4 WD	low	slight
WS:P4/5-6 d	7 TPJ	6 PGJ	4 K	medium	extreme
WSM1/3	3 M	2 U	3 C	medium	moderate
WSM1/4	3 M	2 U	3 C	medium	very severe
WSM4/5-6 d	5 TJE	6 JGE	4 K	medium	extreme
WSM7/4	3 D	2 D	3-4 D	medium	very severe
WSM7/5-6 d	5 TJD	6 JGD	4 D	medium	extreme
WSM9/5	3 T^8 7 WD^2	5 WDG	3-4 DW	low	extreme
WSPM7/4 d	4 TJE	6 JGE	4 KD	medium	extreme
WTN3/2	7 ES	6 ES	5-6 KS	high	slight
YNY2/2-3	7 MD	6 MDW	6 MD	high	negligible
ZAV1	4 M^4 7 T^6	4 GJ	4 C	low	moderate
ZAV3	5 S^4 7 T^6	5 GJS	4-5 S	low	moderate
ZCV	7 T	6 RB	6-7 K	high	extreme
ZDL	na	na	na	na	na
ZRB1	7 T	6 RB	6 KT	na	extreme
ZRB2	7 TER	6 RB	6-7 KT	na	extreme
ZRB3	7 TER	6 RB	7 KT	na	extreme
ZRB4	7 T	6 RB	6 KT	na	extreme
ZWW	7 W	6 I	na	na	na

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Appendix A. Climate

The continental climate of the County of Forty Mile features short, warm summers and cold winters. However, frequent chinook winds from the west reduce the severity of the winter season. The semi-arid climatic conditions resulted in the formation of Brown soils (dominantly Chernozemic) developed under Dry Mixed Prairie grassland vegetation (Appendix B). The local climate of the Sweetgrass Upland and the Cypress Shoulder is influenced by higher elevation resulting in reduced evapotranspiration and /or increased precipitation which account for the Dark Brown soils (Figure 5).

The high elevation of the Cypress Hills plateau (about 1400 m) is characterized by both lower temperatures and increased precipitation resulting in the formation of Black soils. The mean annual temperature for the Cypress Hills plateau is 2°C and the average annual precipitation is 460 mm (Greenlee 1981). Although the Cypress Hills plateau is 15 km east of the county, this climatic data provides an insight into soil formation.

Climatic characteristics pertinent to the County are measured at several meteorological stations in southeastern Alberta (Table 6). Mean annual precipitation varies from a low of 316.7 mm at Bow Island in the Brown soil zone to 393.0 mm at Aden in the Dark Brown soil zone. Snow contributes about 30% of the annual precipitation and the May to September (growing season) precipitation consists of about 60% of the annual total. The precipitation during the growing season is favorable for crop production but this is offset by yearly variability.

Most of the summer rainfall is the result of convective storms. The variability and timing of precipitation events may result in rill or gully erosion (Part 4). The extent of water erosion is dependent on the severity of the event and current land management practices.

The mean annual temperature ranges from 6.1°C at Bow Island to 2.9°C at Altawan (on the Alberta - Saskatchewan border, south of the Cypress Hills). Warmer January temperatures in the western portion of the region (Aden, Foremost, Taber and Bow Island stations, Table 6) are the result of moderating westerly winds, or chinooks.

The frost-free period on the southeastern Alberta plains is generally greater than 115 days (Dzikowski and Heywood 1990) but is markedly reduced in areas of higher elevation (Sweetgrass Upland and the Cypress Shoulder). Coarse grain production and grazing are suitable agricultural land uses in areas with a limited growing season.

Agroclimate

Agroclimate is an assessment of regional climate as it relates to arable agriculture. Agroclimate zones (ASAC 1987) are broad areas with similar evapo-transpiration rates, precipitation, frost-free period and growing degree days. Within Alberta, zones are ranked from 1 to 5, with 5 being the lowest limit for arable agriculture. The letters following the numeral indicate the major climatic factors that limit agricultural capability as follows:

A - aridity
H - cool temperature

Three agroclimatic zones (Figure 5) are recognized in the county and include:

Zone 3A

- This agroclimatic zone corresponds to the Brown Soil zone. Arable agriculture faces moderate limitations due to aridity. The major land uses are dryland agriculture (primarily a wheat/fallow rotation), irrigated agriculture and grazing. The uppermost elevation at which Brown soils occur in the County of Forty Mile is about 1000 m. Annual precipitation typically averages about 350 mm (Dzikowski and Heywood 1990). Potential moisture deficits over the growing season are estimated to range from 450 to 500 mm (ASAC 1987). Annual total degree days above 5°C range from 1700 to 1900 (Dzikowski and Heywood 1990).

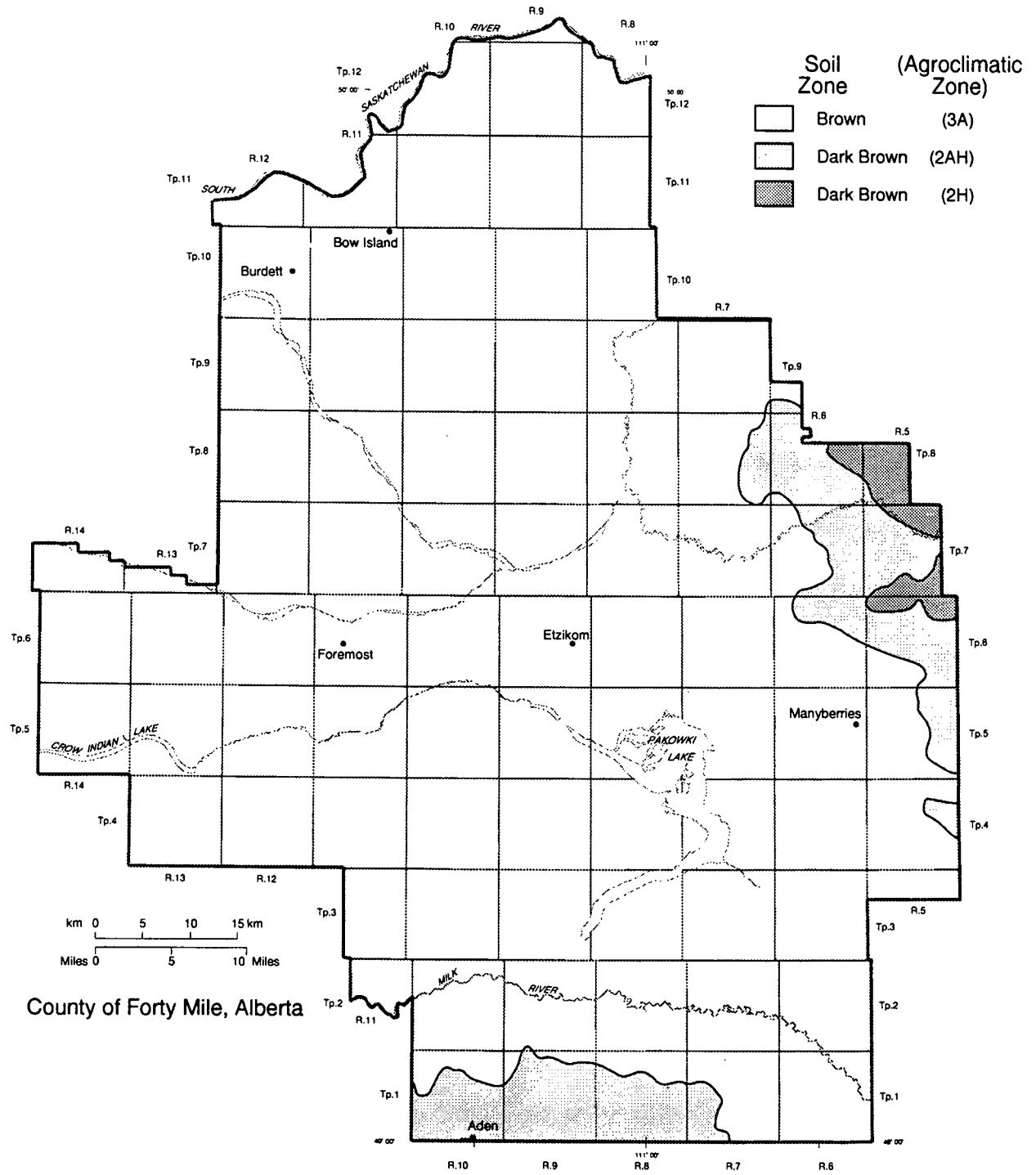

Figure 5. Map of Soil and Agroclimatic zones.

Appendix A. *(concluded)*

- Chernozemic soil series specific to Zone 3A include Cranford (CFD), Chin (CHN), Maleb (MAB) and Masinasin (MSN). Solonetzic soils include Hemaruka (HUK), Halliday (HDY), Wardlow (WDW), Duchess (DHS), Gem (GEM) and Karlsbad (KBD).

Zone 2AH

- This agroclimatic zone corresponds to the low-elevation Dark Brown soil zone, which occurs between 1000 and 1110 m along the Cypress Shoulder and above 1000 m on the Sweetgrass Upland. Aridity and a cooler growing season present limitations to arable agriculture. Major land uses are grazing and dryland agriculture (predominantly wheat/fallow). The average annual precipitation is between 350 and 400 mm (Dzikowski and Heywood 1990). Potential moisture deficits over the growing season are typically about 375 mm (Alberta Soils Advisory Committee 1987). Annual total degree days above 5°C average about 1700 (Dzikowski and Heywood 1990). The Aden meteorological station characterizes the conditions of agroclimate zone 2AH.

- Chernozemic soils include Purescape (PUR) and Lupen (LUP) on the Sweetgrass Upland. Tothill (TTH) and Glennbanner (GNN) are mapped on the Cypress Shoulder. Solonetzic soils specific to this zone include Minda (MNA), Maher (MHR) and Craigower (CGW).

Zone 2H

- This agroclimatic zone corresponds to the high-elevation Dark Brown soil zone, occurring above an elevation of 1110 m on the Cypress Shoulder. Climatic limitations to arable agriculture are due to the cool growing season. The predominant land use is grazing, although there is also some coarse grain production with a lesser proportion of fallow than in Zone 2AH. Long term average precipitation ranges from 400 to 450 mm (Dzikowski and Heywood 1990). Potential moisture deficits over the growing season are typically about 325 mm (Alberta Soils Advisory Committee 1987). On an annual basis there are usually less than 1700 total degree days above 5°C (Dzikowski and Heywood 1990).

- Chernozemic soils specific to zone 2H include Wisdom (WSM) and Plume (PME). Solonetzic soils include McAlpine (MCA).

Table 6. Precipitation and Temperature for Selected Climate Stations in Southeastern Alberta.

Station and Elevation (m)	Soil and Agroclimate Zones	Period of Record and Total Years	Precipitation (mm)			Mean Temperature °C		
			Mean Annual	May to September	Snow (cm)	January	July	Annual
Medicine Hat 717 m	Brown 3A	1883-1990 (108)	322.6	206.5	108.2	-10.7	19.8	5.5
Bow Island 799 m	Brown 3A	1961-1988 (28)	316.7	206.9	NA	-9.1	19.8	6.1
Taber 808 m	Brown 3A	1907-1990 (84)	365.8	207.5	120.3	- 9.3	18.8	5.5
Foremost 884 m	Brown 3A	1915-1990 (76)	358.2	205.1	122.6	- 9.2	18.8	5.2
Onefour 934 m	Brown 3A	1928-1992 (65)	351.0	195.9	122.8	-11.9	19.5	4.4
Altawan 945 m	Brown 3A	1965-1985 (21)	355.2	202.8	137.7	-15.1	19.8	2.9
Aden 1036 m	Dark Brown 2AH	1962-1990 (29)	393.0	184.0	144.3	- 7.4	19.0	5.8

Sources: Environment Canada 1981. Canadian Climate Normals 1951-1980; Data for 1981-1992 and prior to 1951, obtained from unpublished records. Data for Bow Island from Millette et al. 1989.

Appendix B.
Native Vegetation

The County is located within the Dry Mixed Grass and Mixed Grass Ecoregions of the Grassland Ecoprovince of Alberta (Strong and Leggat 1992). Grasses dominate the climax plant communities of these ecoregions. They are adapted for drought and adequately cure on the stem. Native grasses provide forage for wildlife and domestic livestock, stabilize the soil surface from erosion, and enrich the soil organic matter content.

A typical range site in the Dry Mixed Grass Ecoregion (well drained, medium to moderately fine textured, Brown Chernozemic soil) is dominated by needle grasses (*Stipa* spp.), and blue grama grasses (*Bouteloua gracilis*) (Strong and Leggat 1992). A typical range site in the Mixed Grass Ecoregion (well drained, medium to moderately fine textured Dark Brown Chernozemic soils) is dominated by wheatgrasses (*Agropyron* spp.) and June grass (*Koelaria macrantha*) (Adams, B.W. and T. Hood, Public Lands Services Branch, Food and Rural Development, Alberta Agriculture, pers. comm. 1993).

Adams and Hood (pers. comm. 1993) identified different subtypes of plant communities that are adapted to specific soil conditions in the County. Potential forage productivity associated with rangelands in the Brown and Dark Brown soil zones is related to these vegetation subtypes (Table 7). Needle and Thread/Blue Grama is the most common subtype in the County. Northern and Western Wheatgrass/June Grass is the most common subtype associated with the Dark Brown soils on the Sweetgrass Arch and the Cypress Shoulder. Areas with solonetzic soils are usually characterized by the Blue Grama/Wheatgrass subtype. Sand dunes typically are characterized by the Sand Grass subtype. The Sagebrush/Western Wheatgrss type is often present in valleys characterized by glaciofluvial apron sediments. The Rough Fescue type only occurs on Ike's Butte in Township 1 Range 9 West of the 4th Meridian.

Disturbances such as drought, fire, hail, tillage or grazing can alter the kinds or amounts of plants that make up the climax or original plant community. Plant species are often grouped as decreasers, increasers or invaders based primarily on the response to grazing pressure by livestock. Decreasers are "species that normally increase in relative abundance under continued heavy use" whereas increasers are "species that normally increase in relative abundance as decreasers decline" (Wroe et al. 1988). Invaders are species that are not components of the climax plant community and have little grazing value.

Decreasers are typically deep rooted, more productive plants which are dominant in the climax community. Increasers are shallow rooted, less productive plants and are present, but not abundant, in the climax plant community. Site assessment of range condition is based on the proportion of decreasers to increasers. Grazing practices can be managed to optimize both species composition and the productive capacity of rangelands (Adams et al. 1986).

Table 7. Vegetation Subtypes within the County of Forty Mile.

Sub-Type	Decreasers	Increasers	Soils	Remarks
Needle and Thread/Blue Grama (Stipa- Bouteloua)	Needle and thread Northern wheatgrass Western wheatgrass Winterfat Nuttall's atriplex Thread-leaved sedge	Blue grama Sandberg's bluegrass June grass Moss phlox Little club moss Pasture sage Prickly pear cactus Sagebrush	Medium to moderately fine textured soils of the Brown Soil Zone. Typically found in the more arid areas of the zone on dominantly Chernozemic soils, but may occur in areas of medium to moderately coarse textured Solonetzic soils.	Precipitation averages 250-350 mm yearly. The majority of the area occupied by this sub-type is presently under cultivation.
Needle and Thread/Blue Grama/Wheatgrasses (Stipa-Bouteloua-Agropyron)	Needle and thread Northern wheatgrass Western wheatgrass Winterfat Green needle grass Western porcupine grass	Blue grama Sandberg's bluegrass June grass Pasture sage Sagebrush Plains reed grass Little club moss Moss phlox and sedges	Medium to moderately fine textured Chernozemic soils of the Brown Soil Zone and the more arid areas of the Dark Brown Soil Zone.	Precipitation averages 250-350 mm yearly. Needle and thread, western porcupine grass, blue grama and wheatgrasses are dominant. The majority of the area occupied by this sub-type is presently under cultivation.
Northern and Western Wheatgrasses/June Grass (Agropyron-Koeleria)	Western wheatgrass Northern wheatgrass Slender wheatgrass Winterfat	June grass Moss phlox Sandberg's bluegrass Low sedge Pasture sage Prickly pear cactus Sagebrush Greasewood	Medium to moderately fine textured Chernozemic soils of the Dark Brown soil zone.	Precipitation averages 350-460 mm yearly. Western and Northern wheatgrasses are the dominanat vegetation. May occur on lacustrine parent material in the Brown Soil Zone.
Blue Grama/Wheatgrass (Bouteloua-Agropyron)	Western wheatgrass Northern wheatgrass Needle and thread grass Green needle grass	Blue grama Sandberg's bluegrass Low sedge Little club moss Pasture sage Prickly pear cactus June grass	Medium to fine textured Solonetzic soils in the Brown Soil Zone.	Precipitation averages 250-350 mm yearly. Generally associated with medium to moderately fine textured soils.
Sagebrush/Western Wheatgrass (Artemesia-Agropyron)	Western wheatgrass Desert salt grass Northern wheatgrass	Sagebrush June grass Nuttall's alkali grass Meadow grass Greasewood Broomweed	Moderately coarse to moderately fine textured soils in the Brown and Dark Brown Soil Zones. The soils are generally moderately well to poorly drained and may or may not be saline.	Precipitation averages 250-400 mm yearly. Often found in coulees, lake basins and on fan or apron sediments. Seasonal flooding may occur.
Sand Grass (Calamovilfa)	Needle and thread Indian rice grass Canada wild rye Sand dropseed	Sand grass June grass Pasture sage Buffalo bean Blue grama	Moderately coarse to coarse textured soils belonging to the Chernozemic and Regosolic orders in the Brown Soil Zone.	Precipitation averages 250-350 mm yearly. Often associated with active or stabilized dunes. Generally uncultivated.
Rough Fescue (Festuca)	Rough fescue Western porcupine grass Mountain brome Columbia needle grass Nuttall's alkali grass American vetch Hedysarum	Parry oat grass Idaho fescue Bearded wheatgrass June grass Lupine Intermediate oatgrass Western porcupine grass Needle and thread grass Plains reed grass Pasture sage	Moderately coarse to moderately fine texured Chernozemic soils in the high elevation (above 1110 metres) Dark Brown Soil Zone.	Occurs on moister aspects within the Dark Brown Soil Zone (northerly aspects and above 1110 metres).Of very limited areal extent within the county.

Appendix C.
Physiography and Drainage

Physiography describes the physical nature of land and is an important component in differentiating land systems (Part 1). Physiography includes topography (the relief and surface form), elevation, aspect, slope, pattern of landforms, and drainage pattern. Pettapiece (1986) recognized eight physiographic districts in the County of Forty Mile. The boundaries and characteristics of some of these districts were modified on the basis of more detailed analysis of landscapes during the course of the project. These differences are able to be represented on the smaller scale map (Figure 6). Two physiographic subdistricts were subdivided on the basis of recognized surface forms which could be depicted at this scale. The Winnifred Upland was recognized as a separate area within the Etzikom Plain and the Lucky Strike Upland was differentiated from the Verdigris Plain.

For convenience, in this report, the McAlpine and Elkwater Benchlands are referred to as the Sweetgrass Arch. The McAlpine and Elkwater Benchlands are referred to as the Cypress Shoulder.

Surface Water Drainage

There are three major drainage systems within the County of Forty Mile, including the South Saskatchewan and Milk River systems and the internally drained Pakowki system.

The South Saskatchewan River system drains into Hudson's Bay. The northern and central portions of the Etzikom Plain, the entire Fincastle Plain and the northern portions of the Cypress Shoulder drain into this system. Important tributaries include the Chin, Forty Mile, Seven Persons and Whitla Coulees and the Red Rock and Piegan Creeks.

The Milk River system, in the southern portion of the County, drains into the Gulf of Mexico via the Missouri and Mississippi Rivers. Most of the Sweetgrass Arch and southern portions of the Verdigris Plain (including the Lucky Strike Upland) drain into this system. Important tributaries of the Milk River include the Breed, Bear, Philp, Lost and Kennedy Creeks from the Sweetgrass Hills and Smith Coulee from the Lucky Strike Upland.

The internally drained Pakowki Lake basin is located between the Milk and South Saskatchewan river systems. Pakowki Lake is a semi-permanent water body which is an evaporative basin. During deglaciation the Pakowki Lake drained into the Milk River system via the Bryant (Pendant d'Oreille) Coulee (Beaty and Young 1975). Holocene fluvial sediments from a small tributary stream in the southeast portion of Township 3 Range 9 effectively blocked flow to the Milk River (Barendregt 1977) and created the present day internal drainage system.

Drainage into Pakowki Lake is provided from the west by Etzikom Coulee and its tributaries of Legend and Skiff Coulees. Numerous creeks including Fourways, Rogers, Irrigation and Manyberries Creeks drain from the east off the Cypress Shoulder. In addition, Ketchum, Canal and Coal Creeks drain the Lost River Plain from the southeast. Most of the water flowing into Pakowki Lake is intercepted by a series of border dikes. This border dike system was developed for irrigation purposes.

Appendix C. *(continued)*

Table 8. Physiographic Characteristics of the County of Forty Mile.

District	Sub-District	Elevation (m)	Surficial Materials	Surface Expression
Fincastle Plain		750 - 800	Glaciofluvial over morainal	Undulating and ridged
Etzikom Plain	Plain	640-1000	Morainal and glaciolacustrine over morainal	Undulating and hummocky
Etzikom Plain	Winnifred Upland	810-860	Morainal over bedrock	Undulating and rolling
Pakowki Basin		855-915	Glaciolacustrine; eolian; glaciofluvial	level; ridged; undulating and terraced
Verdigris Plain	Plain	860-1000	Morainal and morainal over bedrock	Undulating
Verdigris Plain	Lucky Strike Upland	945-1000	Morainal over bedrock	Inclined and rolling
Lost River Plain		835-1065	Morainal over bedrock and exposed bedrock	Undulating, inclined and rolling; dissected
Sweetgrass Upland		1035-1195	Morainal and morainal over bedrock	Hummocky, undulating and inclined; dissected
McAlpine Benchland		850-1000	Morainal and morainal over bedrock	Undulating and inclined; dissected
Elkwater Benchland		1000-1190	Morainal and morainal over bedrock	Hummocky, rolling and inclined; dissected

Appendix C. *(concluded)*

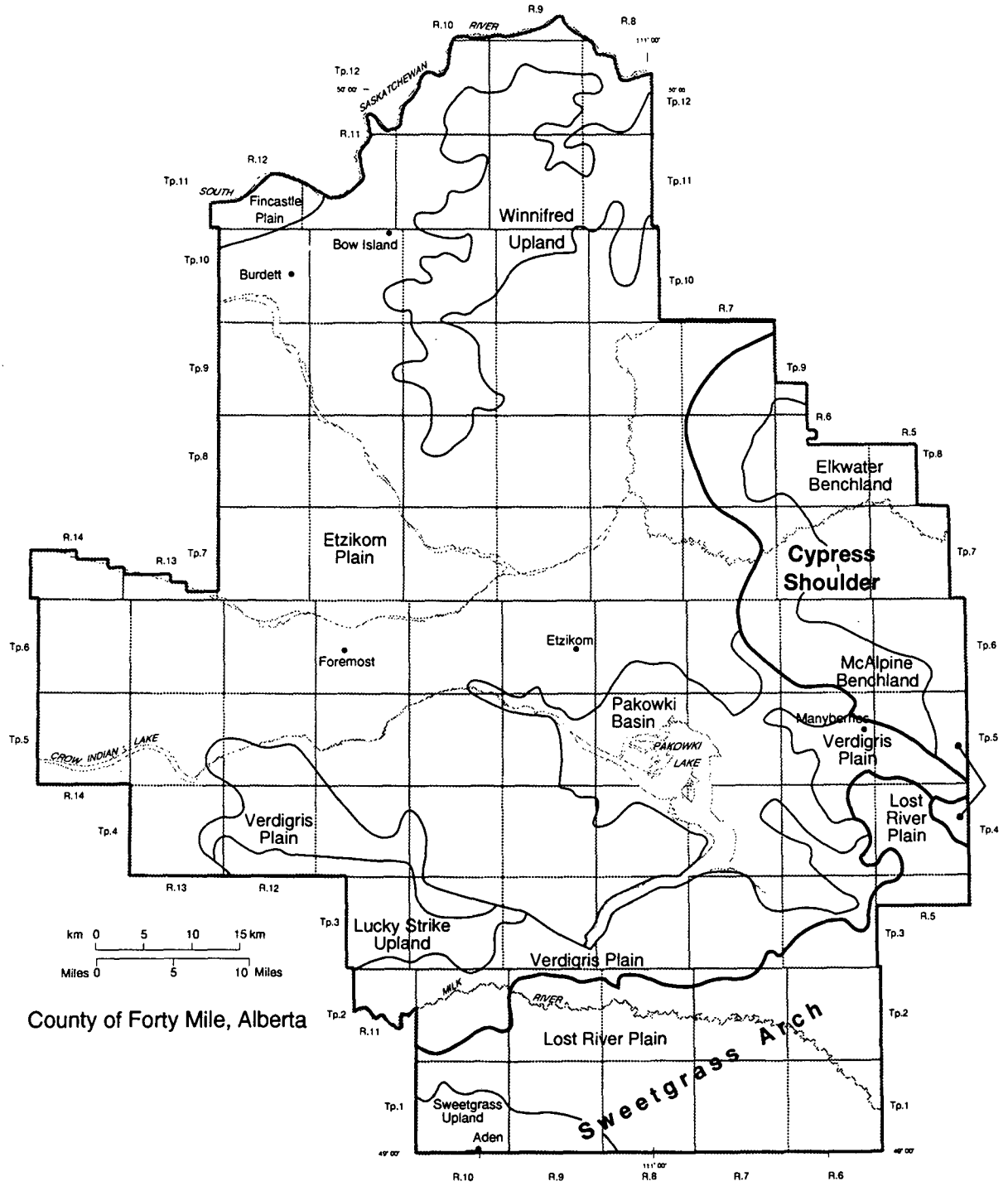

Figure 6. Physiographic map for the County.

