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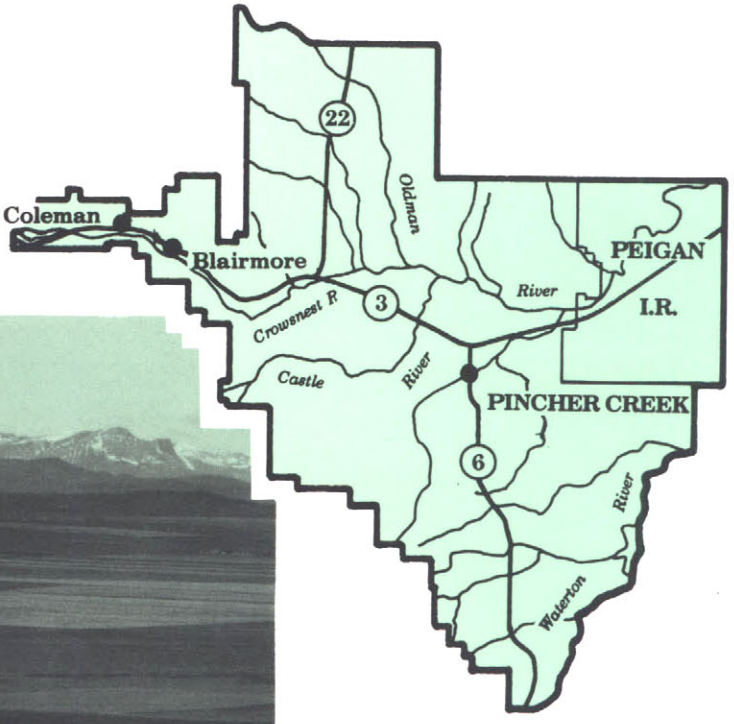
Soil survey of the Pincher Creek-Crowsnest Pass area, Alberta

Report No. 50
Alberta Soil Survey

1991



Canada

SOIL SURVEY OF THE PINCHER CREEK-CROWSNEST PASS AREA, ALBERTA

Alberta Soil Survey Report No. 50

B.D. Walker, J.A. Brierley and G.M. Coen

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PREFACE

Soil surveys have been ongoing in Alberta since the early 1920's. Their purpose is to provide basic information on the province's soil resources. Most of the settled portions of Alberta have been covered by generalized, small scale, soil surveys. Yet several areas require resurvey and updating to current standards, particularly those areas covered by the earliest surveys. In recent years, resurveys that provide greater detail have been conducted within the boundaries of local administrative areas, usually the county or municipal district.

The Municipality of Crowsnest Pass and most of the Municipal District of Pincher Creek were initially included in the early "Soil Survey of the Lethbridge and Pincher Creek Map Sheet" (Wyatt *et al.* 1939). During the 1960's, parts of southwestern Alberta were resurveyed by Agriculture Canada personnel, again at a generalized scale, to provide information for the Canada Land Inventory maps. This resurvey covered the Municipality of Crowsnest Pass and part of the Municipal District of Pincher Creek. But the basic soil information was never fully correlated and published.

In 1985 the soil survey of the Pincher Creek-Crowsnest Pass area was initiated. It is one in a series of survey projects to update the soil information for southwestern Alberta. The others include Warner County (Kjearsgaard *et al.* 1986) and Cardston M.D. (Brierley *et al.* In press). This soil information complies with semi-detailed level (Survey Intensity Level 3) specifications (E.C.S.S. 1987a). Field work on the Pincher-Crowsnest project was completed in 1987.

ACKNOWLEDGEMENTS

The soil survey of the Pincher Creek-Crowsnest Pass area was conducted by personnel of Agriculture Canada's Soil Survey Unit based in Edmonton, Alberta. The support and interaction of Alberta Research Council's Environmental Research and Engineering Department and the Alberta Institute of Pedology, University of Alberta, is gratefully acknowledged.

Other persons and organizations recognized for their contributions and assistance during the course of this survey project are:

Soil landscape mappers J.A. Brierley, M. Fawcett, A.T. Rodvang, J. Tajek, and B.D. Walker.

Field assistants Jim Bradley, Mark Fawcett, Tom Messier, Rhonda Penny, Lester Perrot, and David Zadnik.

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Soil classification and mapping correlators G.M. Coen, W.W. Pettapiece and J.A. Shields.

C. Richter who compiled the generalized maps for the report; R. Swenson who drafted the generalized maps and other figures for the report.

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Farmers, ranchers and other land owners throughout the survey area who allowed surveyors access to their land so that the survey project could proceed to completion. In particular, the C. Smyth family of Cowley is gratefully acknowledged for providing rental accommodation and other field support.

ABSTRACT

The Pincher Creek-Crowsnest Pass area, located in the southwestern corner of Alberta, includes the Municipal District of Pincher Creek (No. 9) and the Municipality of Crowsnest Pass. Approximately 270 000 ha were mapped at a scale of 1:50 000 to show landscape relationships and the distribution of soils classified at the series level in the accepted Canadian taxonomy.

The recognized soil series and equivalents, taxadjuncts and variants, were organized into 78 soil units, each representing a geographic grouping of soils. The soil units were subdivided into 126 map units according to repeating topographic classes. Map units represent segments of the landscape that can be seen on the ground and delineated on a map. Thirteen miscellaneous units were added to bring total mapping units for the area to 139, excluding water bodies.