Appendix D.
Surficial Materials

Major differences amongst the soil series and land systems identified in the County were attributed to surficial materials. The chemical and physical characteristics of soil series are due to the nature of the soil parent material.

The surficial materials in the County of Forty Mile are primarily the result of Laurentide glaciation and the post-glacial activity of water and wind. Multiple glacial advances during the Late Wisconsin glacial period (22,000 to 11,000 years ago) were reported by Stalker (1963;1977), Westgate(1968) Barendregt (1977) and Vreeken (1986; 1988). Information about glacial geology for the County of Forty Mile was summarized and illustrated by Shetsen (1987).

Glacial till is the predominant surficial material in the County of Forty Mile (Figure 7). Other materials of more limited extent include glaciofluvial, eolian and glaciolacustrine materials as well as residual softrock which was slightly modified by glacial action.

Surficial Materials - Extended Legend For Figure 7.

The relationship between soil parent material and the associated series is described below.

1. The weakly saline till is referred to as both the Pakowki and Etzikom drift (Westgate 1968). This till has a greater crystalline pebble content compared to unit 2. Hummocky, ridged and undulating landscapes of end, recessional and ground moraines are representative of the unit. Maleb (MAB) soils are developed on the Pakowki and Etzikom drift materials.

2. The non-saline till, referred to as the Wild Horse drift, typically has a higher silt and carbonate pebble content and a lower crystalline pebble content than the Pakowki and Etzikom drift (Westgate 1968). The characteristic surface pattern of this southern till area includes northwest to southeast flutings with extensive scouring indicative of subglacial processes (Rains et al. 1993). Masinasin (MSN) soils are developed on the Wild Horse drift.

3. The Cretaceous softrock unit consists of mixed and contorted weathered bedrock with some till and water-sorted materials. Shetsen (1987) mapped ice-thrust moraine which is characterized by ridges and depressions transverse to ice movement (trending southwest to northeast). The principal soil series are Pinhorn (PHN) and Comrey (CMR) in the Brown soil zone and Minda (MNA) in the Dark Brown soil zone.

4. Glaciofluvial sands and gravels were deposited by running water associated with glaciers. The largest area was mapped on the Pakowki Delta land system but scattered areas of sand and gravel occur throughout the County. The major soils include Ramillies (RAM), Pemukan (PUN) and Cavendish (CVD).

5. The ice contact glaciofluvial materials were deposited by running water at the ice margin. Materials of varying textures including gravels were deposited with till. The materials include angular to well rounded, poorly sorted gravels with variable sand, silt and clay inclusions mixed with unsorted and unstratified drift (till). Common soil series include variants of Bingville (BVL), Ramillies (RAM), Pemukan (PUN) in association with Maleb (MAB).

6. Eolian materials include sands and silts that have been transported and deposited by wind action. Eolian materials commonly accumulate in dune formations and on the lee slopes of steep ridges and occur on the north and east side of Pakowki Lake. Common soils include Vendisant (VST), Antelope (ATP) and Cavendish (CVD).

7. The medium textured glaciolacustrine deposits are well sorted sediments settled from suspension in lakes formed at the margins of glaciers. Medium textured glaciofluvial sediments were deposited on low gradient fans. The latter are largely mapped in the Pakowki Lake area and the sediments are derived from creeks draining from the Cypress Shoulder. The dominant soil series are Bunton (BUT), Chin (CHN) and Cranford (CFD).

8. The moderately fine and fine textured glaciolacustrine deposits are well sorted sediments settled from suspension in lakes formed at the margins of glaciers. Minor amounts of glaciofluvial sediments were deposited on low gradient fans. The dominant soil series are Gleddies (GLS), Craigower (CGW), Timko (TIK) and Patricia (PTA).

Appendix D. *(concluded)*

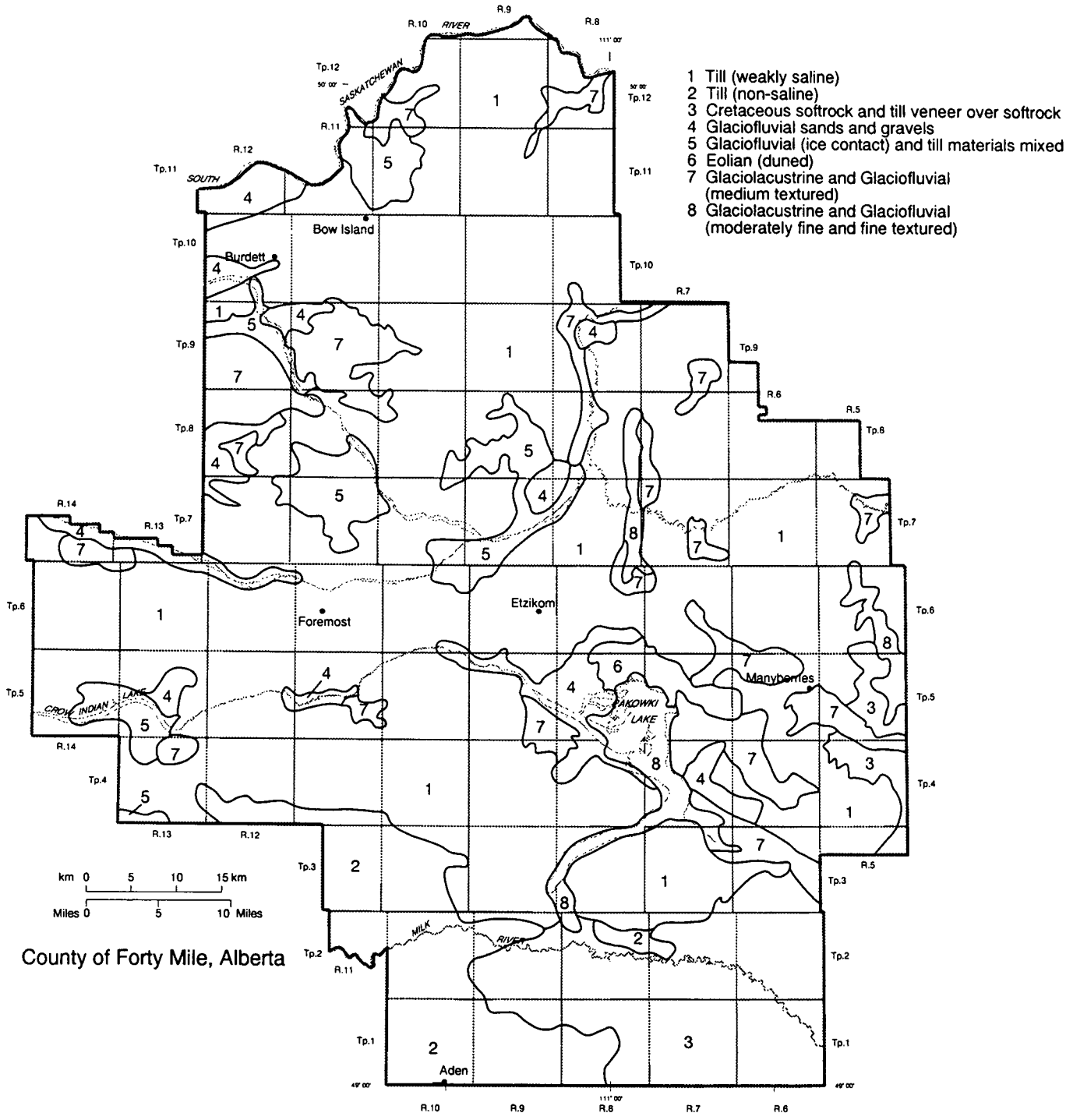

Figure 7. Generalized Map of Surficial Materials (refer to the extended legend on the previous page).

Appendix E.
Bedrock Formations, Depth to Bedrock, and Hydrogeology

Bedrock Formations

Bedrock formations and their characteristic properties influence the chemical and physical nature of soils. Irish (1968) and Green (1972) recognized six bedrock formations in the County (Figure 8). These bedrock formations are softrock sediments including shale, mudstone, siltstone, and sandstone of Upper Cretaceous age. Tertiary volcanic rock outcrops are found in Township 1 - Range 8 (Black Butte) and in Township 2 - Range 9 along the Milk River Canyon.

Extended Legend - Bedrock Formations For Figure 8.

1. TERTIARY IGNEOUS: The lithology is a dark minette (Green 1972) and was uplifted in dykes with the Sweetgrass Hills pluton of northern Montana.

2. EASTEND FORMATION: Composed of sandstone, siltstone, pale grey shale and coal seams (Lines 1963). Largely non-marine and is considered correlative with the St. Mary River Formation of southwestern Alberta (Nielsen 1974).

3. BEARPAW FORMATION: Dominantly dark gray blocky shale and silty shale; greenish glauconite and gray clayey sandstone; thin concretionary ironstone and bentonite beds; marine. Approximately 320 m thick at the Cypress Shoulder (Lines 1963) and sedimentation began at 74 million years ago (Eberth and Ryan 1992).

4. JUDITH RIVER FORMATION - OLDMAN MEMBER: Composed of pale gray, thick-bedded, medium to coarse grained, feldspathic sandstone; gray clayey siltstone, green and gray mudstone, dark gray and brown carbonaceous shale, concretionary ironstone beds. The Oldman member is essentially non-marine (alluvial), approximately 250 m thick (McLean 1971) and deposited between 78 and 74 million years ago (Eberth and Ryan 1992).

5. JUDITH RIVER FORMATION - FOREMOST MEMBER: Composed of pale gray feldspathic sandstone, gray and green siltstone; greenish gray mudstone and dark gray carbonaceous shale; concretionary ironstone beds; with coal beds at both the top and bottom (79 and 78 million years ago respectively). This member is largely non-marine but includes marine partings with numerous coarsening upwards shoreline cycles (Eberth and Ryan 1992).

6. PAKOWKI FORMATION: Consists of dark gray shale and silty shale; minor sandstone; thin chert-pebble conglomerate or pebble bed (coquina) at base and are marine sediments dated at 82 to 79 million years of age (Eberth and Ryan 1992).

7. MILK RIVER FORMATION - UPPER: Composed of pale dark gray shale and silty shale; pale gray, thick-bedded, feldspathic sandstone with hard calcareous beds. The upper member includes ironstone concretions and is both marine and non-marine. Sedimentation occurred between 84 and 82 million years ago (Eberth and Ryan 1992).

The Oldman and Foremost members of the Judith River Formation and the underlying Pakowki Formation can be viewed in a near complete section within the Milk River Canyon. The Bearpaw Formation is exposed east and northwest of Manyberries in the upper watersheds of Manyberries and Four-ways Creeks respectively. Numerous other creeks and coulees afford visible bedrock exposures throughout the County.

Depth to Bedrock

Depth to bedrock is integral in assessing the agricultural potential of landscapes, particularly for irrigation. Westgate (1968), Barendregt (1977) and Shetsen (1987) described and mapped the depth to bedrock in the region. Observations during the course of the soil survey augmented this work and the generalized map is based on the information (Figure 9).

A major area of the southeastern portion of the county (the Sweetgrass Arch and the southern portion of the Cypress Shoulder) have bedrock at or within 1 m of the surface. Neighboring areas are characterized by having bedrock within 15 m of the surface. Two small exceptions occur; one in the North Manyberries Creek watershed and the other in the Breed Creek valley near Aden.

The Lucky Strike Upland and its flanks within the Verdigris and Etzikom Plains have a bedrock depth

Appendix E. *(continued)*

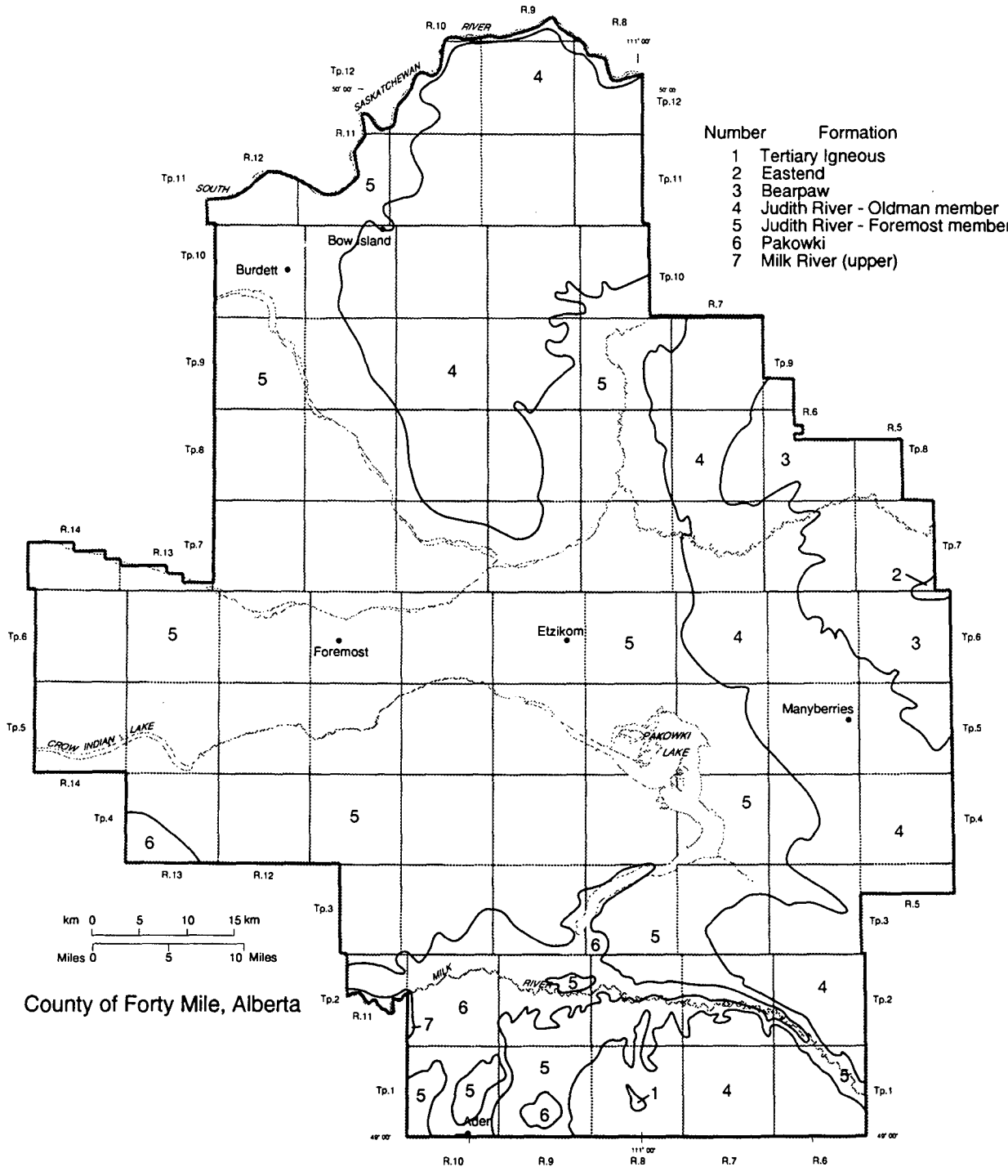

Figure 8. Map of Bedrock Formations (refer to the extended legend on the previous page).

approaching 15 m although two areas with bedrock less than 5 m were identified. One flank extends northwest to the Crow Indian Lake (King's Lake) area while another extends north to Chin Coulee, east of Foremost. This general northern trend continues north of Chin Coulee to the eastern Bow Island and Winnifred area. Here, the depth to bedrock is within 5 m and the incidence of salinity increases appreciably.

Hydrogeology

The hydrogeology of the region can influence soil development. For example, the formation of Solonetzic soils is considered to be a consequence of high soluble salt content resulting from proximity to groundwater. Hydrogeology is important for land use applications in terms of groundwater supplies and water quality. Depth to bedrock and the bedrock formation characteristics influence regional hydrogeology.

The most significant aquifers in the County of Forty Mile are the Lower Milk River Formation and preglacial gravels in the buried Medicine Hat Valley. Minor quantities of groundwater come from permeable lenses in the drift in the northern part of the County.

Preglacial Gravels

Preglacial gravels in Alberta and Saskatchewan are known as the Saskatchewan Sands and Gravels (Stalker 1968). They were deposited by rivers flowing east and north during the formation of the Rocky Mountains in the Tertiary period. Deposition ended with the advance of the first Quaternary ice sheet.

Westgate (1968) identified three major preglacial (buried) valleys which traverse the County from the Milk River in the south to the South Saskatchewan River in the north. From west to east, they are the Skiff, Foremost and Medicine Hat Valleys.

Borneuf (1976) reported that the Medicine Hat Valley (Figure 6) is the most significant preglacial water-bearing aquifer. This valley forms a break between the bedrock controlled lands of the Sweetgrass Arch and the Lucky Strike Upland. The Medicine Hat Valley acts as a drain for groundwater, directing it across the northern divide of the internally drained Pakowki Lake basin to the Murray Lake region (Borneuf 1976). This prevents groundwater from discharging in the Pakowki Lake basin. Sub-irrigated sands in the Pakowki Lake Basin may be related to the proximity of groundwater in the Medicine Hat Valley.

The Milk River Sandstone

The lower member of the Milk River Formation (Green 1972) is an artesian aquifer which underlies the County of Forty Mile. The aquifer is recharged where it outcrops in the Sweetgrass Hills in northern Montana, and along the Milk River between ranges 11 and 15, just west of the County of Forty Mile. From an elevation of 1045 to 1370 m in the outcrop areas, the aquifer dips to the north, east and west, to reach a minimum elevation of about 550 m in the Medicine Hat area (Swanick 1982). The aquifer is up to 50 m thick in the Foremost area. Phillips et al. (1986) used a groundwater flow model to estimate that groundwater in the Taber area (60 km west of Bow Island) was 500,000 years old.

Nearly all wells drilled into the Milk River aquifer flowed when groundwater exploitation commenced in 1916 (Phillips et al. 1986). By 1960 there were 409 wells producing from the aquifer, and sixty-three of them had already stopped flowing (Meyboom 1960). In 1971 many wells continued to flow freely, and several farmers expressed concern over sharply decreasing flow rates (Borneuf 1976). Robertson (1988) noted that water-levels continued to decline throughout the 1980's.

Yields from the Milk River Aquifer in the County range mainly from one to 25 imperial gallons per minute (igpm) (0.08 to 1.9 L/s), but values of 25 to 500 igpm (1.9 to 38.2 L/s) were noted in the Pakowki Lake and Etzikom areas (Borneuf 1976).

Appendix E. *(concluded)*

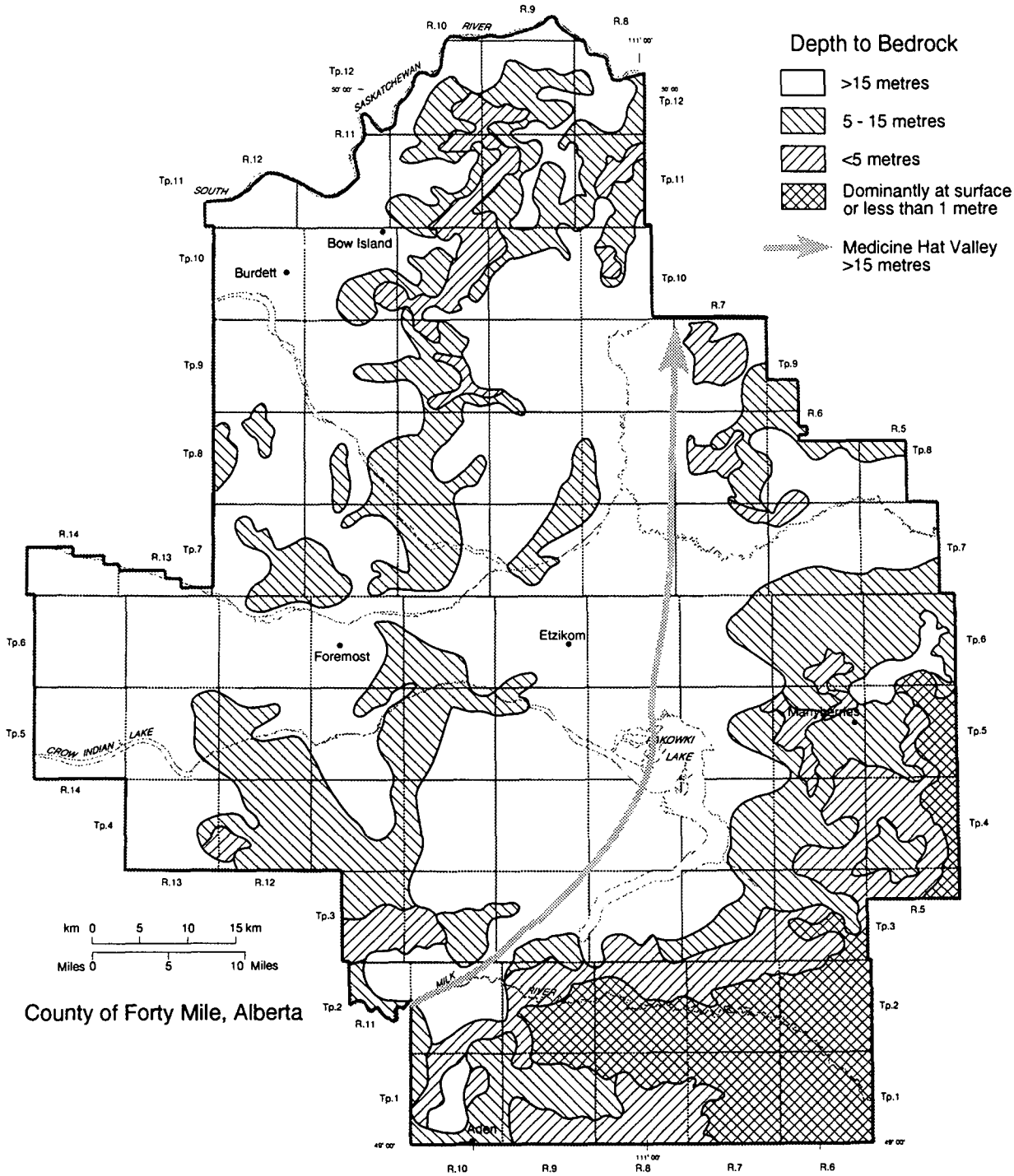

Figure 9. Generalized Map Showing Depth to Bedrock.

Appendix F.
Glossary of Terms

Many of the definitions are taken directly, or are slightly modified from the Glossary of Terms (Agriculture Canada 1976). Other references are supplied where appropriate.

Ablation moraine Morainal material deposited from stagnant glacial ice.

Acid soil A soil having a pH of less than 7.0

Aerobic Having molecular oxygen as part of the environment.

Alkaline soils A soil that has pH greater than 7.0

Alluvial deposit (alluvium) Materials such as clay, silt, sand and gravel deposited by modern streams and rivers.

Anaerobic Lacking molecular oxygen as part of the environment.

Apron An apron describes coalesced fans which occur at coulee footslopes. They are characterized by a relatively gentle slope at the foot of a steeper slope and formed by materials transported from the steeper, upper slope. Deposition of materials typically occurs during extreme storm or runoff events.

Arable Agricultural production based on cultivation practices; land that is cultivated or capable of being cultivated; arable agriculture contrasted with grazing systems.

Bedrock A general term for the solid (harder than 3 on Moh's scale of hardness) rock that underlies surficial materials and the soils developed on them.

Blanket A mantle of unconsolidated material greater than 1 metre that masks minor irregularities in the underlying material but retains its overall general topography.

Blowout pits A small trough or bowl shaped depression, formed by wind erosion. Pits are typically 5 - 10 m in diameter but may in extreme cases be much larger. They are rarely more than 30 cm in depth. Blowout pits commonly indicate the presence of a Solonetzic soil profile. (Kjearsgaard 1988, p. 24).

Boulders Coarse fragments greater than 60 cm in diameter.

Calcareous classes Six classes that represent the amount of carbonates, expressed as percent calcium carbonate ($CaCO_3$) equivalent, present in the soil or parent material. The classes are noncalcareous (<1%), weakly calcareous (1-5%), moderately calcareous (5-15%), strongly calcareous (15-25%), very strongly calcareous (25-40%), and extremely calcareous (>40%). At the family level of taxonomy, strongly calcareous means 5-40% $CaCO_3$ equivalent.

Capability Ranking system that expresses the suitability of land for a certain use, and conveys the kind and degree of limitations imposed by climate and physical characteristics of the land.

Carryover The portion of the annual growth of range vegetation that is not consumed (Wroe et al. 1988).

Cation A positively charged ion. The common soil cations are calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), and hydrogen (H).

Cation exchange capacity (CEC) A measure (centimoles per kilogram) of the total amount of exchangeable cations a soil or horizon can absorb.

Chroma One of the three variables of color (**Munsell system**); refers to the relative purity, strength or saturation of a color. It is directly related to the dominance of the determining wavelength of light and inversely related to grayness.

Classification, soil The systematic arrangement of soils into categories according to their inherent characteristics, or on some interpretation of those properties for various uses. Broad groupings are made on the basis of general characteristics, subdivisions according to more detailed differences in specific properties.

Clay (i) As a particle size term: a size fraction less than 0.002 mm equivalent diameter, or some other limit (geology or engineering). (ii) As a soil term: a textural class with abundant clay sized particles.

Appendix F. *(continued)*

Coarse fragments Rock or mineral particles (harder than 3 on Moh's scale of hardness) larger than 2 mm in diameter but smaller than bedrock. Coarse fragments in soils are: **gravels** or **channers** (up to 8 cm in diameter or 15 cm in length), **cobbles** or **flags** (8-25 cm diameter or 15-38 cm length), and **stones** (greater than 25 cm diameter or 38 cm length).

Codominant Two or more soils (or other features) of roughly equal proportion that together comprise the majority of a mapping unit.

Colluvium Any loose, heterogeneous and incoherent mass of material and rock fragments deposited chiefly by gravity. Movement includes slow displacement such as soil creep and rapid events such as landslides, avalanches and rockfalls (ECSS 1987).

Compound unit A soil or map unit that is characterized by two to four major soils or groups of soils. For example, MACF1 is based on the co-dominant MAB (Maleb) and CFD (Cranford) series. As an example of the extreme, MACF9 is characterized by four major groups of soils: MAB (Maleb) series, CFD (Cranford) series, imperfectly to very poorly drained soils (Gleyed subgroups, Gleysolics and water) and the Solonetzic soils group (adapted from Walker et al. 1991).

Concave Basinal water collection areas influenced by two factors acting alone or in combination: (i) Surface water collection by runoff from adjacent areas that are higher in elevation. (ii) Groundwater gradients which result in water movement upwards to the surface or provide additional moisture within the rooting zone for plant growth (groundwater discharge).

Consistence (i) The resistance of a material to deformation or rupture. (ii) The degree of cohesion or adhesion of the soil mass.

Consolidated Firm and coherent materials.

Control section The vertical section of soil upon which the taxonomic classification is based. It extends from the mineral or ground surface to a lithic contact if present, or to a depth of 160 cm in Organic soils, or up to 2 m depth in mineral soils. In non-lithic mineral soils the control section reaches from the mineral surface to 25 cm below the top of the C or IIC horizon, or to at least 1 m depth.

Cretaceous Period of geologic time beginning 135 million years before present and ending 65 million years before present.

Deflation hollows A trough or depression in the land surface created by wind erosion.

Deglaciation The uncovering of an area from beneath glacier ice as a result of melting.

Delineation see polygon.

Deltaic deposit Materials deposited in a delta, characterized by well developed cross bedding (Bates and Jackson 1987).

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

Dissected Product of erosion, where a relatively uniform topographic surface has been sculptured or destroyed by the formation of gullies, ravines or canyons (Gary et al. 1972).

Dominant The soil (or other feature) that comprises the majority of a mapping unit (generally 30% or more).

Dryland farming Arable agriculture based on natural precipitation rather than irrigation systems. Also termed rainfed.

Dunes Wind built ridges and hills of sand formed in the same manner as snowdrifts. They are started by some obstruction such as a bush, boulder, fence, or other obstacle which causes an eddy.

Eluviation The transportation of soil material in suspension or in solution within the soil by the downward or lateral movement of water.

End Moraine A ridgelike accumulation of drift built along the margin of an ice sheet.

Erosion (i) The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. (ii) Detachment and movement of soil or rock by water, wind, ice, or gravity.

Appendix F. *(continued)*

Erratic A transported rock fragment different from the local bedrock. It is generally applied to fragments transported by glacier ice or floating ice.

Esker A winding ridge of irregularly stratified sand, gravel, cobbles, and stones that was deposited under or in ice by a rapidly flowing glacial stream.

Evapotranspiration The loss of water from a given area during a specified time by evaporation from the soil surface and by transpiration from plants. **Potential evapotranspiration** is the calculated maximum evapotranspiration that can occur in a given weather situation with a low-growing crop that is not short of water and does not completely shade the ground.

Exposure An area of a rock formation that is visible at the land surface (Bates and Jackson 1987).

Fan Landform with a perceptible gradient from the apex to the toe. Deposited by a stream when it emerges from an upslope position on to a lowland with a marked decrease in gradient.

Fertility, soil The status of a soil with respect to the amount and availability to plants of elements necessary for plant growth.

Flank Sideslopes of an upland.

Floodplain The land bordering a stream, comprised of sediments from overflow of the stream and subject to inundation when the stream is at flood stage.

Flutings Landform produced subglacially, comprised of grooves and ridges exhibiting a linear orientation parallel to the direction of ice sheet movement.

Fluvial (alluvial) material All sediments, past and present, deposited by flowing water, including glaciofluvial deposits.

Fluvial/Eolian sediments Originally deposited from moving water, subsequently transported by wind.

Frost free period Season of the year between the last frost of spring and first frost of fall.

Glacial (i) Of or relating to the presence and activities of ice or glaciers, such as glacial erosion. (ii) Pertaining to distinctive features and materials produced by or derived from glaciers and ice sheets, such as glacial lakes. (iii) Pertaining to an ice age or region of glaciation. (Gary et al. 1972.)

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

Glaciolacustrine material Fine-grained sediment deposited in proglacial lake environments. This sediment is composed of suspended material brought by meltwater streams flowing into lakes bordering glaciers (Gary et al. 1972).

Gravel (i) As a deposit term used herein: glaciofluvial or fluvial materials with 60% or more coarse fragments, usually subrounded to rounded and of variable size. (ii) As a particle size term: a size fraction between 2 and 75 mm diameter with rounded, subrounded, angular, or irregular shapes.

Ground moraine Till material largely derived from the contact between rock materials and the overlying ice sheet.

Groundwater That portion of the total precipitation which at any particular time is either passing through or standing in the soil and the underlying strata and is free to move under the influence of gravity.

Groundwater discharge Release of groundwater from subsurface zone of saturation (Bates and Jackson 1987).

Gully A channel caused by erosion and the concentrated but intermittent flow of water during or immediately after heavy rains or snow melt. It is deep enough to interfere with and not be removed by tillage operations.

Halophyte A generic term for species of plants which tolerate or thrive on saline soils.

Holocene The geologic time period since deglaciation (about 10,000 years).

Appendix F. *(continued)*

Horizon A layer of soil or soil material approximately parallel to the land surface; each horizon differs from genetically related layers in proper-ties such as color, structure, texture, consist-ence, and chemical, biological, and mineralog-ical composition. Detailed definitions of the var-ious horizons and layers may be found in The Canadian System of Soil Classification (ECSS 1987).

Hue The aspect of color that is determined by the wavelengths of light, and changes with the wavelength. Munsell hue notations indicate the visual relationship of a color to red, yellow, green, blue, or purple, or an intermediate of these hues.

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

Ice contact stratified drift Partially sorted material deposited in contact with melting glacier ice but with concurrent and subsequent reworking, locally, by flowing and ponded glacial meltwater. The reworked material is usually coarse textured and resembles **glaciofluvial** sediments; in some cases it is fine to medium textured and resembles **glaciolacustrine** deposits.

Ice contact terrain Landform or landforms, often moraine-like in appearance, comprised of a complex mixture of materials including the basal material, usually till or glaciolacustrine sediment, plus layers and pockets of **ice contact stratif-led drift**. The individual materials are not map-pable except at very large scales (eg. larger than 1:5000 or 1:2000).

Illuviation The process of depositing soil material that has been transported in suspension or solution from one horizon in the soil to another, usually from an upper to a lower horizon in the soil profile. Illuviated substances include silicate clay, hydrous oxides of iron and aluminum, and organic matter.

Immature soil A soil with indistinct or only slightly developed horizons.

Impeded Drainage A condition which hinders the movement of water through soils under the influence of gravity.

Inclined A sloping, unidirectional surface of at least 400 metres in length and not broken by marked irregularities. Slopes are 2-70% and slope length exceeds 400 m.

Inclusion A soil (or other feature) that comprises up to 15 or 20% of a unit. Some map units contain several inclusions that together add up to a substantial percentage.

Indicator plants Plants characteristic of specific soil or site conditions.

Indurated Rendered hard or cemented.

Infiltration The downward entry of water into the soil.

Inflection point A point on a slope where the curvature relative to a plane changes from concave to convex.

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

Kame A low steep-sided hill, mound, knob, hummock, or short irregular ridge, composed chiefly of poorly sorted and stratified sand and gravel deposited by a subglacial stream upon or against the terminal margin of a melting glacier (Gary et al. 1972).

Kettle A steep-sided, bowl or basin-shaped hole or depression in glacial drift deposits, especially outwash or kame, and believed to have formed by the melting of a large, detached block of stagnant ice (left behind by a retreating glacier) that had been wholly or partly buried in the glacial drift. Kettles commonly lack surface drainage and some may contain a lake or swamp (Gary et al. 1972).

Lacustrine Pertaining to, produced by, or formed in a lake or lakes, eg. "lacustrine sands" deposited on the bottom of a lake, or a "lacustrine terrace" formed along the margin of a lake (Gary et al. 1972).

Landform Parent material and surface form combined.

Appendix F. *(continued)*

Leaching The removal of soil materials in suspension or solution from a soil or soil horizon (layer).

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

Lime Synonymous with carbonates, mainly of calcium and magnesium, that are measured as calcium carbonate equivalent and reported as calcareous classes.

Lithic A general term referring to soils with consolidated bedrock within 1 m.

Loess A homogenous, commonly nonstratified, porous, friable, slightly coherent, usually calcareous material transported and deposited by wind, and consisting of predominantly silt-sized particles (Gary et al. 1972).

Major soil Includes the dominant or co-dominant, significant, and other soils of widely ranging percentage that are necessary to form a mental concept of a soil or map unit.

Marine Refers to materials that were deposited in an ocean environment.

Matrix, soil The main soil constituent or material that encloses other soil features, for example, concretions embedded in a fine-grained matrix.

Meander scar An abandoned channel of a stream or river.

Meltwater channel A large channel formed by water derived from melting of glacial ice. In the prairie region these channels are often referred to as coulees.

Microtopography Small scale, local difference in topography, including mounds, swales, or pits that are only a few feet in diameter and with elevation differences of up to 2 m.

Modal Profile The soil profile (pedon) with physical, chemical and biophysical characteristics lying close to the centre of the ranges of properties that define a soil series; the most frequently occurring profile within a soil series (adapted from ECSS 1987).

Modern Recent landforms, formed in the last few hundred to few thousand years, that are still actively developing.

Moraine A mound, ridge, or other distinct accumulation of unsorted, unstratified drift, predominantly **till**, deposited chiefly by direct action of glacier ice in a variety of topographic landforms that are independent of control by the surface on which the drift lies (Gary et al. 1972). It is now commonly used as a geomorphologic name for a landform composed mainly of till that has been deposited by a glacier.

Moraine plateau Flat topped hummock within a hummocky moraine which is mantled by glaciolacustrine sediments. Formed by deposition from a lake which was situated upon the ice.

Morphology, soil (i) The physical constitution, particularly the structural properties, of a soil profile as exhibited by the kinds, thickness, and arrangement of the horizons in the profile, and by the texture, structure, consistence, and porosity of each horizon. (ii) The structural characteristics of the soil or any of its parts.

Mottles Spots or blotches of different color or shades of color interspersed with the dominant color; formed mainly by the affects of impeded drainage.

Mudflow A general term, now often including debris flow and mass flow, for a landform (fan or apron-shaped) and a process characterized by a flowing mass of earth and rock debris possessing a high degree of fluidity during movement (Gary et al. 1972). Mudflow deposits tend to be poorly sorted, uniformly textured (little or no stratification), till-like materials that resemble source materials, often till or colluvium (Walker et al. 1984).

Mudstone A sedimentary rock composed of silt and clay sized particles that breaks along bedding planes much less easily than siltstone or shale (Stiegeler 1976).

Munsell color system A color designation system specifying the relative degrees of the three simple variables of color: **hue**, **value** and **chroma**. For example, 10YR6/4 is the color of a soil having a hue of 10YR, value of 6, and chroma of 4. These notations can be translated into several different systems of color names.

Appendix F. *(continued)*

Non-marine Refers to materials that were deposited in a fresh water or deltaic environment.

Organic matter The decomposition residues of plant material derived from: a: plant materials deposited on the surface of the soils; and b: roots that decay beneath the surface of the soil.

Outwash Sediments washed out beyond the glacier by flowing water and laid down as stratified drift in thin foreset beds. Particle size may vary from boulders to silt.

Paralithic Soils with residual material (bedrock softer than 3 on Moh's hardness scale or partially weathered and fractured bedrock) within 1 m of the surface.

Parent material The unconsolidated and more or less chemically weathered mineral or organic material from which the **solum** of a soil has developed by pedogenic processes.

Particle size The effective diameter (grain size) of a particle measured by sedimentation, sieving, or micrometric methods.

Partings Thin sedimentary layer, occurring between two thicker layers of different lithology, for example, a shale layer in sandstone (Bates and Jackson 1987).

Pedogenesis The mode of origin of the soil, especially the processes or soil-forming factors responsible for the development of the solum, the true soil, from unconsolidated parent material. Also called soil genesis.

Pedology The aspects of soil science dealing with the origin, morphology, genesis, distribution, mapping, and taxonomy of soils, and classification in terms of their use.

Phase, soil A subdivision of a soil type or other unit of classification having characteristics that affect the use and management of the soil but which do not vary sufficiently to differentiate it as a separate type. A variation in a property or characteristic such as depth of lime, degree of erosion, content of stones etc.

pH, soil The negative logarithm of the hydrogen-ion activity of a soil. The degree of acidity or alkainity of a soil as determined by means of a suit-able electrode or indicator at a specified moisture content or soil-water (or $CaCl_2$ solution) ratio and expressed in terms of the pH scale.

Polygon A map delineation that represents a tract of land with certain landform, soil and vegetation features. The smallest polygon on a 1:50 000 scale map is about 0.5 cm^2 and represents a tract of about 12.5 ha (30 ac).

Pothole A term used herein to refer to a wetland, usually smaller than 5 ha (12 ac), lying in a shallow undrained depression, that contains standing water only during the wettest parts of most years.

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

Proglacial Immediately in front of or just beyond the outer limits of a glacier or ice sheet, generally at or near its lower end; said of lakes, streams, deposits, and other features produced by or derived from the glacier ice (Gary et al. 1972).

Range condition Health of the range, as measured by the proportion of climax species present (Adams et al 1986); the current productivity of a range relative to what that range is naturally capable of producing (Smoliak et al. 1988).

Range type (Vegetation type or subtype) A plant community typified by an association of species different from that of other habitats (Smoliak et al. 1988).

Recent Deposits of late post-glacial age, i.e. within the last few hundred to few thousand years. Soils have had insufficient time to develop "normal" profiles. See **modern**.

Recessional moraine A moraine built during a temporary but significant pause in the retreat of an ice sheet (Bates and Jackson 1987).

Recharge The process by which water is absorbed and added to the subsurface zone of saturation (groundwater).

Appendix F. *(continued)*

Residual material (residuum) Unconsolidated and partly weathered (physically and chemically) mineral materials formed by the disintegration of consolidated rock in place; includes saprolite (ECSS 1987).

Reworked Residual Unconsolidated material principally derived from local bedrock. The material is a mixture of different particle sizes and bedrock types with most of the evidence of stratification lost. It is differentiated from till by its greater internal variability. Pockets of siltstone, sandstone and other rock types which have retained much of the original character of consolidated rock occur within the matrix. Reworked residual material was poorly mixed and was transported only over a short distance.

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

Rilled Channelled landscape on inclined slopes. Requires unidirectional and uniform (simple) slopes that are typically greater than 400 m in length. The symbol indicates that there are 4 or more channels or rills per 800 m of cross-sectional distance. Rills are typically 10 to 50 cm deep and 50 to 150 cm wide, with lengths sometimes up to 3 kms. Rills are ephemeral channels, formed by runoff and can be destroyed by plowing or by frost action. They can be seasonal in nature and are caused by runoff following preferential flow lines.

Rolling Long, very regular or smooth, often convex slopes with a cycle distance of about 0.5 - 1 km.

Salinity, soil The amount of soluble salts in a soil, expressed as electrical conductivity in decisiemens per meter (dS/m) and measured by the saturated paste method or equivalent.

Saline soil A non-alkali soil containing soluble salts in such quantities that they interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 dS/cm, the exchangeable sodium percentage is less than 15, and the pH is usually less than 8.5.

Salinization The process of accumulation of salts in soils.

Saltation A mode of sediment transport in which particles are moved progressively forward in a series of short intermittent leaps, jumps, hops, or bounces along a surface, eg. sand particles skipping downwind by impact and rebound along the ground surface (Gary et al. 1972).

Sand (i) As a particle size term: a size fraction between 0.05 and 2.0 mm equivalent diameter, or some other limit (geology or engineering). (ii) As a soil term: a textural class with abundant sand sized particles.

Sandstone A sedimentary rock formed largely of sand-sized particles.

Scour Erosion by moving water.

Sediment Solid particles of material that have been derived from rock weathering. They are transported and deposited from water, ice or air as layers at the earth's surface.

Seep An area, generally small, where water percolates slowly to the land surface. Synonymous with spring where the flow of water is substantial but includes flows that are very small (Gary et al. 1972).

Series, soil A category (or level) in the Canadian system of soil classification. This is the basic unit of soil classification, and consists of soils that are essentially alike in all major profile characteristics except the texture of the surface.

Shale A sedimentary rock composed of clay and silt sized particles that splits readily along bedding planes (Stiegeler 1976).

Significant A major soil (or other feature) that is clearly subordinate (subdominant) to the dominant. The typical range of proportions of a significant soil is 15-40%.

Silt (i) As a particle size term: a size fraction between 0.002 and 0.05 mm equivalent diameter, or some other limit (geology or engineering). (ii) As a soil term: a textural class with abundant silt sized particles.

Siltstone A sedimentary rock with at least two thirds silt-sized particles (Bates and Jackson 1987).

Appendix F. *(continued)*

Slope The degree of deviation of a surface from horizontal, measured in a numerical ratio, percent and degree.

Slough A generic term used herein to refer to water bodies that occupy shallow undrained depres-sions. They may be intermittent or permanent (e.g. lakes) but contain standing water throughout most years.

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

Soil The naturally occurring, unconsolidated mineral or organic material at least 10 cm thick that occurs at the earth's surface and is capable of supporting plant growth. Soil extends from the earth's surface through the genetic horizons, if present, into the underlying material to the depth of the control section (normally about 1-2 m). Soil development involves climatic factors and organisms, conditioned by relief and water regime, acting through time on geological materials, and thus modifying the properties of the parent material (ECSS 1987).

Soil complex A mapping unit used in detailed and reconnaissance soil surveys where two or more defined soil units are so intimately intermixed geographically that it is impractical, because of the scale used, to separate them.

Soil drainage classes Seven classes that describe the overall natural drainage of soils, taking into account factors of external (surface runoff) and internal (perviousness) soil drainage in relation to supply of water. The classes from driest to wettest are very rapidly, rapidly, well, moderately well, imperfectly, poorly, and very poorly drained. Each describes water removal from the soil in relation to supply, and can be equated with a range in available water storage capacity (ECSS 1983).

Soil map A map showing the distribution of soil types, classes, or other soil mapping units in relation to the prominent physical and cultural features of the earth's surface.

Soil survey The systematic examination of an area in order to describe, classify and map its soils. Soil surveys are classified according to the kind and intensity of the field examination.

Solum (plural **sola**) The upper horizons of a soil in which the parent material has been modified and in which most plant roots are contained. It usually consists of A and B horizons.

Stratification The arrangement of sediments in layers or strata marked by a change in color, texture, size of particles, and composition. **Stratification** usually means layers of sediments that separate readily along bedding planes because of different sizes and kinds of material or some interruption in deposition that permitted changes to take place before more material was deposited.

Structure, soil The combination or arrangement of primary soil particles into secondary particles, units, or peds. These peds may be arranged in the profile in such a manner as to give a distinctive characteristic pattern. The peds are characterized and classified on the basis of size, shape, and degree of distinctness into classes, types, and grades.

Subglacial Formed or accumulated in, or by the bottom parts of a glacier or ice sheet.

Subirrigated Condition where root zone receives moisture through subsurface water movement.

Subsoil The B horizon of a soil profile.

Supraglacial Situated or occurring at or immediately above the surface of a glacier or ice sheet; said of till, drift, meltwater streams, etc. (Gary et al. 1972).

Terrace A nearly level, usually narrow, plain bordering a river or lake. Rivers sometimes are bordered by a number of terraces at different levels.

Till Unsorted and unstratified drift (**morainal** material) deposited by and underneath a glacier without subsequent reworking by glacial meltwater (Gary et al. 1972).

Texture, soil The relative proportions of the various soil separates (mineral particles of varying diameter) in a soil as described by the thirteen textural classes plus modifiers.

Appendix F. *(concluded)*

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

Topography The physical features of a district or region, such as those represented on a map, taken collectively; especially the relief and contours of the land. On most soil maps topography may also mean topography classes which describe slopes according to standard ranges of percent gradient.

Topsoil (i) The layer of soil moved in cultivation. (ii) The A horizon. (iii) The Ah horizon. (iv) Presumably fertile soil material used to topdress roadbanks, gardens and lawns.

Undulating A wave-like pattern of very gentle slopes with low local relief. Slope length is generally less than 0.5 km and slope gradients are commonly 2-5%.

Value, color One of the three variables of color (**Munsell system**); expresses the relative lightness of color, which is approximately a function of the square root of the total amount of light.

Variant A soil which is dissimilar from all existing series but comprises less than 800 ha may be designated as a variant of the most closely related, existing series (ECSS 1987). The series name plus a modifier identify the variant which may then be used in naming map/soil units.

Veneer A mantle of unconsolidated material too thin (usually less than 1 m) to mask the minor topographic irregularities of the underlying material.

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

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

Appendix G.
Soil Analytical File

Introduction

Included are 14 soil series, of SCA 1 and 2, created and described during the course of the County of Forty Mile soil survey. Morphological characteristics in addition to chemical and physical analyses are provided. Other soil series of SCAs 1 and 2 are documented in the previously published soil survey reports of Oyen (Kjearsgaard 1988), Newell (Kjearsgaard et al. 1983) and Warner (Kjearsgaard et al. 1986).

The following methods were used in the analytical procedures:

Methods for Laboratory Analyses

Soil pH: pH was measured with a pH meter using a 2:1 slurry of 0.01 M $CaCl_2$ (McKeague 1978).

Total Carbon: Total carbon was measured by dry combustion using a LECO CR12 carbon analyzer (Leco Corporation 1979). Total carbon is a measure of both organic and inorganic forms of carbon. Carbonate minerals in the soil are the primary source of inorganic carbon.

Organic Carbon and Organic Matter: Organic matter was calculated by multiplying the value for organic carbon by 1.72. Organic carbon is assumed to be equal to the level of total carbon in non-calcareous soil samples.

Total Nitrogen: Total nitrogen was estimated by digesting soil samples according to the semi-micro Kjeldahl procedure (McKeague 1978) followed by analysis with a Tecator Kjeltec Auto 1030 Analyzer distillation and titration unit.

Carbon/Nitrogen Ratio: The ratio of organic carbon to total nitrogen was determined from values determined by methods outlined herein.

Inorganic Carbon and $CaCO_3$ Equivalent: Inorganic carbon was determined by acid dissolution and measurement by the manometric (calcimeter) method of Bascombe (1961). The equivalent amount of $CaCO_3$ was then calculated from the inorganic carbon value.

Cation Exchange Capacity and Exchangeable Cations: Cation exchange capacity (CEC) and extractable cations were determined by displacement of ions with a normal (1M at pH 7.0) ammonium acetate solution (USDA Soil Conservation Service 1984). The NH_4 ions were measured with a Tecator Kjeltec Auto 1030 Analyzer distillation and titration unit, and exchangeable Ca, Mg, K and Na were measured by Inductively Coupled Plasma Atomic Emission Spectroscopy.

Calcium/Sodium Ratio: This is the ratio of exchangeable calcium to exchangeable sodium, expressed as cmol (+)/kg, determined as described herein. A ratio of 10 or less distinguishes soil subgroups in the Solonetzic order.

Electrical Conductivity and Soluble Salts: Electrical conductivity (EC) and soluble ions were determined on extracts of saturated pastes (McKeague 1978). The EC was measured with a Yellow Springs Instruments conductivity cell and model 32 conductance meter. Ca, Mg, K and Na were measured by Inductively Coupled Plasma Atomic Emission Spectroscopy. Sodium Absorption Ratios (SAR, the ratio $[Na]/[Ca+Mg]^{0.5}$, where concentrations are in mmol/L) were also calculated.

Particle Size Distribution: The contents of sand, silt and clay in soil samples were determined by a simplified hydrometer method as described by Gee and Bauder (1979).

Appendix G.
Soil Analytical File

Comrey (CMR)

Classification: Orthic Brown Chernozemic
Agroclimate: 3A
Parent Material: Residual
Location: LSD 9-Sec30-Twp1-R6-W4th
Elevation (m): 990
Slope Position: upper
Land Use: grazing

Horizon	Depth (cm)	Description
Ah	0 - 10	Olive brown (2.5Y 4/3d); loam to sandy loam; weak to moderate subangular blocky; very friable; slightly plastic; clear, wavy boundary.
Bm	10- 27	Dark olive brown (2.5Y 3/3m); loam to sandy loam; weak to medium subangular blocky; very friable; slightly plastic; gradual, wavy boundary.
Cca	27 - 80	Olive brown (2.5Y 4/3 m); loam; structureless; friable; plastic; moderately calcareous.

Comments: This profile is typical of the Comrey series except for the texture of the Cca horizon, which is usually SL, but in this case is L. At 80 cm the residual was hard and could not be penetrated by hand auger.

Analysis	Ah	Bm	Cca
Depth, cm	0-10	10-27	27-80
Sand, %	51	52	46
Silt, %	41	32	34
Clay, %	8	16	20
Texture	L-SL	L-SL	L
Organic Matter, %	4.0	1.7	
N, %	0.21		
C/N Ratio	11.0		
Exchangeable Cations, cmol (+) /kg			
Ca	13.80	12.66	
Mg	2.72	2.89	
Na	0.01	0.01	
K	0.90	0.43	
Total CEC, cmol (+) /kg	17.9	17.6	
Ca/Na Ratio	>100	>100	
pH ($CaCl_2$)	7.2	7.2	
$CaCO_3$ eq., %		0.1	11.9
EC, dS/m			0.50
Soluble Cations mmol/L			
Ca			0.67
Mg			1.02
Na			2.94
K			0.11
SAR			2.3

Craigower (CGW)

Classification: Dark Brown Solodized Solonetz
Agroclimate: 2AH
Parent Material: Glaciolacustrine
Location: LSD8-Sec4-Twp 1-R8-W4th
Elevation (m): 1050
Slope Position: lower
Land Use: grazing

Horizon	Depth (cm)	Description
Ahe	0 - 7	Olive brown to light olive brown (2.5Y 4.5/3 d): silt loam; moderate, very fine to fine platy; very friable; slightly plastic; clear smooth boundary.
Ae	7 - 14	Light olive brown (2.5Y 5/3 d); sandy loam; moderate to strong, fine platy; very friable; slightly plastic; abrupt smooth boundary.
Bnt	14 - 28	Olive brown (2.5Y 4/3 d); loam; strong, medium to coarse columnar; very firm; very plastic; clear wavy boundary; common, moderately thick clay films (10YR 3/2 m).
Csk1	28 - 55	Dark olive brown (2.5Y 3/3 m); clay loam; massive; friable; plastic; gradual wavy boundary; weakly calcareous; strongly saline.
Csk2	55 - 100	Very dark grayish brown (2.5Y 3/2 m); clay loam to loam; structureless; firm; very plastic; weakly calcareous; strongly saline.

Comments: This profile is typical of the Craigower series except in terms of subsoil salinity and solum texture. Typically CGW has a subsoil EC of between 4 and 15 dS/m (weak to moderate salinity) and a solum texture of CL or SiCL.

Analysis	Ahe	Ae	Bnt	Csk1	Csk2
Depth, cm	0-7	7-14	14-28	28-55	55-100
Sand, %	41	53	37	24	31
Silt, %	51	42	44	43	41
Clay, %	7	5	19	32	28
Texture	SiL	SL	L	CL	CL-L
Organic Matter, %	4.8	2.2			
N, %	0.19				
C/N Ratio	14.6				
Exchangeable Cations, cmol (+) /kg					
Ca	5.61		3.64		
Mg	2.04		5.80		
Na	1.18		7.81		
K	0.83		0.59		
Total CEC, cmol (+) /kg	12.7		16.6		
Ca/Na Ratio	4.8		0.5		
pH ($CaCl_2$)	5.9	5.9	7.9	8.6	8.9
$CaCO_3$ eq., %				0.2	1.5
EC, dS/m			3.86	24.10	24.20
Soluble Cations mmol/L					
Ca				11.70	11.50
Mg				62.50	59.90
Na				397.80	388.40
K				0.94	0.78
SAR				46.2	46.0

Appendix G. *(continued)*

Glenbanner (GNN)

Classification: Orthic Dark Brown Chernozemic
Agroclimate: 2AH
Parent Material: Glaciolacustrine
Location: LSD15-Sec1-Twp 6-R5-W4th
Elevation (m): 1050
Slope Position: mid
Land Use: grazing

Horizon	Depth (cm)	Description
Ah	0 - 12	Dark grayish brown to dark brown (10YR 3.5/2.5 d); loam to clay loam; weak, fine subangular blocky; friable; slightly plastic; clear, smooth boundary.
Bm	12 - 37	Dark grayish brown (10YR 4/2 m); clay loam; weak to moderate, fine to medium subangular blocky; friable; plastic; clear, irregular boundary.
Ck	37 - 100	Dark grayish brown (10YR 4/2 d); silty clay loam; structureless; soft; weakly calcareous.

Analysis	Ah	Bm	Ck
Depth, cm	0-12	12-37	37-100
Sand, %	32	29	17
Silt, %	42	41	48
Clay, %	27	31	35
Texture	L-CL	CL	SiCL
Organic Matter, %	4.0	2.9	
N, %	0.20		
C/N Ratio	11.6		
Exchangeable Cations, cmol (+) /kg			
Ca	10.96	10.95	
Mg	5.54	7.07	
Na	0.01	0.01	
K	1.96	1.84	
Total CEC, cmol (+) /kg	25.5	26.8	
Ca/Na Ratio	>100	>100	
pH ($CaCl_2$)	6.1	5.9	7.9
$CaCO_3$ eq., %			2.5
EC, dS/m			0.51
Soluble Cations mmol/L			
Ca			
Mg			
Na			
K			
SAR			

Maher (MHR)

Classification: Dark Brown Solodized Solonetz
Agroclimate: 2AH
Parent Material: Till
Location: LSD5-Sec2-Twp 6-R5-W4th
Elevation (m): 1020
Slope Position: mid
Land Use: grazing

Horizon	Depth (cm)	Description
Ahe	0 - 9	Brown (10YR 5/3 d); loam; moderate to strong, very fine to fine platy; very friable;nonplastic to slightly plastic; abrupt, smooth boundary.
Bnt	9 - 33	Olive brown to light olive brown (2.5Y 4.5/3 d); clay loam; moderate to strong, medium to coarse columnar; very firm; plastic; clear, wavy boundary; many, moderately thick clay films (10YR 3/3 d).
Csk	33 - 100	Light brownish gray (2.5Y 6/2 d); clay loam; structureless; moderately calcareous; weakly saline.

Analysis	Ahe	Bnt	Csk
Depth, cm	0-9	9-33	33-100
Sand, %	42	29	26
Silt, %	47	41	41
Clay, %	11	29	33
Texture	L	CL	CL
Organic Matter, %	3.3	1.7	
N, %	0.16		
C/N Ratio	12.1		
Exchangeable Cations, cmol (+) /kg			
Ca	3.88	8.15	
Mg	3.08	10.45	
Na	0.27	2.53	
K	0.89	0.96	
Total CEC, cmol (+) /kg	15.8	26.9	
Ca/Na Ratio	14.4	3.2	
pH ($CaCl_2$)	5.1	6.7	8.2
$CaCO_3$ eq., %			10.0
EC, dS/m			5.04
Soluble Cations mmol/L			
Ca			
Mg			
Na			
K			
SAR			

Appendix G. *(continued)*

McAlpine (MCA)

Classification: Dark Brown Solodized Solonetz
Agroclimate: 2H
Parent Material: Till
Location: LSD15-Sec17-Twp8-R5-W4th
Elevation (m): 1180
Slope Position: upper
Land Use: grazing

Horizon	Depth (cm)	Description
Ahe	0 - 11	Dark grayish brown (10YR 4/2 d); loam; moderate to strong, very fine to fine platy; very friable; slightly plastic; abrupt, smooth boundary.
Bnt	11 - 28	Brown (10YR 5/3 d); clay; strong, very coarse columnar; very firm; very plastic; clear, smooth boundary; many, moderately thick clay films (10YR 3/2.5 d).
Bnk	28 - 34	Olive brown (2.5Y 4/3 d); clay loam; moderate to strong, fine to medium prismatic; firm; plastic; clear, wavy boundary; common, thin clay films (10YR 4/2); weakly calcareous.
Csk	34 - 100	Grayish brown to light olive brown (2.5Y 5.5/2.5 d); clay to clay loam; structureless; slightly hard; plastic; moderately calcareous; weakly saline.

Comments: This profile is slightly finer textured than is typical of the McAlpine series. The till at this location may have a higher component of material derived from local Bearpaw shale.

Analysis	Ahe	Bnt	Bnk	Csk
Depth, cm	0-11	11-28	28-34	34-100
Sand, %	43	28	26	26
Silt, %	45	30	37	33
Clay, %	12	42	38	41
Texture	L	C	CL	C
Organic Matter, %	6.6	2.3		
N, %	0.27			
C/N Ratio	14.3			
Exchangeable Cations, cmol (+) /kg				
Ca	6.90	10.09		
Mg	2.89	13.22		
Na	0.18	3.77		
K	0.80	0.51		
Total CEC, cmol (+) /kg	22.1	37.3		
Ca/Na Ratio	38.3	2.7		
pH ($CaCl_2$)	5.1	6.0	8.1	8.0
$CaCO_3$ eq., %			2.4	5.8
EC, dS/m			1.61	5.62
Soluble Cations mmol/L				
Ca				
Mg				
Na				
K				
SAR				

Minda (MNA)

Classification: Dark Brown Solodized Solonetz
Agroclimate: 2AH
Parent Material1: Till
Parent Material 2: Reworked Residual
Location: LSD10-Sec14-Twp5-R5-W4th
Elevation (m): 1070
Slope Position: lower
Land Use: grazing

Horizon	Depth (cm)	Description
Ahe	0 - 5	Olive brown (2.5Y 4/3 d); sandy loam to loam; weak, very fine to fine, platy; soft; slightly plastic; abrupt, smooth boundary.
Ae	5 - 14	Light olive brown (2.5Y 5/3 d); sandy loam to loam; weak to moderate, fine platy; soft; slightly plastic; abrupt, wavy boundary.
Bnt	14 - 28	Olive brown (2.5Y 4/3 d); loam; moderate to strong, medium to coarse columnar; very firm; plastic; clear, wavy boundary; common, moderately thick clay films (10YR 3/2 d).
Csk1	28 - 57	Light olive brown (2.5Y 5/3 d); silt loam to clay loam; structureless; friable; plastic; clear, irregular boundary; weakly calcareous; weakly saline.
Csk2	57 - 81	Olive brown (2.5Y 4/3 d); loam to clay loam; structureless; friable; plastic; gradual, wavy boundary; moderately calcareous; weakly saline.
2Csk	81 - 120	Light olive brown (2.5Y 5/3 d); loam; structureless; soft; plastic; moderately calcareous; weakly saline.

Comments: This profile differs from the modal Minda in terms of texture. The underlying reworked residual is normally fine textured.

Analysis	Ahe	Ae	Bnt	Csk1	Csk2	2Csk
Depth, cm	0-5	5-14	14-28	28-57	57-81	81-120
Sand, %	52	51	47	21	37	30
Silt, %	42	43	43	53	37	46
Clay, %	6	6	10	26	26	25
Texture	SL-L	SL-L	L	SiL-CL	L-CL	L
Organic Matter, %	7.8	1.7				
N, %	0.23					
C/N Ratio	19.6					
Exchangeable Cations, cmol (+) /kg						
Ca	7.27		4.12			
Mg	2.88		3.58			
Na	0.19		2.74			
K	1.45		0.78			
Total CEC, cmol (+) /kg	16.5		11.1			
Ca/Na Ratio	38.3		1.5			
pH ($CaCl_2$)	5.9	5.8	7.6	8.1	8.3	8.2
$CaCO_3$ eq., %				3.0	6.3	6.5
EC, dS/m				4.49	7.46	7.71
Soluble Cations mmol/L						
Ca				12.45	10.37	
Mg				9.39	9.85	
Na				31.02	81.69	
K				0.38	0.32	
SAR				6.6	18.2	

Appendix G. *(continued)*

Orion (ORN)

Classification: Orthic Regosol
Agroclimate: 3A
Parent Material: Glaciofluvial
Location: LSD11-Sec22-Twp8-R7-W4th
Elevation (m): 970
Slope Position: mid
Land Use: grazing

Horizon	Depth (cm)	Description
Ahk	0 - 3	Olive brown to light olive brown (2.5Y 4.5/3.5 d); silty clay loam; weak, fine granular; soft; slightly plastic; abrupt, wavy boundary; very weak effervescence.
Ck	3 - 100	Light olive brown (2.5Y 5/3 d); silty clay loam; structureless; friable; slightly plastic; weakly calcareous.

Comments: This profile is slightly finer textured than usual for the series.

Analysis	Ahk	Ck
Depth, cm	0-3	3-100
Sand, %	19	19
Silt, %	49	49
Clay, %	32	32
Texture	SiCL	SiCL
Organic Matter, %	3.0	
N, %	0.15	
C/N Ratio	11.6	
Exchangeable Cations, cmol (+) /kg		
Ca		
Mg		
Na		
K		
Total CEC, cmol (+) /kg	33.1	
Ca/Na Ratio		
pH ($CaCl_2$)	7.5	8.0
$CaCO_3$ eq., %		2.1
EC, dS/m	0.49	2.08
Soluble Cations mmol/L		
Ca	1.87	3.35
Mg	0.69	1.47
Na	0.57	19.10
K	0.77	0.20
SAR	0.36	8.70

Philp (PLP)

Classification: Orthic Dark Brown Chernozemic
Agroclimate: 2AH
Parent Material1: Till
Parent Material 2: Reworked Residual
Location: LSD10-Sec18-Twp 1-R8-W4th
Elevation (m): 1070
Slope Position: upper
Land Use: grazing

Horizon	Depth (cm)	Description
Ah	0 - 11	Dark olive brown to olive brown (2.5Y 3.5/3 d); loam; weak to moderate, fine to medium granular; very friable; slightly plastic; clear, smooth boundary.
Bm	11 - 26	Olive brown (2.5Y 4/3 d); loam; weak to moderate, medium to coarse prismatic; friable; slightly plastic; clear, irregular boundary.
Ck	26 - 46	Light olive brown (2.5Y 5/3 d); loam; structureless; friable; slightly plastic; clear, irregular boundary; moderately calcareous.
2Ck	46 - 100	Light olive brown to light yellowish brown (2.5Y 5.5/3 d); loam; structureless; firm; slightly plastic; moderately calcareous.

Analysis	Ah	Bm	Ck	2Ck
Depth, cm	0-11	11-26	26-46	46-100
Sand, %	42	43	42	42
Silt, %	47	42	41	43
Clay, %	11	15	16	15
Texture	L	L	L	L
Organic Matter, %	4.0	2.8		
N, %	0.21			
C/N Ratio	11.0			
Exchangeable Cations, cmol (+) /kg				
Ca				
Mg				
Na				
K				
Total CEC, cmol (+) /kg	18.1	18.2		
Ca/Na Ratio				
pH ($CaCl_2$)	7.1	7.6	7.9	8.2
$CaCO_3$ eq., %			9.9	8.9
EC, dS/m				1.32
Soluble Cations mmol/L				
Ca				
Mg				
Na				
K				
SAR				

Appendix G. *(continued)*

Pinhorn (PHN)

Classification: Orthic Brown Chernozemic
Agroclimate: 3A
Parent Material: Residual
Location: LSD13-Sec10-Twp3-R6-W4th
Elevation (m): 910
Slope Position: lower
Land Use: grazing

Horizon	Depth (cm)	Description
Ah	0 - 18	Olive brown (2.5Y 4/3 m); sandy loam to loam; weak to moderate, fine granular; very friable; nonplastic to slightly plastic; clear, wavy boundary.
Bm	18 - 39	Dark olive brown (2.5Y 3/3 m); loam; weak, fine to medium prismatic; very friable; slightly plastic; gradual, wavy boundary.
BCk	39 - 56	Dark olive brown (2.5Y 3/3 m); loam; very weak, fine to medium prismatic; friable; slightly plastic; gradual, wavy boundary; weakly calcareous.
Ck	56 - 100	Olive brown (2.5Y 4/3 m); loam to clay loam; structureless; friable; slightly plastic; moderately calcareous.

Comments: This profile is typical of the Pinhorn series except for the texture of the Ah horizon, which is usually loam.

Analysis	Ah	Bm	BCk	Ck
Depth, cm	0-18	18-39	39-56	56-100
Sand, %	53	46	44	30
Silt, %	37	39	40	43
Clay, %	9	15	16	27
Texture	SL-L	L	L	L-CL
Organic Matter, %	3.1	3.0		
N, %	0.16			
C/N Ratio	11.1			
Exchangeable Cations, cmol (+) /kg				
Ca				
Mg				
Na				
K				
Total CEC, cmol (+) /kg	15.3	17.1		
Ca/Na Ratio				
pH ($CaCl_2$)	7.2	7.7	7.8	8.5
$CaCO_3$ eq., %			2.3	11.5
EC, dS/m				2.67
Soluble Cations mmol/L				
Ca				
Mg				
Na				
K				
SAR				

Plume (PME)

Classification: Rego Dark Brown Chernozemic
Agroclimate: 2H
Parent Material: Till
Location: LSD12-Sec17-Twp 8-R5-W4th
Elevation (m): 1160
Slope Position: upper
Land Use: grazing

Horizon	Depth (cm)	Description
Ah	0 - 8	Very dark grayish brown to dark grayish brown (10YR 3.5/2 d); loam; weak, fine to medium granular; friable; clear, irregular boundary.
Ck1	8 - 32	Grayish brown; (10YR 5/2 d); clay loam; structureless; firm; gradual, wavy boundary; moderately calcareous.
Ck2	32 - 100	Light brownish gray (10YR 6/2 d); clay loam; structureless; firm; moderately calcareous.

Analysis	Ah	Ck1	Ck2
Depth, cm	0-8	8-32	32-100
Sand, %	40	34	31
Silt, %	39	36	38
Clay, %	22	30	31
Texture	L	CL	CL
Organic Matter, %	6.9		
N, %	0.29		
C/N Ratio	13.9		
Exchangeable Cations, cmol (+) /kg			
Ca	17.06		
Mg	5.15		
Na	0.01		
K	1.09		
Total CEC, cmol (+) /kg	30.0		
Ca/Na Ratio			
pH ($CaCl_2$)	6.1	7.8	8.1
$CaCO_3$ eq., %		13.8	10.8
EC, dS/m			0.41
Soluble Cations mmol/L			
Ca			
Mg			
Na			
K			
SAR			

Appendix G. *(continued)*

Skiff (SKF)

Classification: Orthic Luvic Gleysol
Agroclimate: 3A
Parent Material 1: Glaciolacustrine
Parent Material 2: Till
Location: LSD1-Sec10-Twp10-R10-W4th
Elevation (m): 870
Slope Position: depressional
Land Use: grazing

Horizon	Depth (cm)	Description
Oh	6 - 0	Dark brown (7.5YR 3/2 m); silt loam.
Aeg	0 - 22	Light brownish gray to light olive brown (2.4Y 5.5/2.5 d); loam to silt loam; common, medium prominent mottles (2.5YR 4/8 m); moderate to strong, medium platy; sticky; plastic; abrupt, smooth boundary.
Btg	22 - 45	Grayish brown (10YR 5/2 d); clay loam; reduced (5Y 4/1 m); moderate, medium to coarse prismatic; very sticky; plastic; gradual, wavy boundary; few, moderately thick clay films (10YR 3/1 m).
Ckg	45 - 90	Grayish brown (2.5Y 5/2 d); silty clay loam; few, medium prominent mottles (5YR 3/2 m); structureless; very sticky; very plastic; clear, wavy boundary; weakly calcareous.
2Ckg	90 - 120	Light brownish gray (10YR 6/2 d); clay loam; common, fine prominent mottles (7.5YR 5/8 m); structureless; sticky; plastic; moderately calcareous.

Comments: The Skiff profile typically lacks the Oh horizon shown here.

Analysis	Oh	Aeg	Btg	Ckg	2Ckg
Depth, cm	6-0	0-22	22-45	45-90	90-120
Sand, %	38	33	24	19	34
Silt, %	52	49	43	48	38
Clay, %	10	18	33	33	29
Texture	SiL	L-SiL	CL	SiCL	CL
Organic Matter, %	22.9	5.2	1.6		
N, %	1.03	0.25			
C/N Ratio	12.9	12.1			
Exchangeable Cations, cmol (+) /kg					
Ca		9.31	8.16		
Mg		3.47	5.88		
Na		0.01	0.14		
K		2.40	2.89		
Total CEC, cmol (+) /kg		27.1	23.3		
Ca/Na Ratio		>100	58.3		
pH ($CaCl_2$)	5.3	5.3	5.9	7.6	8.0
$CaCO_3$ eq., %				0.9	8.6
EC, dS/m					0.74
Soluble Cations mmol/L					
Ca					
Mg					
Na					
K					
SAR					

Tothill (TTH)

Classification: Orthic Dark Brown Chernozemic
Agroclimate: 2AH
Parent Material: Till
Location: LSD1-Sec25-Twp7-R6-W4th
Elevation (m): 1060
Slope Position: upper
Land Use: grazing

Horizon	Depth (cm)	Description
Ah	0 - 11	Dark brown (10YR 3.5/3 d); loam; weak, very fine to fine granular; very friable; slightly plastic; clear, wavy boundary.
Bm	11 - 27	Dark brown to brown (10YR 4/3 d); clay loam; weak to moderate, fine subangular blocky; friable; slightly plastic; clear, wavy boundary.
Ck	27 - 100	Grayish brown (2.5Y 5/2 d); clay loam; structureless; soft; moderately calcareous.

Analysis	Ah	Bm	Ck
Depth, cm	0-11	11-27	27-100
Sand, %	37	35	32
Silt, %	41	33	38
Clay, %	22	32	31
Texture	L	CL	CL
Organic Matter, %	6.4	2.4	
N, %	0.29		
C/N Ratio	12.8		
Exchangeable Cations, cmol (+) /kg			
Ca	16.45	18.51	
Mg	4.92	6.02	
Na	0.01	0.01	
K	1.22	0.78	
Total CEC, cmol (+) /kg	28.4	31.2	
Ca/Na Ratio	>100	>100	
pH ($CaCl_2$)	6.3	6.6	8.1
$CaCO_3$ eq., %			9.6
EC, dS/m			0.45
Soluble Cations mmol/L			
Ca			
Mg			
Na			
K			
SAR			

Appendix G. *(concluded)*

Wisdom (WSM)

Classification: Orthic Dark Brown Chernozemic
Agroclimate: 2H
Parent Material: Till
Location: LSD10-Sec17-Twp8-R5-W4th
Elevation (m): 1190
Slope Position: upper
Land Use: grazing

Horizon	Depth (cm)	Description
Ah	0 - 14	Very dark brown to yellowish dark brown (10YR 2.5/2.5 d); silt loam; weak to moderate, fine granular; friable; slightly plastic; clear, irregular boundary.
Bm	14 - 30	Greyish brown to light grayish brown (10YR 5.5/2 d); clay loam; weak to moderate, fine to medium subangular blocky; friable; plastic; clear, wavy boundary.
Ck	30 - 100	Brown (10YR 5/3 d): clay loam; structureless; firm; plastic; moderately calcareous.

Comments: Organic matter in the surface horizon is higher than normal for a Dark Brown Chernozemic soil. The high organic matter level can be explained by both the elevation and aspect of the site. The profile was sampled near the Dark Brown-Black soil zone boundary and has a north aspect. The solum is more acidic than is usual for a Dark Brown Chernozem. The very low clay content in the Ah may indicate an eolian origin.

Analysis	Ah	Bm	Ck
Depth, cm	0-14	14-30	30-100
Sand, %	42	37	34
Silt, %	52	33	34
Clay, %	6	30	32
Texture	SiL	CL	CL
Organic Matter, %	11.5	3.2	
N, %	0.45		
C/N Ratio	14.9		
Exchangeable Cations, cmol (+) /kg			
Ca	16.74	19.54	
Mg	4.48	5.89	
Na	0.01	0.01	
K	1.16	0.45	
Total CEC, cmol (+) /kg	35.7	30.2	
Ca/Na Ratio	>100	>100	
pH ($CaCl_2$)	5.2	5.9	7.9
$CaCO_3$ eq., %			12.0
EC, dS/m			0.51
Soluble Cations mmol/L			
Ca			
Mg			
Na			
K			
SAR			

Woolchester (WCR)

Classification: Rego Dark Brown Chernozemic
Agroclimate: 2AH
Parent Material: Till
Location: LSD5-Sec22-Twp 6-R5-W4th
Elevation (m): 1080
Slope Position: crest
Land Use: grazing

Horizon	Depth (cm)	Description
Ah	0 - 10	Dark brown to dark grayish brown (10YR 3.5/2.5 d); loam; weak, fine to medium granular; very friable; slightly plastic; clear, irregular boundary.
Ck	10 - 100	Light brownish gray (2.5Y 6/2 d); clay loam;structureless; firm; plastic; moderately calcareous.

Analysis	Ah	Ck
Depth, cm	0-10	10-100
Sand, %	39	35
Silt, %	39	31
Clay, %	21	34
Texture	L	CL
Organic Matter, %	5.4	
N, %	0.27	
C/N Ratio	11.7	
Exchangeable Cations, cmol (+) /kg		
Ca	18.23	
Mg	5.17	
Na	0.01	
K	1.21	
Total CEC, cmol (+) /kg	28.3	
Ca/Na Ratio	>100	
pH ($CaCl_2$)	6.7	8.1
$CaCO_3$ eq., %		10.0
EC, dS/m		0.57
Soluble Cations mmol/L		
Ca		
Mg		
Na		
K		
SAR		

Appendix H. Information to Assist the User With This Soil Survey Report

Soil Classification

Soils are classified according to the Canadian System of Soil Classification (ECSS 1987). The soil subgroups found in the County are listed in Table 9.

Table 9. Soil Subgroups Commonly Found in the County.

Chernozemic Order		Gleysolic Order	
CA.B	Calcareous Brown	HU.LG	Humic Luvic Gleysol
E.B	Eluviated Brown	O.G	Orthic Gleysol
GL.B	Gleyed Brown	O.HG	Orthic Humic Gleysol
O.B	Orthic Brown	O.LG	Orthic Luvic Gleysol
R.B	Rego Brown	R.G	Rego Gleysol
SZ.B	Solonetzic Brown	R.HG	Rego Humic Gleysol
CA.DB	Calcareous Dark Brown	Sa.R.G	Saline Rego Gleysol
E.DB	Eluviated Dark Brown	SZ.G	Solonetzic Gleysol
GL.DB	Gleyed Dark Brown	SZ.LG	Solonetzic Luvic Gleysol
O.DB	Orthic Dark Brown		
R.DB	Rego Dark Brown		
SZ.DB	Solonetzic Dark Brown		
Regosolic Order		**Solonetzic Order**	
CU.HR	Cumulic Humic Regosol	B.SO	Brown Solod
CU.R	Cumulic Regosol	B.SS	Brown Solodized Solonetz
GL.R	Gleyed Regosol	B.SZ	Brown Solonetz
O.HR	Orthic Humic Regosol	DB.SO	Dark Brown Solod
O.R	Orthic Regosol	DB.SS	Dark Brown Solodized Solonetz
		DB.SZ	Dark Brown Solonetz

Parent Material Type

The types of parent material used in this report are as indicated below. In cases where two parent materials are recognized, the first is uppermost in the profile. The second parent material underlies the first and is usually within a metre of the land surface (veneer). Refer to Appendix F (Glossary) for definitions.

Bedrock
Eolian
Fluvial/Eolian
Fluvial and Glaciofluvial
Lacustrine and Glaciolacustrine
Residual
Reworked Residual
Till (Moraine)

Parent Material Thickness

Veneer: A mantle of unconsolidated material that ranges from 0.3 to 1 m in thickness.

Blanket: A mantle of unconsolidated material that is at least 1 m in thickness.

Texture

Texture refers to the proportions of particle sizes in a soil. Three broad classes, or fractions, of particle sizes are recognized: sand, silt and clay. Their sizes are shown below. Particles greater than 2 mm in size are treated as coarse fragments and are not part of the texture measurement. The proportion of each fraction determines the textural class shown in the textural triangle (Figure 10) of the soil (ECSS 1983).

Name of Fraction	Diameter (mm)
Sand	2.0 - 0.05
Silt	0.05 - 0.002
Clay	< 0.002

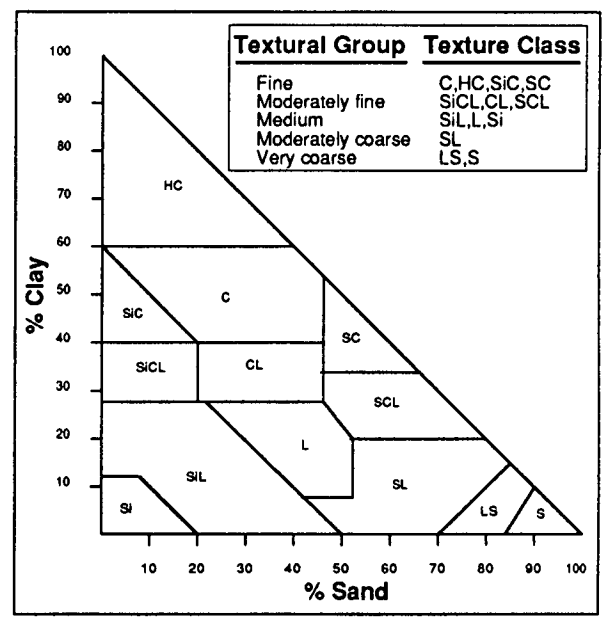

Figure 10. Textural Triangle

Appendix H. *(Continued)*

Coarse Fragments

Coarse fragments are particles greater than 2 mm in size. Terms for the four classes of coarse fragments are as follows:

Term	Diameter
gravel	0.2 cm - 7.5 cm
cobble	7.5 - 25 cm
stone	25 - 60 cm
boulder	> 60 cm

Soil Map Unit Symbol

Each delineation on the map contains a label (Figure 11) which is described in the legend.

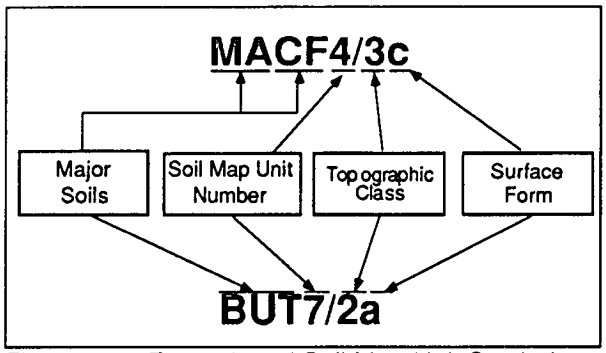

Figure 11. Examples of Soil Map Unit Symbols

Soil Map Unit Numbers

1. Pure unit with only minor amounts (<15%) of soils belonging to other series.

2. Significant component of imperfectly and poorly drained soils (Gleyed subgroups and soils of the Gleysolic order).

3. Significant saline phases.

4. Significant eroded soils. A significant component of soils which belong to the eroded group. See definition under "Soil Groups".

5. Significant component of soils with textures finer than the soils named in the soil map unit label.

6. Significant component of soils with textures coarser than the soils named in the soil map unit label.

7. Significant component of soils of the Solonetzic order and Solonetzic subgroups within the Chernozemic order.

8. Combination of units 2 and 4, with eroded soils, gleyed, Gleysols and water significant.

9. Combination of units 2 and 7. Includes soils of the Solonetzic order and gleyed, Gleysols and water.

Modifiers

Modifiers are used to recognize an additional feature which cannot be described adequately by soil series names. Examples of soil map units which use modifiers are MA:P4/4-5, MSN1/3:R and VSCV:W1/2-3.

P Modifier used when surface stoniness is class S3 or greater. Classes are defined as below (ECSS 1983).

Stoniness Class	Percentage of land surface covered by stones or boulders
very stony (S3)	3-15
excessively stony (S4)	15-50
exceedingly stony (S5)	> 50

R Reworked residual or bedrock generally within 5 m of the land surface. In the County of Forty Mile these materials are typically (or derived from) Cretaceous softrock.

W Soils influenced by high watertable. Typically they are imperfectly to poorly drained and may be subirrigated. The majority of profiles have evidence of gleying and anaerobic conditions with mottles of distinct or prominent contrast. There is a significant component of well and moderately well drained soils where the water table is close to the surface and enhances growing conditions.

Appendix H. *(Concluded)*

Topographic Classes (ECSS 1983)

Class	% Slope
1	0 - 0.5
2	0.5 - 2.0
3	2 - 5
4	5 - 9
5	9 - 15
6	15 - 30
7	30 - 45
8	45 - 70

Surface Form (see Glossary for definitions)

a apron
c rilled
d dissected
i inclined
n concave

Soil Groups

Soil groups are composed of different series, subgroups or phases with a common feature of importance. They are used to simplify and summarize the information portrayed in the soil map unit descriptions of the legend. The overall proportion of the group is provided rather than each individual component. The soil groups used in the legend are defined as follows:

Eroded soils:

- Denotes soils which are affected by erosion or have immature profile development. A soil belongs to the eroded group if it meets one or more of the following criteria:

1. An A horizon of less than 10 cm
2. Solum depth of less than 20 cm
3. The B horizon is less than 5 cm thick (Regosolic)
4. Presence of carbonates in the A or B horizon

Solonetzic Soils:

- Encompasses soils of the Solonetzic order as well as Solonetzic subgroups of the Chernozemic order.

Gleyed, Gleysols and water:

- Describes soils with excessive wetness and drainage classes ranging from imperfect to very poor. Gleysolic soils are saturated for extensive periods resulting in anaerobic conditions in the soil. They have prominent mottles in the upper 50 cm. Gleyed subgroups of Chernozemic, Solonetzic and Regosolic orders have faint or distinct mottles in the upper 50 cm. Water describes permanent or semi-permanent water bodies.

Saline soils:

Denotes soils with greater surface and/or subsurface salinity relative to the other soil components of the map unit.

Soil Drainage

For a discussion of the classes of drainage and their characteristics refer to "The Canada Soil Information System (CanSIS)" manual (ECSS 1983).

Slopes and Soil Location

In the detailed legend (Appendix I) soils are frequently described as occurring at a particular slope position. These positions are shown in the following diagram (ECSS 1983).

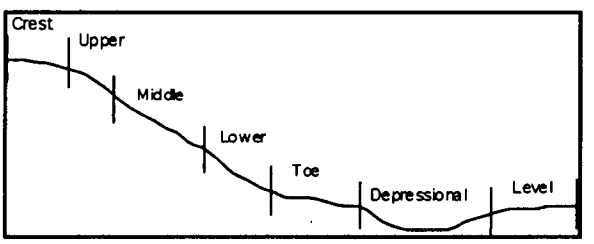

Figure 12. Slope Positions

Appendix I. County of Forty Mile Detailed Soil Legend

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
BUT1/3 a	Bunton	Medium textured glaciofluvial sediments derived from adjacent uplands.	2-5% apron well to moderately well	O.B (BUT) 50-70%	Solonetzic soils Saline soils Eroded soils	Delineations usually located below steep side slopes of coulees. Buried soil layers and immature soils may occur because of recurring deposition. Lenses of coarser texture or gravel may occur. May have saline seepage at the ZRB-apron contact.
BUT4/2 a	Bunton	Medium and moderately coarse textured glaciofluvial sediments derived from adjacent uplands.	0.5-2% apron well to moderately well	O.B (BUT) 20-50% O.R (ORN) 20-40% Coarser textured soils 15-30% CA.B (EXP) 15-25%	Saline soils Gleyed soils	Delineations found mainly on long low-gradient fans entering the Pakowki Basin. Fluvial sediments also present because of recent deposition. Therefore, soils with weak profile development (carbonates at or near the surface) occur. Profiles are typically stone free, but with coarse textured lenses.
BUT7/2 a	Bunton	Medium textured glaciofluvial sediments derived from adjacent uplands.	0.5-2% apron well to moderately well	O.B (BUT) 40-60% Solonetzic soils 20-40%	Saline soils Gleyed soils	Delineations mapped on long low-gradient fans entering the Pakowki Basin. Sediments primarily derived from Bearpaw shale. The sodic characteristics of Bearpaw shale account for the solonetzic soils component.
BUT7/3-4 a	Bunton	Medium and moderately coarse textured glaciofluvial sediments derived from adjacent uplands.	2-9% apron well to moderately well	O.B (BUT) 30-50% Solonetzic soils 15-40% Coarser textured soils 15-30%	Saline soils	Delineations usually located below steep side slopes of coulees. Rough microtopography due to blowout pits. Some minor rilling occurs on fan surfaces.
BVAN1/3	Bingville-Antonio	Moderately coarse textured glaciofluvial veneer to blanket overlying moderately fine textured till.	2-5% undulating well	O.B (BVL) 30-50% O.B (ANO) 30-50%	O.B (PLS) O.B (MAB) Eroded soils	Glaciofluvial veneer (< 1 m) is typically found on the upper slope positions while a glaciofluvial blanket (> 1 m) is found in the swales.
BVAN4/3	Bingville-Antonio	Moderately coarse textured glaciofluvial veneer to blanket overlying moderately fine textured till.	2-5% undulating to ridged well	O.B (BVL) 20-50% O.B (ANO) 20-50% Eroded soils 20-40%	O.B (PLS) O.B (MAB)	Erosion occurs principally on upper and crest positions and on sinuous and linear ridges. Glaciofluvial veneer (< 1 m) is typically found on the upper slope positions while a glaciofluvial blanket (> 1 m) is found in the swales.
BVCF4/3	Bingville-Cranford	Moderately coarse to moderately fine textured glaciofluvial and glaciolacustrine veneer to blanket overlying moderately fine textured till.	2-5% undulating to ridged well to moderately well	O.B (BVL) 20-40% O.B (CFD) 20-40% Eroded soils 20-40%	O.B (MAB) O.B (TAB) O.B (RIR)	Soil textures range from sandy loam to silty clay loam resulting in complex soil distribution within delineations.
BVL6/4	Bingville	Moderately coarse textured and gravelly moderately coarse textured glaciofluvial blanket.	6-9% hummocky to ridged well to rapidly	O.B (BVL) 20-50% Gravelly and coarser textured soils 20-40% Eroded soils 20-40%	O.B (MAB) O.B (KGO)	Eroded soils typically associated with upper slope and crest positions.
BVRI3/3	Bingville-Rainier	Moderately coarse textured glaciofluvial blanket to veneer overlying moderately fine textured glaciolacustrine sediments.	2-5% undulating well to moderately well	O.B (BVL) 20-50% Saline soils 15-30% O.B (RIR) 15-30%	Gleyed and Gleysols O.B (ANO) O.B (CHN)	Saline discharge typically occurs in lower slope and depressional positions. Some delineations have a concave surface expression.
BVTA1/3	Bingville-Taber	Moderately coarse to very coarse textured glaciofluvial blanket with a discontinuous veneer of medium textured glaciolacustrine.	2-5% undulating well	O.B (BVL) 30-50% O.B (TAB) 15-40%	O.B (CHN) O.B (CVD)	Delineations have complex textural variability with surface texture ranging from sandy loam to silt loam and parent material texture varying from loamy sand to silt loam.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
CFD1/2 i	Cranford	Discontinuous medium textured glaciolacustrine veneer to blanket overlying moderately fine textured till.	0.5-2% inclined well to moderately well	O.B (CFD) 50-70% O.B (MAB) 15-25% O.B (CHN) 15-25%	Gleyed soils Eroded soils	Delineations found largely in Skiff and Foremost regions of the Etzikom Plain. Rill erosion occurs in some delineations. Stones may occur on the surface.
CFD1/3	Cranford	Discontinuous medium textured glaciolacustrine veneer to blanket overlying moderately fine textured till.	2-5% undulating well to moderately well	O.B (CFD) 50-70% O.B (MAB) 15-25% O.B (CHN) 15-25%	Gleyed soils Eroded soils Solonetzic soils	Stones may occur on the surface. CHN soils generally occur in lower slope positions while MAB is typically found in upper slope positions.
CFD2/2-3 n	Cranford	Discontinuous medium textured glaciolacustrine veneer to blanket overlying moderately fine textured till.	0.5-5% concave well to poorly	O.B (CFD) 20-50% Gleyed, Gleysols and Water 15-40% O.B (CHN) 15-25% O.B (MAB) 15-25%	Solonetzic soils Eluviated Brown	Solonetzic and eluviated soils tend to occur in toe slope positions adjacent to depressions. MAB soils typically occur on the upper slopes.
CFD3/3 n	Cranford	Discontinuous medium textured glaciolacustrine veneer to blanket overlying moderately fine textured till.	2-5% concave well to poorly	O.B (CFD) 30-50% Saline soils, Gleyed, Gleysols and Water 15-40% O.B (MAB) 15-25% O.B (CHN) 15-25%	Solonetzic soils	Discharge, sometimes seasonal, results in upward salt and carbonate movement impairing soil development (calcareous and carbonated phases). Saline, gleyed, Gleysols and water occur in association together and occupy lower slope positions and depressional areas. Delineations of this map unit often occur adjacent to ZAV3 delineations.
CFD5/3	Cranford	Medium to fine textured glaciolacustrine veneer to blanket overlying moderately fine textured till.	2-5% undulating well to moderately well	O.B (CFD) 20-50% Finer textured soils 20-40%	O.B (MAB) O.B. (CHN)	Finer textured soils (> 40% clay) make up a significant proportion of the soils in delineations. Usually occurs on supraglacial lacustrine materials in moraine plateau settings along the Lethbridge-Etzikom moraine. Calcareous phases occur due to the reduced leaching potential of finer textured soils.
CFD7/2-3	Cranford	Discontinuous medium textured glaciolacustrine veneer to blanket overlying moderately fine textured till.	0.5-5% level to undulating well to moderately well	O.B (CFD) 30-50% Solonetzic soils 15-30% O.B (MAB) 15-25% O.B (CHN) 15-25%	Saline soils Gleyed soils	The thickness of the lacustrine veneer and the proportion of Solonetzic soils tend to increase from mid to lower slope positions. MAB soils typically occupy the upper slope and crest positions.
CFD9/3 n	Cranford	Medium textured glaciolacustrine veneer overlying moderately fine textured till.	2-5% concave well to poorly	O.B (CFD) 30-50% Solonetzic soils 15-25% Gleyed, Gleysols and Water 15-25%	O.B (MAB) Saline soils	The solonetzic soil component tends to occur in mid to lower slope positions and is often found within or along the edges of depressions. This pattern may indicate a groundwater influence on soil formation.
CFGE1/3c	Cranford-Gem	Medium textured glaciolacustrine veneer overlying moderately fine textured till.	2-5% inclined and rilled well to moderately well	O.B (CFD) 30-50% B.SO (GEM) 20-40% Other Solonetzic soils 15-30% Other Chernozemic soils 15-30%	Eroded soils	Delineations generally found east of Seven Persons Coulee on the regional incline below the Cypress Shoulder. Chernozemic soils include CHN and MAB. Solonetzic soils may include DHS and TIK and are generally found in mid to lower slope positions.
CGTT1/3	Craigower-Tothill	Discontinuous moderately fine textured glaciofluvial veneer to blanket derived from adjacent uplands overlying moderately fine textured till.	2-5% undulating well to moderately well	DB.SS (CGW) 20-50% O.DB (TTH) 20-50% O.DB (GNN) 15-30% DB.SS (MHR) 15-30%	Eroded soils Gleyed soils	Delineations found between 1025 and 1110 m on the Cypress Shoulder. CGW and GNN (developed on moderately fine textured apron sediments) occur in mid to lower slope positions. TTH and MHR form on till deposits in upper slope and crest positions. Some slopes associated with the latter soils may be class 4.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
CGW1/2-3 a	Craigower	Moderately fine textured glaciofluvial sediments derived from adjacent uplands.	0.5-5% apron well to moderately well	DB.SS (CGW) 30-50% O.R (ORN) 15-20% O.DB (GNN) 15-20%	Eroded soils DB.SO	Delineations of this map unit occur on the Cypress Shoulder and Sweetgrass Arch. Sediments are often derived from marine mudstone, siltstone and shale resulting in textural variations (silty clay loam to clay) and the development of Solonetzic soils. Rilling may be locally important in some delineations.
CGW2/2-3 n	Craigower	Moderately fine textured glaciofluvial sediments derived from adjacent uplands.	0.5-5% concave well to poorly	DB.SS (CGW) 30-50% Gleyed, Gleysols and Water 15-40%	O.R (ORN) O.DB (GNN) DB.SO	Delineations of this map unit occur on the Cypress Shoulder and Sweetgrass Arch. The sediments are often derived from marine mudstone, siltstone and shale resulting in textural variations (silty clay loam to clay) and the development of Solonetzic soils.
CHCF1/2	Chin-Cranford	Medium textured glaciolacustrine veneer to blanket overlying moderately fine textured till.	0.5-2% gently undulating well to moderately well	O.B (CHN) 40-60% O.B (CFD) 30-50%	O.B (MAB) Gleyed soils Coarse textured soils	Texture is generally uniform, but lenses of coarser textured materials are occasionally encountered. Surface stones may sometimes occur. Rill erosion apparent in some delineations.
CHN6/2-3	Chin	Medium to moderately coarse textured glaciofluvial and glaciolacustrine blanket to veneer overlying moderately fine textured till.	0.5-5 % level to undulating well to moderately well	O.B (CHN) 30-60% Coarser textured soils 20-40% O.B (CFD) 15-25%	O.B (MAB) Eroded soils	Textural variability is common. Coarser textured soils include BVL, RIR, TAB and CVD.
CMSI4/3-5	Comrey-Steveville	Moderately coarse to medium textured residual and/or reworked residual with a discontinuous medium textured till veneer.	2-15% undulating to ridged well to moderately well	O.B (CMR) 20-40% B.SS (SIL) 20-40% Eroded soils 20-30% O.B (PHN) 15-30%	B.SS (HUK) O.B (MSN)	Topography is highly variable ranging from gently undulating to irregular knobs and ridges with moderate to steep slopes. Bedrock lithology ranges from sandstone to mudstone and siltstone with shale partings.
CMR1/3	Comrey	Moderately coarse textured residual and/or reworked residual.	2-5% undulating to ridged well to rapidly	O.B (CMR) 60-80%	O.B (PHN) Solonetzic soils	Delineations of this map unit are found only on the Sweetgrass Arch. CMR has developed on Cretaceous sandstone and may become coarser with depth. Competent bedrock may be encountered within 1 m of the surface.
CVD1/3	Cavendish	Very coarse textured fluvial/eolian blanket.	2-5% undulating well to rapidly	O.B (CVD) 60-80%	Eroded soils O.B (BVL) O.B (MAB)	Soils have developed on fluvial sediments retransported by wind. Coarse fragment content generally 0-2% but may approach 10%.
CVPL4/3	Cavendish-Purple Springs	Very coarse textured fluvial/eolian blanket to veneer overlying moderately fine textured till.	2-5% undulating to ridged well to rapidly	O.B (CVD) 30-50% Eroded soils 20-40% O.B (PLS) 20-30%	O.B (MAB) O.B (HMS)	PLS usually occurs in the mid to upper slope positions and CVD occurs in lower to mid slope positions. Eroded soils are common in cultivated polygons. Delineations of this map unit occur mainly from Chin Coulee north to the Burdett region on both the Etzikom and Fincastle Plains.
CVPU5/2-3	Cavendish-Pemukan	Moderately coarse to very coarse, non gravelly to very gravelly glaciofluvial sediments.	0.5-5% undulating to terraced well to rapidly	O.B (PUN) 30-50% O.B (CVD) 20-40% Finer textured soils 20-30%	O.R (EZM)	Finer textured soils include BVL, RAM and KGO. Delineations of this map unit are found exclusively on the deltaic deposits at the west end of the Pakowki Basin. PUN is commonly found at the edges of the terraces.
CVVS1/3	Cavendish-Vendisant	Very coarse textured fluvial/eolian blanket.	2-5% undulating well to rapidly	O.B (CVD) 30-50% R.B (VST) 20-40%	O.R (ATP) Gleyed soils	Soils developed on fluvial sediments retransported by wind. VST usually occurs in the mid slope to crest positions on the windward side of a dune. This map unit describes stabilized dune landscapes.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
CVVS1/4	Cavendish-Vendisant	Very coarse textured fluvial/eolian blanket.	6-9% ridged to hummocky well to rapidly	O.B (CVD) 30-50% R.B (VST) 20-40%	O.R (ATP) Gleyed soils	Soils developed on fluvial sediments retransported by wind. VST usually occurs in the mid slope to crest positions on the windward side of a dune. This map unit describes stabilized dune landscapes.
DHRO1/3	Duchess-Ronalaine	Discontinuous medium textured glaciolacustrine veneer overlying moderately fine textured till.	2-5% undulating well to moderately well	B.SS (DHS) 30-50% SZ.B (ROL) 20-40% O.B (MAB) 15-30%	Saline soils Gleyed soils	DHS and ROL are the primary soils while other Solonetzic soils include WDW, HUK, GEM and HDY. Generally, the Solonetzic soils are found in mid to lower slope positions while the Chernozemic soils are found in the upper slope and crest positions. Blowout pits occupy from 5-40% of the surface area.
GLS1/2 n	Gleddies	Fine textured lacustrine blanket.	0.5-2% concave poorly	R.G-saline (GLS) 60-80%	O.R (WTN) Sz.G Gleyed soils	High watertable with saline and sodic soils. Native vegetation characterized by halophytes such as foxtail barley. Shallow, seasonal basins in coulee bottoms and lake flats. Profiles exhibit dull matrix colours indicative of anaerobic conditions. Clay content may exceed 60%.
GNCG1/3 a	Glenbanner-Craigower	Moderately fine textured glaciofluvial sediments derived from adjacent uplands.	2-5% apron well to moderately well	O.DB (GNN) 30-50% DB.SS (CGW) 20-40%	SZ.DB DB.SO R.DB	Typically coalesced fans with slope lengths often exceeding 200 m. Delineations found on the Cypress Shoulder and Sweetgrass Arch. Chernozemic and Solonetzic soils are distributed randomly in equal proportion within delineations.
GNCG4/3 c	Glenbanner-Craigower	Moderately fine textured glaciofluvial sediments derived from adjacent uplands.	2-5% inclined and rilled well to moderately well	O.DB (GNN) 30-50% DB.SS (CGW) 20-40% Eroded soils 15-40%	SZ.DB DB.SO R.DB	Typically coalesced fans with rill erosion on slopes that often exceed 200 m. Delineations found on the Cypress Shoulder and Sweetgrass Arch. Chernozemic and Solonetzic soils are distributed randomly in equal proportion within delineations.
GNN1/3 a	Glenbanner	Moderately fine textured glaciofluvial sediments derived from adjacent uplands.	2-5% apron well to moderately well	O.DB (GNN) 50-80%	CU.R DB.SO R.DB	Delineations found on the Cypress Shoulder and Sweetgrass Arch. Typically coalesced fans with slope length often exceeding 200 m. Minor rill erosion may occur.
HDRO1/3-4	Halliday-Ronalaine	Medium to moderately fine textured till.	2-9% undulating to hummocky well to moderately well	B.SO (HDY) 30-50% SZ.B (ROL) 20-40% B.SS (HUK) 15-25% O.B (MAB or MSN) 15-25%	Gleyed and Gleysols Eroded soils SZ.B (TIK)	Blowout pits abundant on native range (15-40% of surface area). Some delineations dominated by a single topographic class.
HDRO1/3:R	Halliday-Ronalaine	Medium to moderately fine textured till. Bedrock generally less than 5 m below surface.	2-5% undulating well to moderately well	B.SO (HDY) 20-50% SZ.B (ROL) 20-40% B.SS (HUK) 15-25% O.B (MAB or MSN) 15-25%	Eroded soils SZ.B (TIK) O.B (PHN)	Lithic phases (R within 1 m) may occur in minor amounts where till is thin. Blowout pits abundant on native range (15-40% of surface area).
HDRO1/3 i:R	Halliday-Ronalaine	Medium to moderately fine textured till. Bedrock generally less than 5 m below surface.	2-5% inclined well to moderately well	B.SO (HDY) 20-50% SZ.B (ROL) 20-40% B.SS (HUK) 15-25% O.B (MAB or MSN) 15-25%	Eroded soils SZ.B (TIK) O.B (PHN)	Lithic phases (R within 1 m) may occur in minor amounts where till is thin. Blowout pits abundant on native range (15-40% of surface area). Some rill erosion may occur on the inclined slopes.
HDRO1/4:R	Halliday-Ronalaine	Medium to moderately fine textured till. Bedrock generally less than 5 m below surface.	6-9% hummocky well to moderately well	B.SO (HDY) 20-50% SZ.B (ROL) 20-40% B.SS (HUK) 15-25% O.B (MAB or MSN) 15-25%	Eroded soils Gleyed and Gleysols O.B (PHN)	Lithic phases (R within 1 m) may occur in minor amounts where till is thin. Blowout pits abundant on native range (15-40% of surface area).

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
HDRO1/4 c:R	Halliday-Ronalaine	Medium to moderately fine textured till. Bedrock generally less than 5 m below surface.	6-9% inclined and rilled well to moderately well	B.SO (HDY) 20-50% SZ.B (ROL) 20-40% B.SS (HUK) 15-25% O.B (MAB or MSN) 15-25%	Eroded soils O.B (PHN)	Lithic phases (R within 1 m) may occur in minor amounts where till is thin. Blowout pits abundant on native range (15-40% of surface area). Four or more rills observed per 800 m of cross-slope distance on inclines.
HDRO2/3-4	Halliday-Ronalaine	Medium to moderately fine textured till.	2-9% undulating to hummocky well to poorly	B.SO (HDY) 20-50% SZ.B (ROL) 20-40% Gleyed, Gleysols and Water 15-40%	O.B (MAB or MSN) B.SS (HUK)	Gleysolic soils include KTM (Saline.RG). Poorly integrated drainage network with localized evidence of saline discharge.
HDTI2/2-3	Halliday-Timko	Discontinuous medium textured glaciolacustrine veneer overlying moderately fine textured till.	0.5-5% level to undulating well to poorly	B.SO (HDY) 20-40% SZ.B (TIK) 20-40% Gleyed, Gleysols and Water 15-40%	O.B (MAB and CFD) B.SS (HUK and DHS)	Delineations are primarily recharge zones, but during times of elevated watertables these areas may have been exclusively discharge locations. Some delineations occur in concave settings.
HMCF1/3	Helmsdale-Cranford	Discontinuous medium textured glaciolacustrine veneer overlying moderately fine textured till.	2-5% undulating well to moderately well	Eroded soils (HMS and TVS) 40-70% O.B (CFD) 15-30%	O.B (MAB)	Eroded soils are frequently found in upper slope and crest positions, are often carbonated and have a high pH and low organic matter content. CFD soils tend to occupy the lower slope positions. Used for severely eroded areas which would have been recognized as MACF1 units prior to erosion.
HMS1/4-5	Helmsdale	Medium to moderately fine textured till.	6-15% hummocky to ridged well to moderately well	Eroded soils (HMS and TVS) 40-70% O.B (MAB) 15-30%		Eroded soils are found from mid slope to crest positions, while non-eroded soils are likely to be found in lower slope positions. Eroded soils are often carbonated, have a high pH and low organic matter content. Proportion of eroded soil is lower in delineations located on native range. Some delineations may be dominated by a single topographic class. Coarse and/or stony phases may occur.
HUHD1/3-4 i:R	Hemaruka-Halliday	Medium to moderately fine textured till. Bedrock generally less than 5 m below surface.	6-9% inclined well to moderately well	B.SS (HUK) 20-50% B.SO (HDY) 20-40%	SZ.B (ROL) O.B (MAB and MSN)	Lithic phases (R < 1 m) may occur. The bedrock has a higher salinity and sodicity level than the overlying till. In areas of native range, vegetative cover is sporadic with numerous blowout pits. Slope length exceeds 400 m.
LLD1/2-3 n	Lilydale	Medium textured fluvial and glaciolacustrine blanket.	0.5-5% concave well to moderately well	O.B saline (LLD) 40-60% O.B (CHN and CFD) 15-30%	Gleyed and Gleysols	Fluvial/glaciolacustrine blanket may overlie till or bedrock. Soils may be calcareous or carbonated because of active saline discharge. Vegetation growth within these delineations is typically sparse. The establishment of high water demanding, saline tolerant plant species is recommended for reclaiming these lands.
MA:P2/5	Maleb-Stony Phase	Medium to moderately fine textured till.	10-15% hummocky to ridged well to poorly	O.B (stony MAB) 40-60% Gleyed, Gleysols and Water 15-30% O.B (MAB) 15-30%	SZ.B B.SO	Stony phase describes surface stoniness classes 3-5 (very, exceedingly, and excessively stony). Delineations associated with ablation moraines. Recharge conditions prevail.
MA:P4/4-5	Maleb-Stony Phase	Medium to moderately fine textured till.	6-15% hummocky to ridged well to moderately well	O.B (stony MAB) 40-60% Eroded soils 15-40% O.B (MAB) 15-30%	SZ.B B.SO	Stony phase describes surface stoniness classes 3-5 (very, exceedingly, and excessively stony). Eroded soils typically occupy upper slope and crest positions. Some delineations may be dominated by a single topographic class; additionally some class 6 topography (15-30% slopes) may occur.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
MA:P7/4	Maleb-Stony Phase	Medium to moderately fine textured till.	6-9% hummocky well to moderately well	O.B (stony MAB) 40-60% Solonetzic soils 15-30% O.B (MAB) 15-30%	Eroded soils	Stony phase describes surface stoniness classes 3-5 (very, exceedingly, and excessively stony). Solonetzic soils include HUK, HDY and ROL which occur randomly within delineations. Localized areas of saline discharge may occur.
MAB1/3-4	Maleb	Medium to moderately fine textured till.	2-9% undulating to hummocky well to moderately well	O.B (MAB) 50-80%	O.B (CFD) Eroded soils Gleyed soils	Some delineations may be dominated by a single topographic class.
MAB2/3	Maleb	Medium to moderately fine textured till.	2-5% undulating well to poor	O.B (MAB) 50-70% Gleyed, Gleysols and Water 15-30%	O.B (CFD) Eroded soils	Depressional areas collect runoff and contribute to groundwater recharge. MAB occurs in the lower slope to crest positions.
MAB2/4	Maleb	Medium to moderately fine textured till.	6-9% hummocky well to poorly	O.B (MAB) 50-70% Gleyed, Gleysols and Water 15-30%	O.B (CFD) Eroded soils	Depressional areas collect runoff and contribute to groundwater recharge. MAB occurs in the lower slope to crest positions.
MAB4/4	Maleb	Medium to moderately fine textured till.	6-9% hummocky well to moderately well	O.B (MAB) 40-60% Eroded soils 20-40%	Gleyed and Gleysols O.B (CFD)	Eroded soils include TVS and HMS. Eroded soils associated with upper slope and crest positions.
MAB4/4 c	Maleb	Medium to moderately fine textured till.	6-9% inclined and rilled well to moderately well	O.B (MAB) 40-60% Eroded soils 20-40%	Gleyed and Gleysols O.B (CFD)	Eroded soils, including TVS and HMS, are more common at or near the rills. Inclined slopes exceed 400 m in length; however, some delineations may have a hummocky surface expression superimposed on a general incline.
MAB4/4-5 d	Maleb	Medium to moderately fine textured till.	6-15% inclined and dissected well to moderately well	O.B (MAB) 40-60% Eroded soils 20-50%	Coarse textured soils O.B (stony MAB)	Frequently occurs on the flanks of uplands or adjacent to coulees. Slope length generally exceeds 400 m. Some delineations may have a hummocky surface expression superimposed on a general incline. Eroded soils, including TVS and HMS, are more common at or near the dissections. Some polygons may be dominated by a single topographic class.
MAB4/5	Maleb	Medium to moderately fine textured till.	10-15% hummocky to ridged well to moderately well	O.B (MAB) 40-60% Eroded soils 20-40%	O.B (CFD) Gleyed and Gleysols	Coarse textured and stony soils occur in some polygons. Delineations are usually associated with recessional and terminal moraines. Polygons in cultivated areas have a higher proportion of eroded soils which generally occur in the mid slope to crest positions.
MAB6/4	Maleb	Medium to moderately fine textured till with moderately coarse textured glaciofluvial sediments.	6-9% hummocky to ridged moderately well to rapidly	O.B (MAB) 30-50% Coarser textured soils 20-40% Eroded soils 15-30%	O.B (CFD)	Soil texture is variable. Coarser textured soils include FMT, ANO and MAB. Both the coarser textured and eroded soils tend to occur in upper slope to crest positions while MAB is predominately found downslope of these positions.
MAB7/3-4:R	Maleb	Medium to moderately fine textured till. Bedrock generally less than 5 m below surface.	2-9% undulating to ridged well to moderately well	O.B (MAB) 40-60% Solonetzic soils 15-40%	O.B (CFD) Eroded soils	Rolling bedrock controlled landscape. Some long (> 400 m) slopes occur, increasing the potential for water erosion. Solonetzic soils, including HUK, HDY and ROL, often occur at slope inflections and may be indicative of a shallow lithic contact. On native range, the landscape is characterized by occasional blowout pits. Some polygons may be dominated by a single topographic class.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
MAB7/4	Maleb	Medium to moderately fine textured till.	6-9% hummocky well to moderately well	O.B. (MAB) 40-60% Solonetzic soils 15-40%	Eroded soils Gleyed and Gleysols O.B (CFD)	Solonetzic soils are primarily HUK, HDY and ROL and usually occur in the mid to lower slope positions.
MAB8/4	Maleb	Medium to moderately fine textured till.	6-9% hummocky well to poorly	O.B (MAB) 30-60% Eroded soils 20-40% Gleyed, Gleysols and Water 15-30%	O.B (CFD and CHN)	Depressional areas collect runoff water and contribute to groundwater recharge. Eroded soils (including HMS and TVS) typically occur in upper slope and crest positions.
MAB8/5	Maleb	Medium to moderately fine textured till.	10-15% hummocky well to poorly	O.B (MAB) 30-50% Eroded soils 20-40% Gleyed, Gleysols and Water 15-30%	O.B (CFD and SPS) Solonetzic soils	Depressional areas collect runoff water and contribute to groundwater recharge. Eroded soils, including HMS and TVS, typically occur in upper slope and crest positions. Supraglacial lacustrine parent material may occur on the crests of widely space hummocks.
MAB9/4	Maleb	Medium to moderately fine textured till.	6-9% hummocky well to poorly	O.B (MAB) 30-60% Solonetzic soils 15-30% Gleyed, Gleysols and Water 15-30%	O.B (CFD and SPS) Eroded soils	Solonetzic soils (GEM, TIK, HDY, HUK and ROL) are usually found in mid to lower slope positions while SZ.GL, R.G, and Sa.R.G are found in depressional areas. The soil pattern is indicative of local discharge. Supraglacial lacustrine materials may also occur in some polygons. On native range, the landscape may be characterized by occasional blowout pits.
MAB9/5	Maleb	Medium to moderately fine textured till.	10-15% hummocky well to poorly	O.B (MAB) 30-60% Solonetzic soils 15-30% Gleyed, Gleysols and Water 15-30%	Eroded soils O.B (CFD and SPS)	Solonetzic soils (including HDY, HUK and ROL) are usually found in mid to lower slope positions. while SZ.G, R.G and Sa.R.G are found in depressional areas. The soil pattern is indicative of local discharge. Supraglacial lacustrine materials may occur on the crests of widely spaced hummocks. On native range, the landscape may be characterized by occasional blowout pits.
MACF1/2	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	0.5-2% gently undulating well to moderately well	O.B (MAB) 20-60% O.B (CFD) 20-60%	Eroded soils Gleyed soils O.B (CHN)	The distribution of MAB and CFD soils is random. Delineations of this unit occur north and west of Foremost.
MACF1/2 i	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	0.5-2% inclined well to moderately well	O.B (MAB) 20-60% O.B (CFD) 20-60%	Eroded soils Gleyed soils Solonetzic soils	The distribution of MAB and CFD soils is random. Rill erosion may sometimes occur. Slope length exceeds 400 m.
MACF1/3	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% undulating well to moderately well	O.B (MAB) 20-60% O.B (CFD) 20-60%	Eroded soils O.B (CHN) Gleyed and Gleysols	MAB soils are generally found in the mid slope to crest positions while CFD may be found in the lower slopes positions and in swales.
MACF1/3 c	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% inclined and rilled well to moderately well	O.B (MAB) 20-60% O.B (CFD) 20-60%	Eroded soils Solonetzic soils	Inclined slopes exceed 400 m in length with four or more observed rills in an 800 m cross-slope distance.
MACF1/3 i	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% inclined well to moderately well	O.B (MAB) 20-60% O.B (CFD) 20-60%	Eroded soils O.B (CHN) SZ.B (ROL and TIK)	Rill erosion often present. Slope length exceeds 400 m.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
MACF2/2-3 n	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	0.5-5% concave well to poorly	O.B (MAB) 20-50% O.B (CFD) 20-40% Gleyed, Gleysols and Water 15-30%	O.B (CHN) SZ.B (ROL and TIK)	Delineations in concave settings with surface water collection and groundwater recharge. Delineations receive runoff from adjacent uplands. Gleysolic soils are typically non-saline and eluviated. MAB soils associated with mid slope to crest positions, CFD with lower slope positions.
MACF2/3	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% undulating well to poorly	O.B (MAB) 20-50% O.B (CFD) 20-40% Gleyed, Gleysols and Water 15-30%	O.B (CHN) SZ.B (ROL and TIK) Eroded soils	Delineations characterized by surface water collection and groundwater recharge due to poorly integrated surface drainage network.. Gleysolic soils are typically non-saline and eluviated. MAB soils associated with mid slope to crest positions, CFD with lower slope positions.
MACF3/2-3	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	0.5-5% level to undulating well to poorly	O.B (MAB) 20-50% O.B (CFD) 20-40% Saline soils, Gleyed, Gleysols and Water 15-40%	SZ.B (ROL and TIK)	Discharge, sometimes seasonal, results in upward salt and carbonate movement impairing soil development (calcareous and carbonated phases). Saline, gleyed, Gleysols and water occur in association together and occupy lower slope positions and depressional areas. Some polygons have a concave surface form.
MACF4/3	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% undulating well to moderately well	O.B (MAB) 20-50% O.B (CFD) 20-50% Eroded soils 20-40%	Gleyed and Gleysols SZ.B (ROL and TIK) O.B (CHN)	Some delineations in the ridged, recessional moraine south of Etzikom Coulee have slopes greater than 5% . Eroded soils (including HMS and TVS) are generally found in the upper slope and crest positions.
MACF4/3 c	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% inclined and rilled well to moderately well	O.B (MAB) 20-50% O.B (CFD) 20-50% Eroded soils 20-40%	Gleyed soils SZ.B (ROL and TIK)	Inclined with significant rill erosion. Inclined slopes exceed 400 m in length. Eroded soils include HMS and TVS.
MACF4/3-4:R	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer. Bedrock generally less than 5 m below the surface.	2-9% undulating to ridged well to moderately well	O.B (MAB) 20-50% O.B (CFD) 20-50% Eroded soils 20-40%	SZ.B (ROL and TIK) Gleyed soils	Rolling bedrock controlled landscape. Some long (> 400 m) slopes are present. The potential for water erosion is high. Some polygons may be dominated by a single topographic class.
MACF4/4	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	6-9% hummocky to ridged well to moderately well	O.B (MAB) 20-50% O.B (CFD) 20-50% Eroded soils 20-40%	SZ.B (ROL and TIK) Gleyed and Gleysols	Hummocky moraine with eroded crest and upper slope positions. Eroded soils include HMS and TVS. Lacustrine veneer occurs in the lower slope positions and depressions.
MACF6/3	Maleb-Cranford	Moderately fine textured till with a discontinuous medium to moderately coarse textured glaciofluvial or glaciolacustrine veneer.	2-5% undulating to ridged well to moderately well	O.B (MAB) 20-50% O.B (CFD) 20-50% Coarser textured soils 20-30%	Eroded soils	Coarser textured soils include ANO, PLS, FMT, BVL, RIR and RAM. Stony and gravelly phases may occur.
MACF7/3	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% undulating well to moderately well	O.B (MAB) 20-50% O.B (CFD) 20-40% Solonetzic soils 15-30%	Eroded soils Gleyed and Gleysols	The Solonetzic soil component includes GEM, DHS, TIK, ROL and HDY. Evidence of their presence includes uneven crop height and density on agricultural lands and occasional pitting on native range.
MACF7/3 i	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% inclined well to moderately well	O.B (MAB) 20-50% O.B (CFD) 20-40% Solonetzic soils 15-30%	Eroded soils Saline soils	Inclined with minor rill erosion. Inclined slopes exceed 400 m in length. The Solonetzic soil component includes GEM, DHS, TIK, ROL and HDY. Evidence of their presence includes uneven crop height and density on agricultural lands and occasional pitting on native range.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
MACF8/3	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% undulating well to poorly	O.B (MAB) 20-40% O.B (CFD) 20-40% Eroded soils 20-40% Gleyed, Gleysols and Water 15-30%	O.B (CHN) SZ.B (ROL and TIK)	Delineations characterized by surface water collection and groundwater recharge due to poorly integrated surface drainage network.. Gleysolic soils are typically non-saline and eluviated. MAB soils typically occur in mid slope to crest positions with CFD in lower slope positions.
MACF8/4	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	6-9% hummocky to ridged well to poorly	O.B (MAB) 20-40% O.B (CFD) 20-40% Eroded soils 20-40% Gleyed, Gleysols and Water 15-30%	SZ.B (ROL and TIK) Saline soils	Hummocky moraine with eroded crests and upper slopes. Lacustrine veneer occurs in lower slope positions and depressional areas. Delineations characterized by surface water collection and groundwater recharge due to poorly integrated surface drainage network. Gleysolic soils are typically non-saline and eluviated.
MACF9/3-4	Maleb-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-9% undulating to hummocky well to poorly	O.B (MAB) 20-40% O.B (CFD) 20-40% Gleyed, Gleysols and Water 15-30% Solonetzic soils 15-30%	Saline soils	Some polygons may be dominated by a single topographic class. Solonetzic soils usually occur in lower slope positions adjacent to depressional areas. SZ.G, R.G and Sa. R.G are found in the depressional areas; a pattern indicative of localized discharge.
MALL6/3-4	Maleb-Lilydale	Medium to moderately fine textured till with discontinuous medium to moderately coarse textured fluvial and glaciolacustrine material.	2-9% undulating to hummocky well to moderately well	O.B (MAB) 20-50% Coarser textured soils 15-30% Saline soils (including LLD) 15-30% Eroded soils 15-30%	O.B (CFD)	Coarser soils include BVL, ANO and stony MAB. Widely spaced hummocks with saline discharge common at toe slope positions and in depressional areas between hummocks.
MCA1/4 i	McAlpine	Moderately fine textured till.	6-9% inclined well to moderately well	DB.SS (MCA) 30-50% Other Solonetzic soils 15-30% O.DB (WSM) 15-30%	R.DB (PME)	Other Solonetzic soils are primarily SZ.DB and DB.SO. The high proportion of Solonetzic soils is due to the shallow depth to bedrock (Bearpaw shale). Delineations are found on the Cypress Shoulder above 1110 m.
MHR1/4 i	Maher	Moderately fine textured till.	6-9% inclined well to moderately well	DB.SS (MHR) 30-50% Other Solonetzic soils 15-30% O.DB (TTH) 15-30%	R.DB (WCR)	Other Solonetzic soils are primarily SZ.DB and DB.SO. The high proportion of Solonetzic soils is due to the shallow depth to bedrock (Bearpaw shale). Delineations are found on the Cypress Shoulder between 1000 and 1110 m.
MKR1/3	Milk River	Moderately coarse to moderately fine textured recent fluvial sediments.	2-5% terraced well to moderately well	CU.R (MKR) 20-50% CU.R (VGR) 15-30%	O.HR (SXT) Gleyed soils	Delineations found on the terraces and meander scars of floodplains. Soils are generally immature and have formed in locations prone to flooding and deposition of river and stream sediments of variable texture. Lenses of gravel may occur.
MNA1/3	Minda	Moderately fine textured till veneer overlying residual.	2-5% undulating well to moderately well	DB.SS (MNA) 20-50% O.DB (TTH-Lithic) 20-40% Other Solonetzic soils 15-30%	Coarser textured soils Eroded soils	Delineations are found only on the Cypress Shoulder. The distribution of Solonetzic and Chernozemic soils is related to the chemical variability of the underlying residual materials. Blowout pits common on native range.
MS:P4/5:R	Masinasin-Stony Phase	Medium to moderately fine textured till. Bedrock generally less than 5 m below surface.	10-15% hummocky to ridged well to moderately well	O.B (stony MSN) 40-60% Eroded soils 15-40% O.B (MSN) 15-30%	O.B (MSN-Lithic) Solonetzic soils	Bedrock controlled landscape often with slopes of irregular length and angle; generally occurring on fluted terrain. Stony phase describes classes 3-5 (very, exceedingly, and excessively stony). Eroded soils include R.DB (CLR).
MSCF1/3	Masinasin-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% undulating well to moderately well	O.B (MSN) 20-60% O.B (CFD) 20-60%	Eroded soils Solonetzic soils Gleyed and Gleysols	Soil distribution within delineations tends to be a function of slope position; mid slope to crest positions are usually MSN and the lower slope positions are usually CFD.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
MSCF1/3 i	Masinasin-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% inclined well to moderately well	O.B (MSN) 20-60% O.B (CFD) 20-60%	Eroded soils Solonetzic soils O.B (CHN)	Rill erosion may occur in some delineations. Slope length exceeds 400 m.
MSCF2/3	Masinasin-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% undulating well to poorly	O.B (MSN) 20-50% O.B (CFD) 20-50% Gleyed, Gleysols and Water 15-30%	Solonetzic soils O.B (CHN)	Delineations characterized by surface water collection and groundwater recharge due to poorly integrated surface drainage network. Gleysolic soils are typically non-saline and eluviated. MSN soils typically occur in mid slope to crest positions and CFD in the lower slope positions.
MSCF4/3	Masinasin-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% undulating well to moderately well	O.B (MSN) 20-50% O.B (CFD) 20-50% Eroded soils 20-40%	Gleyed and Gleysols SZ.B (ROL and TIK)	MSN is associated with mid slope to crest positions while CFD is typically found in lower slope positions. Eroded soils (including HMS and TVS) generally occur with MSN in the upper slope and crest positions.
MSCF7/3	Masinasin-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% undulating well to moderately well	O.B (MSN) 20-50% O.B (CFD) 20-40% Solonetzic soils 15-30%	Eroded soils Saline soils Gleyed soils	The Solonetzic soil component includes GEM, DHS, TIK, ROL and HDY. Evidence of their presence includes uneven crop height and density on agricultural lands and occasional pitting on native range.
MSCF7/3 i	Masinasin-Cranford	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% inclined well to moderately well	O.B (MSN) 20-50% O.B (CFD) 20-40% Solonetzic soils 15-30%	Eroded soils Gleyed soils	Inclined with minor rill erosion. Inclined slopes exceed 400 m in length. The Solonetzic soil component includes GEM, DHS, TIK, ROL and HDY. Evidence of their presence includes uneven crop height and density on agricultural lands and intermittent pitting on native range.
MSN1/3	Masinasin	Medium to moderately fine textured till.	2-5% undulating well to moderately well	O.B (MSN) 60-80%	O.B (CFD) Eroded soils Solonetzic soils	Delineations found on the undulating ground moraine of the Lucky Strike Upland and southern Verdigris Plain.
MSN1/3 i:R	Masinasin	Medium to moderately fine textured till. Bedrock generally less than 5 m below surface.	2-5% inclined well to moderately well	O.B (MSN) 60-80%	Solonetzic soils Eroded soils	Inclined bedrock controlled landscape with slopes exceeding 400 m in length. Lithic (bedrock contact at < 1 m) phases may occur. Delineations associated with the Lucky Strike Upland.
MSN1/4	Masinasin	Medium to moderately fine textured till.	6-9% hummocky to ridged well to moderately well	O.B (MSN) 60-80%	Gleyed and Gleysols Eroded soils Solonetzic soils	Delineations associated with the Lucky Strike Upland and Sweetgrass Arch.
MSN1/4 i:R	Masinasin	Medium to moderately fine textured till. Bedrock generally less than 5 m below surface.	6-9% inclined well to moderately well	O.B (MSN) 50-80%	Eroded soils Solonetzic soils	Inclined bedrock controlled landscape with slopes lengths exceeding 400 m. Rill erosion may occur. Delineations associated with the Lucky Strike Upland and the Sweetgrass Arch.
MSN4/3-4:R	Masinasin	Medium to moderately fine textured till. Bedrock generally less than 5 m from surface.	2-9% undulating to ridged well to moderately well	O.B (MSN) 40-60% Eroded soils 20-40%	Solonetzic soils O.B (CFD)	Rolling bedrock controlled landscape. Eroded soils include R.DB (CLR) and usually occur in the upper slope and crest positions. Slopes of irregular length and angle. Some long slopes (> 400 m) are present. The potential for water erosion is high. Some delineations may be dominated by a single topographic class. Delineations associated with the Lucky Strike Upland and the Sweetgrass Arch.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
MSN4/4	Masinasin	Medium to moderately fine textured till.	6-9% hummocky to ridged well to moderately well	O.B (MSN) 40-60% Eroded soils 20-40%	O.B (CFD) Gleyed and Gleysols	Eroded soils usually found on crest and upper slope positions and include R.DB (CLR). Delineations associated with the Lucky Strike Upland and the Sweetgrass Arch.
MSN4/4 c	Masinasin	Medium to moderately fine textured till.	6-9% inclined and rilled well to moderately well	O.B (MSN) 40-60% Eroded soils 20-50%	Solonetzic soils	Inclined with rill erosion with slopes exceeding 400 m. Eroded soils include R.DB (CLR) and are more common at or near rills. Delineations associated with the Lucky Strike Upland and the Sweetgrass Arch.
MSN4/5	Masinasin	Medium to moderately fine textured till.	10-15% ridged to hummocky well to moderately well	O.B (MSN) 40-60% Eroded soils 20-40%	SZ.B (ROL) B.SO (HDY) Gleyed and Gleysols	Eroded soils occur in the mid slope to crest positions. Cultivated delineations have a higher proportion of eroded soils. Delineations associated with the Lucky Strike Upland and the Sweetgrass Arch.
MSN6/5	Masinasin	Medium to moderately fine textured till with moderately coarse textured glaciofluvial material.	10-15% ridged to hummocky rapidly to moderately well	O.B (MSN) 30-50% Coarser textured soils 20-40% Eroded soils 15-30%	SZ.B (ROL) B.SO (HDY)	Stony and gravelly phases of MSN may occur. Glaciofluvial landforms include eskers and kames. Both the coarser textured and eroded soils tend to occur in upper slope and crest positions while MSN is predominantly found downslope of these positions. Delineations associated with the Lucky Strike Upland and the Sweetgrass Arch.
MSN7/3-4:R	Masinasin	Medium to moderately fine textured till. Bedrock generally less than 5 m from surface.	2-9% undulating to ridged well to moderately well	O.B (MSN) 40-60% Solonetzic soils 20-40%	Eroded soils O.B (CFD)	Rolling bedrock controlled landscape. Some long (> 400 m) slopes are present. The potential for water erosion is high. Lithic phases (R < 1 m) may occur. Solonetzic soils (including HUK, HDY and ROL) often occur at slope inflections and may be indicative of a shallow lithic contact. Some delineations may be dominated by a single topographic class. Delineations associated with the Lucky Strike Upland and the Sweetgrass Arch.
MSN7/4-5:R	Masinasin	Medium to moderately fine textured till. Bedrock generally less than 5 m from surface.	6-15% hummocky to ridged well to moderately well	O.B (MSN) 30-50% Solonetzic soils 20-40%	Eroded soils	Rolling bedrock controlled landscape. Lithic phases (R < 1 m) may occur. Solonetzic soils (including HUK, HDY and ROL) often occur at slope inflections and may be indicative of a shallow lithic contact. Some delineations may be dominated by a single topographic class. Delineations associated with the Lucky Strike Upland and the Sweetgrass Arch.
MSN7/5 d	Masinasin	Medium to moderately fine textured till.	10-15% inclined and dissected well to moderately well	O.B (MSN) 30-60% Solonetzic soils 20-40%	Eroded soils	Rolling bedrock controlled landscape with numerous dissections on inclined slopes (inclined slopes exceed 400 m in length). Lithic phases (R < 1 m) may occur. Delineations associated with the Lucky Strike Upland and the Sweetgrass Arch.
ORBU9/2 a	Orion-Bunton	Medium to moderately coarse textured glaciofluvial sediments derived from adjacent uplands.	0.5-2% apron well to poorly	O.R (ORN) 20-40% Coarser textured soils 15-30% O.B (BUT) 15-30% Solonetzic soils 15-30% Gleyed, Gleysols and Water 15-30%	O.R-saline (MCN) GL.OR-saline (SFD) O.HR (SXT)	Delineations associated with coulee bottoms or broad depressional basins (eg. the Murray Lake region). Localized spots of saline discharge occur.
ORSI4/3-5	Orion-Steveville	Medium textured glaciofluvial sediments and moderately fine textured till veneer overlying bedrock.	2-15% undulating to ridged well to moderately well	O.R (ORN) 30-50% B.SS (SIL) 20-40% Eroded soils 20-30%	B.SS (HUK and WDW) B.SO (HDY and KBD) O.B (BUT)	Delineations associated with the Sweetgrass Arch. SIL soils form in marine partings (shale and mudstone) while ORN soils form in non-marine (siltstone and sandstone) sediments. Discontinuous till veneer occurs due to subglacial water scouring at deglaciation. Exposures of bedrock (without soil formation) are common.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
ORWD3/2-3 a	Orion-Wardlow	Medium to moderately fine textured glaciofluvial sediments derived from adjacent uplands.	0.5-5% apron well to moderately well	O.R (ORN) 20-40% B.SS (WDW) 15-40% Saline soils 15-40%	O.B (BUT) CA.B (EXP) Fine textured soils	Saline soils include SFD and MCN. Areas of native range are characterized by sparse vegetative cover and bare soil. Subsoil is weakly to strongly saline. Saline discharge occurs and is a significant problem in delineations which are irrigated and cultivated.
PHCM4/4	Pinhorn-Comrey	Medium to moderately coarse textured residual.	6-9% hummocky to ridged rapidly to moderately well	O.B (PHN) 20-50% O.B (CMY) 20-50% Eroded soils 15-40%	Solonetzic soils O.B (MSN-Lithic)	Delineations occur on the Sweetgrass Arch. PHN typically forms in siltstone and CMR in sandstone. Isolated areas of till veneer may occur.
PHCM7/3-4	Pinhorn-Comrey	Medium to moderately coarse textured residual.	2-9% undulating to ridged rapidly to moderately well	O.B (PHN) 20-50% O.B (CMR) 20-50% Solonetzic soils 15-40%	Eroded soils Gleyed and Gleysols	Isolated areas of till veneer may occur (lithic phases of MSN and ROL). Delineations occur on the Sweetgrass Arch. PHN typically forms in siltstone and CMR in sandstone. The solonetzic soils generally form in marine partings (shale and mudstones) and include B.SS (SIL) and B.SO.
PHMS6/3	Pinhorn- Masinasin	Discontinuous moderately fine textured till veneer to blanket overlying moderately coarse to medium textured residual.	2-5% undulating well to moderately well	O.B (PHN) 20-50% O.B (MSN-Lithic) 20-50% O.B (CMY) 15-30% O.B (MSN) 15-30%	Solonetzic soils Eroded soils	Delineations occur on the Sweetgrass Arch. PHN typically forms in siltstone and CMR in sandstone. A significant area of till blanket (till > 1 m depth) is indicated by the presence of MSN.
PHMS7/3-4	Pinhorn-Masinasin	Discontinuous moderately fine textured till veneer to blanket overlying medium textured residual.	2-9% undulating to ridged well to moderately well	O.B (PHN) 20-50% O.B (MSN-Lithic)20-40% Solonetzic soils 15-40% O.B (MSN) 15-30%	Eroded soils O.B (CMR) Gleyed and Gleysols	Delineations occur on the Sweetgrass Arch. PHN typically forms in siltstone and Solonetzic soils in marine partings (shale and mudstone). A significant proportion of till blanket (till > 1 m depth) is indicated by the presence of MSN. Some polygons may be dominated by a single topographic class.
PHMS7/3 i	Pinhorn-Masinasin	Discontinuous moderately fine textured till veneer to blanket overlying medium textured residual.	2-5% inclined well to moderately well	O.B (PHN) 20-50% O.B (MSN-Lithic) 20-40% Solonetzic soils 15-40% O.B (MSN) 15-30%	Eroded soils O.B (CMR)	Inclined bedrock controlled landscape. Delineations occur on the Sweetgrass Arch. PHN typically forms in siltstone while Solonetzic soils form in marine partings (shale and mudstone). A significant area of till blanket (till > 1 m depth) is indicated by the presence of MSN.
PHMS7/4-5	Pinhorn-Masinasin	Discontinuous moderately fine textured till veneer to blanket overlying medium textured residual.	6-15% hummocky to ridged well to moderately well	O.B (PHN) 20-40% O.B (MSN-Lithic) 20-40% Solonetzic soils 15-40% O.B (MSN) 15-30%	Eroded soils O.B (CMR)	Some units dominated by a single topographic class. Delineations occur on the Sweetgrass Arch. PHN typically forms in siltstone while Solonetzic soils form in marine partings (shale and mudstone). A significant area of till blanket (till > 1 m depth) is indicated by the presence of MSN.
PLMN1/3-5	Philp-Minda	Medium to fine textured residual with a discontinuous medium to moderately fine textured till veneer.	2-15% undulating to ridged well to moderately well	O.DB (PLP) 40-60% DB.SS (MNA) 20-40% Other Solonetzic soils 15-30%	Eroded soils O.DB (PUR) DB.SS (GRG)	Delineations occur on the Sweetgrass Arch. Residual material consists of weathered and glacially modified (reworked residual) softrock sediments with PLP forming in till veneer and reworked non-marine siltstone and MNA in marine partings (shale and mudstone). Bedrock exposures (without soil formation) are common.
PLS4/4	Purple Springs	Very coarse textured fluvial/eolian veneer to blanket overlying moderately fine textured till.	6-9% ridged to hummocky rapidly to moderately well	O.B (PLS) 40-70% Eroded soils 20-50% O.B (CVD) 15-30%	O.B (BVL, ANO, MAB)	Delineation occurs where sand dunes have encroached upon till plains. Eroded soils are most common in cultivated delineations.
PTSI1/2	Patricia-Sterling	Fine textured glaciolacustrine blanket.	0.5-2% gently undulating well to moderately well	B.SS (PTA) 30-50% B.SZ (SIG) 30-50% O.R sa (WTN) 15-40%	B.SO (RMR) SZ.B (MCT) Gleyed soils	Shrink-swell cycles due to variable moisture conditions and high clay content result in large surface cracks.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
PUGR1/3-4:R	Purescape-Grudge	Moderately fine to medium textured till. Bedrock generally less than 5 m below the surface.	2-9% undulating to ridged well to moderately well	O.DB (PUR) 20-50% DB.SS (GRG) 20-40% Other Solonetzic soils 15-30%	O.DB (PUR-Lithic)	Rolling bedrock controlled landscape with irregular slope lengths and angles. The till blanket generally conforms to the underlying surface expression of the bedrock and is usually saline and sodic (explaining the high proportion of Solonetzic soils). Blowout pits are abundant (15-40%) in native range. Delineations occur on the Sweetgrass Arch.
PUGR2/4:R	Purescape-Grudge	Moderately fine to medium textured till. Bedrock generally less than 5 m below the surface.	6-9% hummocky to ridged well to poorly	O.DB (PUR) 20-50% DB.SS (GRG) 20-30% Other Solonetzic soils 15-30% Gleyed, Gleysols and Water 15-30%	Eroded soils O.DB (LUP)	Bedrock controlled landscape with irregular slope length and angles. Depressional areas collect surface water runoff for groundwater recharge but localized discharge also occurs. The till blanket generally conforms to the underlying bedrock surface and is usually saline and sodic (explaining the high proportion of Solonetzic soils). Blowout pits are abundant (15-40%) on native range. Delineations occur on the Sweetgrass Arch.
PULU3/3	Purescape-Lupen	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% undulating well to moderately well	O.DB (PUR)20-50% O.DB (LUP) 20-40% Saline soils 15-30%	Solonetzic soils	Delineations characterized by groundwater discharge. Some delineations have a concave surface expression. Saline soils tend to occupy the lower slope positions and depressional areas. Delineations occur on the Sweetgrass Arch.
PULU7/3	Purescape-Lupen	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% undulating well to moderately well	O.DB (PUR)20-50% O.DB (LUP) 20-40% Solonetzic soils 15-30%	Saline soils Gleyed and Gleysols Eroded soils	The distribution of the major soils are related to slope position; PUR in mid slope to crest positions and LUP and Solonetzic soils in the lower slope positions and depressional areas. Solonetzic soils include DB.SS (GRG), DB.SO and SZ.DB. Blowout pits are common on native range. Delineations occur on the Sweetgrass Arch.
PULU9/3 n	Purescape-Lupen	Moderately fine textured till with a discontinuous medium textured glaciolacustrine veneer.	2-5% concave well to poorly	O.DB (PUR) 20-40% O.DB (LUP) 20-40% Gleyed, Gleysols and Water 15-30% Solonetzic soils 15-30%	Saline soils	Solonetzic soils occur in lower slope positions adjacent to depressional areas. Gleysolic soils are typically non-saline and eluviated. Delineations associated with the Sweetgrass Arch.
PUN5/4-5	Pemukan	Very gravelly, very coarse to moderately coarse glaciofluvial materials.	6-15% ridged to hummocky rapidly to well	O.B (PUN) 30-60% Finer textured soils 20-40%	O.R (EZM) O.B (CVD) O.B (stony MAB)	Ridged and hummocky glaciofluvial landscape. Finer textured soils include RAM and KGO. Profiles often exhibit varying textures and coarse fragment content. Some delineations dominated by a single topographic class and some may have limited areas of 6 topography.
PUPL1/3-4	Purescape-Philp	Medium to moderately fine textured till blanket to veneer overlying medium textured residual and/or reworked residual.	2-9% undulating to ridged well to moderately well	O.DB (PUR) 30-50% O.DB (PLP) 30-50%	O.DB (LUP) Eroded soils Solonetzic soils	Rolling bedrock controlled landscape. Till blanket is generally 5 m or less in depth. PLP occurs where till is a veneer (< 1 m to residual). Delineations associated with the Sweetgrass Arch.
PUPL7/3-4	Purescape-Philp	Medium to moderately fine textured till blanket to veneer overlying medium textured residual and/or reworked residual.	2-9% undulating to ridged well to moderately well	O.DB (PUR) 20-50% O.DB (PLP) 20-50% Solonetzic soils 15-40%	O.DB (LUP) Eroded soils	Solonetzic soils include DB.SS (GRG and MNA), DB.SO and SZ.DB. Soil distribution is related to the variable sodicity of the parent materials and variable depth of the till. Delineations associated with the Sweetgrass Arch.
PUR1/3	Purescape	Moderately fine to medium textured till.	2-5% undulating well to moderately well	O.DB (PUR) 50-80%	Eroded soils Gleyed and Gleysols Solonetzic soils	Delineations occur on the Sweetgrass Arch and are associated with an undulating ground moraine.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
PUR4/3-4 c	Purescape	Moderately fine to medium textured till.	2-9% inclined and rilled well to moderately well	O.DB (PUR) 40-60% Eroded soils 20-40%	O.DB (LUP) Solonetzic soils	Inclined landscape with rill erosion. Delineations occur on the Sweetgrass Arch. Eroded soils include O.R, CA.DB and R.DB (WID) and are more common in areas adjacent to rilling or on steeper slopes. Some dissections may occur.
PUR4/4	Purescape	Moderately fine to medium textured till.	6-9% hummocky to ridged well to moderately well	O.DB (PUR) 40-60% Eroded soils 20-40%	O.DB (LUP) Solonetzic soils	Eroded soils include R.DB (WID) and CA.DB. The eroded soils tend to occur in upper slope and crest positions. Delineations associated with the Sweetgrass Arch.
PUR4/4-5 c:R	Purescape	Moderately fine to medium textured till. Bedrock generally less than 5 m below the surface.	6-15% inclined and rilled well to moderately well	O.DB (PUR) 40-60% Eroded soils 20-40%	Coarser textured soils O.DB (stony PUR) Solonetzic soils	Strongly inclined bedrock controlled landscape. Delineations occur on the flanks of the Sweetgrass Arch. Some dissections may occur. Eroded soils include R.DB (WID) and CA.DB and typically occur adjacent to rills and on steeper slopes.
PUR4/4:R	Purescape	Moderately fine to medium textured till. Bedrock generally less than 5 m below the surface.	6-9% hummocky to ridged well to moderately well	O.DB (PUR) 40-60% Eroded soils 15-40%	Gleyed soils Solonetzic soils	Rolling bedrock controlled landscape. Delineations occur on the flanks of the Sweetgrass Arch. Eroded soils are more common on steep slopes and in upper slope and crest positions.
PUR4/5-6 d	Purescape	Moderately fine to medium textured till.	10-30% inclined and dissected well to moderately well	O.DB (PUR) 40-60% Eroded soils 20-40%	O.DB (PUR) Solonetzic soils Coarser textured soils	Strongly inclined bedrock controlled landscape. Delineations associated with the flanks of the Sweetgrass Arch. Slopes associated with dissections may exceed 30%. Eroded soils include O.R, CA.DB and R.DB (WID) and are associated with steeper slopes, crest and upper slope positions.
PUR7/3-4:R	Purescape	Moderately fine to medium textured till. Bedrock generally less than 5 m below the surface.	2-9% undulating to ridged well to moderately well	O.DB (PUR) 40-60% Solonetzic soils 15-40%	O.DB (LUP) Eroded soils	Rolling bedrock controlled landscape. Delineations associated with the Sweetgrass Arch. Solonetzic soils include DB.SS (GRG), DB.SO and SZ.DB and often occur at slope inflections, a pattern that may be indicative of a shallow lithic contact. Occasional blowout pits occur on native range. Some polygons are dominated by a single topographic class.
PUR7/3 i	Purescape	Moderately fine to medium textured till.	2-5% inclined well to moderately well	O.DB (PUR) 30-60% Solonetzic soils 15-30%	O.DB (LUP) Gleyed and Gleysols Eroded soils	Inclined with rill erosion. Solonetzic soils include DB.SS (GRG), DB.SO and SZ.DB. Delineations associated with the Sweetgrass Arch.
PUR7/4	Purescape	Moderately fine to medium textured till.	6-9% hummocky to ridged well to moderately well	O.DB (PUR) 40-60% Solonetzic soils 15-40%	Eroded soils Gleyed and Gleysols	Delineations associated with the Sweetgrass Arch. Solonetzic soils include DB.SS (GRG), DB.SO and SZ.DB.
PUR7/4 c	Purescape	Moderately fine to medium textured till.	6-9% inclined and rilled well to moderately well	O.DB (PUR) 40-60% Solonetzic soils 15-40%	Eroded soils	Delineations associated with the Sweetgrass Arch. Inclined landscape with rill erosion. Solonetzic soils include DB.SS (GRG), DB.SO and SZ.DB.
PUR7/4 d:R	Purescape	Moderately fine to medium textured till. Bedrock generally less than 5 m below the surface.	6-9% inclined and dissected well to moderately well	O.DB (PUR) 40-60% Solonetzic soils 15-40%	Eroded soils	Inclined and dissected bedrock controlled landscape. Delineations associated with the Sweetgrass Arch. Stony and coarse phases may occur. Solonetzic soils include DB.SS (GRG), DB.SO and SZ.DB.
PUR7/5	Purescape	Moderately fine to medium textured till.	10-15% hummocky to ridged well to moderately well	O.DB (PUR) 40-60% Solonetzic soils 15-40%	Gleyed and Gleysols Eroded soils	Delineations associated with the Sweetgrass Arch. Solonetzic soils include DB.SS (GRG), DB.SO and SZ.DB.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
RAM1/2-3	Ramillies	Medium textured glaciofluvial veneer overlying very coarse, very gravelly glaciofluvial.	0.5-5% undulating to terraced rapidly to moderately well	O.B (RAM) 50-80% O.B (BVL) 15-30%	O.B (MAB and CHN) O.B (PUN and TAB)	Delineations associated with terraced landforms near meltwater channels.
RAM2/2-3 n	Ramillies	Medium textured glaciofluvial veneer overlying very gravelly, very coarse glaciofluvial.	0.5-5% concave well to poorly	O.B (RAM) 40-60% Gleyed and Gleysols 15-30%	O.B (MAB) and PUN) Saline soils	Concave with depressions affected by fluctuating watertable. Till beneath gravels acts as impermeable barrier. Gravels promote movement of water from upslope recharge areas.
RAPU1/2-3	Ramillies-Pemukan	Very gravelly, very coarse glaciofluvial material with discontinuous medium to moderately coarse textured glaciofluvial veneer.	0.5-5% undulating to terraced rapidly to moderately well	O.B (RAM) 30-60% O.B (PUN) 30-60% O.B (KGO) 15-30%	Solonetzic soils Eroded soils	Delineations associated with glaciofluvial terraces adjacent to meltwater channels and deltas (eg. Pakowki Lake delta).
ROSI1/3-4	Ronalaine-Steveville	Medium to moderately fine textured till veneer to blanket overlying residual.	2-9% undulating to ridged well to moderately well	SZ.B (ROL) 20-50% B.SS (SIL) 20-40%	O.B (PHN and CMR) O.B (MAB) B.SO (HDY)	Lithic phases of ROL (till < 1 m) occur. SIL soils typically occupy the eroded pits and form in shale or partings in marine bedrock.
ROSI4/5-6	Ronalaine-Steveville	Medium to moderately fine textured till veneer to blanket overlying residual.	10-30% ridged to steep well to moderately well	SZ.B (ROL) 20-40% B.SS (SIL) 20-40% Eroded soils 20 -40%	O.B (PHN and CMR) O.B (MAB) B.SO (HDY)	Lithic phases of ROL (till < 1 m) occur. SIL soils typically occupy the eroded pits and form in shale or partings of marine bedrock.
SIPH1/2-3	Steveville-Pinhorn	Medium textured residual with a discontinuous medium textured till veneer.	0.5-5% level to undulating well to moderately well	O.B (PHN) 30-50% B.SS (SIL) 20-40% Other Solonetzic soils 15-30%	O.B (CMR and MAB) Eroded soils	Lithic phases (till < 1 m) occur. Other Solonetzic soils include B.SO and SZ.B. Solonetzic soils typically develop on shale or mudstone bedrock partings.
SIPH1/3-4	Steveville-Pinhorn	Medium textured residual with a discontinuous medium textured till veneer.	2-9% undulating to ridged well to moderately well	O.B (PHN) 30-50% B.SS (SIL) 20-40% Other Solonetzic soils 15-30%	O.B (CMR and MAB) Eroded soils	Lithic phases (till < 1 m) occur. Other Solonetzic soils include B.SO and SZ.B. Solonetzic soils are typically developed on shale or mudstone bedrock partings.
SKF7/2 n	Skiff	Moderately fine textured glaciolacustrine blanket to veneer overlying moderately fine textured till.	0.5-2% concave imperfectly to poorly	O.LG (SKF) 30-50% SZ.G 30-50% Gleyed soils 15-30%		Delineations may have fluctuating watertable levels and may be subject to periods of groundwater discharge. Gleyed soils associated with the edges of delineations. Surface often gray in colour.
SKMA1/2-3 n	Skiff-Maleb	Moderately fine to medium textured till with a discontinuous moderately fine textured glaciolacustrine veneer to blanket overlying till.	0.5-5% concave well to poorly	O.LG (SKF) 30-60% O.B (MAB) 20-50% Gleyed soils 15-30%	Solonetzic soils Eroded soils	Typically, poorly drained soils are co-dominant with well and moderately well drained soils. There is a significant component of imperfectly drained soils (Gleyed phases).
TIPT1/2-3	Timko-Patricia	Medium to fine textured glaciolacustrine veneer to blanket overlying moderately fine textured till.	0.5-5% level to undulating well to moderately well	SZ.B (TIK) 20-40% B.SS (PTA) 20-40% Other Chernozemic soils 15-30% Other Solonetzic soils 15-30%	Gleyed and Gleysols Eroded soils	Textures varying from medium to fine occur within delineations. Other Chernozemic soils can include SPS, MCT, CHZ, CHN and TIY. Other Solonetzic soils can include RMR, SIG, DHS, GEM, WDW, KBD and BLP. Delineations associated with preglacial valleys which have been infilled with lacustrine sediments (eg. Medicine Hat Valley).
TTH1/3	Tothill	Moderately fine textured till.	2-5% undulating well to moderately well	O.DB (TTH) 50-80%	Gleyed and Gleysols Solonetzic soils Eroded soils	Delineations found between 1025 and 1110 m on the Cypress Shoulder.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
TTH1/4	Tothill	Moderately fine textured till.	6-9% hummocky to ridged well to moderately well	O.DB (TTH) 50-80%	Gleyed and Gleysols Solonetzic soils Eroded soils	Delineations found between 1025 and 1110 m on the Cypress Shoulder.
TTH4/4	Tothill	Moderately fine textured till.	6-9% hummocky to ridged well to moderately well	O.DB (TTH) 40-60% Eroded soils 20-40%	Gleyed and Gleysols Solonetzic soils	Delineations found between 1025 and 1110 m on the Cypress Shoulder.
TTH4/4 d	Tothill	Moderately fine textured till.	6-9% inclined and dissected well to moderately well	O.DB (TTH) 40-60% Eroded soils 20-40%	Gleyed soils O.DB (stony TTH)	Delineations associated with inclined and dissected flanks of the Cypress Shoulder (1025-1110 m zone). Eroded soils include O.R, CA.DB and R.DB (WCR) and are associated with dissections and strongly inclined slopes.
TTH4/5-6 d	Tothill	Moderately fine textured till.	10-30% inclined and dissected well to moderately well	O.DB (TTH) 30-60% Eroded soils 20-50%	Solonetzic soils O.DB (stony TTH)	Strongly inclined topography with numerous dissections. Delineations associated with flanks of the Cypress Shoulder (1025-1110 m zone). Eroded soils include O.R, CA.DB and R.DB (WCR) and are associated with dissections and the strongly inclined slopes.
TTH7/3 c	Tothill	Moderately fine textured till.	2-5% inclined and rilled well to moderately well	O.DB (TTH) 30-60% Solonetzic soils 20-50%	Eroded soils Gleyed soils	Inclined with rill erosion. Delineations occur between 1025 and 1110 m on the Cypress Shoulder. Solonetzic soils include DB.SS (MHR), DB.SO and SZ.DB and frequently occur at mid and lower slope positions.
TTH7/4	Tothill	Moderately fine textured till.	6-9% hummocky well to moderately well	O.DB (TTH) 30-60% Solonetzic soils 20-50%	Eroded soils Gleyed and Gleysols	Delineations associated with flanks of the Cypress Shoulder (1025-1110 m zone). Solonetzic soils include DB.SS (MHR), DB.SO and SZ.DB and frequently occur in the lower slope positions.
TTH7/4 c	Tothill	Moderately fine textured till.	6-9% inclined and rilled well to moderately well	O.DB (TTH) 30-60% Solonetzic soils 20-50%	Eroded soils Gleyed soils	Inclined with rill erosion. Delineations associated with flanks of the Cypress Shoulder (1025-1110 m zone). Solonetzic soils include DB.SS (MHR), DB.SO and SZ.DB and frequently occur at inflection points and lower slope positions. Some polygons may have a significant proportion of Gleyed, Gleysols and water because of surface water collection between hummocks.
TTH7/5	Tothill	Moderately fine textured till.	10-15% hummocky to ridged well to moderately well	O.DB (TTH) 30-50% Solonetzic soils 20-50%	Eroded soils Gleyed and Gleysols	Delineations associated with flanks of the Cypress Shoulder (1025-1110 m zone). Solonetzic soils include DB.SS (MHR), DB.SO and SZ.DB and frequently occur at inflection points and lower slope positions. Some polygons may have a significant proportion of Gleyed, Gleysols and water because of surface water collection between hummocks.
TTH7/5-6 d	Tothill	Moderately fine textured till.	10-30% inclined and dissected well to moderately well	O.DB (TTH) 30-60% Solonetzic soils 20-50%	Eroded soils O.DB (stony TTH) Gleyed soils	Delineations associated with flanks of the Cypress Shoulder (1025-1110 m zone). Strongly inclined topography with numerous dissections. Slopes associated with dissections may exceed 30%. Solonetzic soils include DB.SS (MHR), DB.SO and SZ.DB.
TTH9/3-4	Tothill	Moderately fine textured till.	2-9% undulating to hummocky well to poorly	O.DB (TTH) 30-50% Solonetzic soils 20-50% Gleyed, Gleysols and Water 15-30%	Eroded soils	Delineations associated with flanks of the Cypress Shoulder (1025-1110 m zone). Solonetzic soils include DB.SS (MHR), DB.SO, SZ.G and SZ.DB and typically occur in the lower slope positions and depressional areas. Some polygons may be dominated by a single topographic class.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
TTMH1/3	Tothill-Maher	Moderately fine textured till.	2-5% undulating well to moderately well	O.DB (TTH) 20-50% DB.SS (MHR) 20-40% Other Solonetzic soils 15-30%	Gleyed and Gleysols Eroded soils	Delineations associated with flanks of the Cypress Shoulder (1025-1110 m zone). Other Solonetzic soils include DB.SZ, DB.SO and SZ.DB.
TTWC1/4 c	Tothill-Woolchester	Moderately fine textured till.	6-9% inclined and rilled well to moderately well	O.DB (TTH) 20-50% R.DB (WCR) 20-40% Other Eroded soils 15-30%	Gleyed soils Solonetz soils	Delineations associated with flanks of the Cypress Shoulder (1025-1110 m zone). Inclined landscape with rill erosion. Eroded soils occur principally at or near the rills.
TTWC7/4	Tothill-Woolchester	Moderately fine textured till.	6-9% hummocky well to moderately well	O.DB (TTH) 20-50% Eroded soils (including WCR) 20-40% Solonetzic soils 20-40%	Gleyed and Gleysols	Delineations associated with flanks of the Cypress Shoulder (1025-1110 m zone). Some areas of class 5 topography may occur. Solonetzic soils include SZ.DB, DB.SO and DB.SS (MHR). Eroded soils generally occur from upper slope to crest positions while Solonetzic soils are found at lower slope positions.
TTWC7/4 c	Tothill-Woolchester	Moderately fine textured till.	6-9% inclined and rilled well to moderately well	O.DB (TTH) 20-50% Eroded soils (including WCR) 20-40% Solonetzic soils 20-40%	Gleyed soils	Delineations associated with flanks of the Cypress Shoulder (1025-1110 m zone). Inclined landscape with rill erosion. Solonetzic soils include SZ.DB, DB.SO and DB.SS (MHR). Eroded soils are associated with the steeper slopes and the Solonetzic soils with the mid to lower slope positions. Some areas of class 5 topography may occur.
VSAT1/4-5	Vendisant-Antelope	Very coarse textured eolian blanket.	6-15% hummocky rapidly to moderately well	R.B (VST) 40-60% O.R (ATP) 30-50%	Gleyed soils R.G (INS) O.B (PLS)	Active and stabilized sand dunes with some slopes exceeding 15%. Trees and shrubs may occur in depressional areas subject to a fluctuating watertable. Some delineations have localized areas with till less than 1 m from the surface.
VSCV:W1/2-3	Vendisant-Cavendish	Very coarse textured fluvial/eolian blanket.	0.5-5% level to undulating well to poorly	GL.RB (gleyed VST) 20-50% O.B (CVD) 15-40% Gleysols and Water 15-25%	O.R (ATP) O.B (PLS)	Delineations are affected by a high watertable. Soils are sub-irrigated, a condition which results in increased vegetative cover and high soil organic matter levels. Gleysolic soils include INS.
WDGE1/3	Wardlow-Gem	Medium to moderately fine textured glaciolacustrine veneer to blanket overlying moderately fine textured till.	2-5% undulating well to moderately well	B.SS (WDW) 20-50% B.SO (GEM) 20-50% Other Solonetzic soils 15-30%	Gleyed and Gleysols	Other Solonetzic soils include KBD, DHS, CHZ and TIK. Blowout pits generally occupy 20% to 40% of the area in delineations occurring on native range.
WDW2/2-3 n	Wardlow	Moderately fine to moderately coarse textured glaciofluvial sediments derived from adjacent uplands.	0.5-5% concave well to poorly	B.SS (WDW) 20-40% Coarser textured soils 20-40% Gleyed, Gleysols and Water 15-30% Other Solonetzic soils 15-30%	O.R (ORN) Saline soils	Other Solonetzic soils include SZ.B, B.SO and B.SZ. Soil textures may vary from sandy loam to silty clay loam. Delineations have surface water collection in depressional areas. Some, in addition, may be affected by seasonal groundwater discharge.
WDW5/2-3 a	Wardlow	Moderately fine to fine textured glaciofluvial sediments derived from adjacent uplands.	0.5-5% apron well to moderately well	B.SS (WDW) 20-40% Finer textured soils 20-40% Other Solonetzic soils 15-30%	O.R (ORN and WTN) O.B (BUT) Gleyed and Gleysols	Surface and parent material textures range from loam to silty clay or clay. Delineations proximal to exposures of Cretaceous Bearpaw shale. Delineations are found only in the watersheds of South and North Manyberries Creeks. Other Solonetzic soils include SZ.B, B.SO and B.SZ.
WDW6/2-3 a	Wardlow	Moderately fine to moderately coarse textured glaciofluvial sediments derived from adjacent uplands.	0.5-5% apron well to moderately well	B.SS (WDW) 20-40% Other Solonetzic soils 15-30% Coarser textured soils 20-40%	O.R (ORN) Gleyed and Gleysols O.B (BUT)	Other Solonetzic soils include SZ.B B.SO and B.SZ. Surface textures range from sandy loam to silty clay loam. Parent material textures range from loamy sand to silty clay loam.

Appendix I. County of Forty Mile Detailed Soil Legend *(Continued)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
WLH7/2 n	Walsh	Fine textured lacustrine blanket.	0.5-2% concave poorly	R.G (WLH) 40-70% SZ.G 20-40%	Gleyed soils Saline soils	Mounded microtopography (rough surface), due to shrink-swell of clay-rich soils, may be evident.
WS:P4/5-6 d	Wisdom-Stony Phase	Moderately fine textured till.	10-30% inclined and dissected well to moderately well	O.DB (stony WSM) 30-50% O.DB (WSM) 20-40% Eroded soils 15-30%		Delineations are confined to areas above 1110 m on the Cypress Shoulder. Eroded soils include R.DB (PME). Stony phases describes classes 3 to 5 (very, exceedingly, and excessively stony).
WSM1/3	Wisdom	Moderately fine textured till.	2-5% undulating well to moderately well	O.DB (WSM) 50-80%	Gleyed and Gleysols Solonetzic soils Eroded soils	Delineations are confined to areas above 1110 m on the Cypress Shoulder.
WSM1/4	Wisdom	Moderately fine textured till.	6-9% hummocky to ridged well to moderately well	O.DB (WSM) 50-80%	Gleyed and Gleysols Solonetzic soils Eroded soils	Delineations are confined to areas above 1110 m on the Cypress Shoulder.
WSM4/5-6 d	Wisdom	Moderately fine textured till.	10-30% inclined and dissected well to moderately well	O.DB (WSM) 40-60% Eroded Soils 20 -40%	Solonetzic soils Gleyed and Gleysols	Delineations are confined to areas above 1110 m on the Cypress Shoulder and are inclined and steeply sloping with numerous dissections. Eroded soils include R.DB. (PME)
WSM7/4	Wisdom	Moderately fine textured till.	6-9% hummocky to ridged well to moderately well	O.DB (WSM) 40-60% Solonetzic soils 15-30%	Eroded soils Gleyed and Gleysols	Delineations are confined to areas above 1110 m on the Cypress Shoulder. Solonetzic soils include DB.SS (MCA), DB.SO and SZ.DB. Some delineations have areas of class 3 topography.
WSM7/5-6 d	Wisdom	Moderately fine textured till.	10-30% inclined and dissected well to moderately well	O.DB (WSM) 30-60% Solonetzic soils 15-30%	Eroded soils Gleyed and Gleysols	Delineations are confined to areas above 1110 m on the Cypress Shoulder. Solonetzic soils include DB.SS (MCA), DB.SO and SZ.DB. Delineations are inclined and steeply sloping with numerous dissections. Slopes associated with dissections may exceed 30%.
WSM9/5	Wisdom	Moderately fine textured till.	10-15% hummocky to ridged well to poorly	O.DB (WSM) 30-50% Gleyed, Gleysols and Water 15-40% Solonetzic soils 15-30%	Eroded soils	Delineations are confined to areas above 1110 m on the Cypress Shoulder. Solonetzic soils (including DB.SS (MCA), DB.SO, SZ.G and SZ.DB) are associated with lower slope positions and depressional areas.
WSPM7/4 d	Wisdom-Plume	Moderately fine textured till.	6-9% inclined and dissected well to moderately well	O.DB (WSM) 30-50% Eroded soils (including PME) 20-40% Solonetzic soils 15-30%		Delineations are confined to areas above 1110 m on the Cypress Shoulder. Solonetzic soils include DB.SS (MCA), DB.SO and SZ.DB. Delineations have inclined slopes with numerous dissections. Slopes associated with dissections range from 10 - 30%.
WTN3/2	Weston	Fine textured glaciolacustrine blanket.	0.5-2% gently undulating well to moderately well	O.R (WTN) 50-70% Saline soils 15-30%	R.G-saline (GLS) B.SZ (SIG) B.SS (PTA)	Delineations associated with coulee bottoms and the Pakowki Basin.
YNY2/2-3	Yarnley	Very coarse textured fluvial/eolian blanket.	0.5-5% level to undulating well to poorly	B.SS (YNY) 40-60% Gleyed and Gleysols 20-40%	O.B (CVD and KGO) B.SS (RHS and YTW) O.R (EZM)	Delineations found in the Pakowki Basin, typically on beach deposits with cobbly and stony surfaces, where the fluctuating watertable is often close to the surface. Subsoil may be indurated. Gleysols include R.G (INS).

Appendix I. County of Forty Mile Detailed Soil Legend *(Concluded)*

Soil Map Unit	Series Name(s)[1]	Parent Material[2] and Texture[3]	Slope, Surface Form, and Drainage[3]	Major Soils[1,3]	Minor Soils (<15% each)[1,3]	Comments
ZAV1	Alluvium	Variably textured, undifferentiated channel materials.	All Slope Classes	Chernozemics Regosolics Solonetzics	Gleysolics	Includes channel bottomlands and sideslopes where the flood-plain occupies more than 50% of a delineation's width. Some delineations join County of Warner delineations of MCN7/3.
ZAV3	Alluvium	Variably textured, undifferentiated channel materials.	All Slope Classes	Chernozemics Regosolics Solonetzics	Gleysolics	Includes channel bottomlands and sideslopes with dominant or localized salinity. Floodplain occupies more than 50% of the width of the delineation.
ZCV	Colluvium	Moderately fine to fine textured, slumped colluvial Bearpaw shale sediments, with occasional till stones on the surface.	2-30% inclined to hummocky	Regosolics		Active wind (deflation hollows) and water erosion (channels) with interspersed horizontal juniper (Juniperus horizontalis) shrub cover. Critical habitat for the Eastern Short Horned Lizard (Powell L., Biology Dept., Univ. of Calgary, 1993 pers. comm.). Greater than 60% bedrock exposures.
ZDL	Disturbed Land	Variably textured, undifferentiated materials.		Undifferentiated		Land disturbed by human activity including resource extraction and community development.
ZRB1	Rough Broken	Variably textured, undifferentiated rough broken land.	Slope Class 5 or Greater	Chernozemics Regosolics Solonetzics		Less than 10% bedrock exposures. Delineations occur on strongly sloping flanks of glacial spillways and major river valleys.
ZRB2	Rough Broken	Variably textured, undifferentiated rough broken land with significant bedrock outcrops.	Slope Class 5 or Greater	Chernozemics Regosolics Solonetzics		10-to 60% bedrock exposures with sparsely vegetated surfaces. Delineations occur on strongly sloping flanks of glacial spillways and major river valleys.
ZRB3	Rough Broken	Variably textured, undifferentiated rough broken land with dominant bedrock outcrops.	Slope Class 5 or Greater	Chernozemics Regosolics Solonetzics		Greater than 60% bedrock exposures with sparsely vegetated surfaces. Delineations occur on strongly sloping flanks of glacial spillways and major river valleys.
ZRB4	Rough Broken	Variably textured, undifferentiated rough broken land. Erosional channels.	Slope Class 5 or Greater	Chernozemics Regosolics Solonetzics		Delineations confined to modern erosional channels which are typically narrow and v-shaped. Minor floodplain or narrow channel width with steep sideslopes.
ZWW	Water					Semi-permanent and permanent water bodies.

[1] Refer to Table 3 (Soil Series Key) pages 15 - 18
[2] Refer to Appendix F (Glossary).
[3] Refer to Appendix H (Information to Assist the User with this Soil Survey Report).