The main part of this report briefly describes the location and extent, population and land use, physiography, climate, vegetation, and surficial geology of the survey area. Soil classification and mapping procedures are outlined, and the generalized distribution of soils is described in terms of physiographic subdivisions. Soil degradation, with emphasis on erosion, is also briefly described.

Appendices provide more detailed technical and descriptive information. Soils are described at the most detailed level of classification, the series level, in Appendix A. The soil, map and miscellaneous units are described in some detail in Appendix B. Appendix C contains interpretive and land capability information for selected agricultural land uses, namely arable agriculture, irrigation and rangeland. A glossary of terms used throughout the report is provided in Appendix D.

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GENERAL DESCRIPTION OF THE AREA

LOCATION AND EXTENT

The Pincher Creek-Crowsnest Pass survey area covers approximately 271 000 ha (668 000 ac) nestled against the Rocky Mountains in southwestern Alberta (Fig. 1). It occurs within latitude 49° 05' and 49° 55'N, longitude 113° 30' and 114° 45'W. Two locally administered areas are included - the Municipal District of Pincher Creek (M.D. No. 9) and the Municipality of Crowsnest Pass.

All of Pincher Creek M.D. except the Peigan Indian Reserve (No. 147) was surveyed. The mapped area is nearly 248 000 ha (612 000 ac).

The boundary of the Municipality of Crowsnest Pass has changed several times in the last few decades and is still tentative. This soil survey covers the area recorded by the Municipality's 1986 land ownership map, plus 15 sections (3900 ha) around Grassy Mountain and Gold Creek and 2 sections (500 ha) south of Burmis. The added areas were once part of the Municipality and were included in an earlier unpublished soil survey. The mapped area of the Municipality of Crowsnest Pass plus associated lands totals nearly 23 000 ha (56 000 ac).

POPULATION AND LAND USE

The population of the surveyed area was 14 095 in 1986 (A.B.S.M., *pers. comm.* 1988)[1]. Slightly over one half (7183) were located in Pincher Creek M.D. (excluding the Peigan Indian Reserve), the remainder (6912) in the Municipality of Crowsnest Pass.

In the Municipality of Crowsnest Pass, most of the populace resides in five towns or villages: Bellevue, Blairmore, Coleman, Frank, and Hillcrest. The largest town in Pincher Creek M.D. is Pincher Creek (pop. 3800).

Agriculture has provided the impetus for this soil survey and is important in Pincher Creek M.D. In 1986, 440 farm and ranch operations with over $2500 gross annual farm sales were headquartered in the M.D. (Alberta Agriculture, Statistics Branch, *pers. comm.* 1988). About 67% were mainly dependent on cattle, 15% on wheat and other small grains.

Cultivated land headquartered in Pincher M.D. in 1986 was about 31% of total farm and range lands (Alberta Agric., Stat. Br., *pers. comm.* 1988). This varied from about 10% in the northern part of the M.D., including the Porcupine Hills, to nearly complete coverage on the Cowley Basin (Fig.2). Only about 1% of cultivated land was irrigated. Roughly 28% of cultivated land was used for forage production. Pasture land headquartered in Pincher M.D. in 1986 was about 69% of total farm and range lands. Pasture land includes improved and unimproved pasture and woodland grazing areas.

Other industries are perhaps more important to the M.D. of Pincher Creek economy than agriculture. The natural gas industry currently constitutes about 60% of its tax base (M.D. of Pincher Creek, No. 9, *pers. comm.* 1988). Tourism dollars including those gained by non-commercial hunting and fishing are also important.

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1. Extracted from Statistics Canada data by Alberta Bureau of Surveying and Mapping, Edmonton, Alberta.

Agriculture is of little economic importance in the Municipality of Crowsnest Pass. Grazing, especially woodland grazing, is likely the most important of the agricultural industries. Coal and related support industries are ranked number one (Municipality of Crowsnest Pass, Economic Development, *pers. comm.* 1988). The lumber industry and tourism are also important. The area has a sulfur plant, a limestone quarry, a large construction company, and is trying to attract manufacturing industries. Rail and truck transportation is important since the area straddles one of Canada's three main corridors through the western mountains.

LEGEND

11	Blackfoot and Calgary sheet
12	Rosebud and Banff sheet
13	Wainwright and Vermilion sheet
14	Peace Hills sheet
15	Rycroft and Watino sheet
16	Red Deer sheet
17	High Prairie and McLennan sheet
18	Grande Prairie and Sturgeon Lake sheet
19	Rocky Mountain House sheet
20	Beaverlodge and Blueberry Mountain sheet
21	Edmonton sheet
22	St. Mary and Milk River project
23	Cherry Point and Hines Creek area
24	Buck Lake and Wabamun Lake area
25	Grimshaw and Notikewin area
26	Hotchkiss and Keg River area
27	Whitecourt and Barrhead area
28	Chip Lake area
29	Tawatinaw map sheet 831
30	Mount Watt and Fort Vermilion area
31	Hinton-Edson area 83F
31a	North Saskatchewan River Valley
33	Waterton Lakes National Park
34	Sand River sheet
35	Two Hills county
36	Oyen sheet
38	Elk Island National Park
39	Wapiti Map area
40	Brazeau Dam
41	Newell county
42	Athabasca oil sands area
43	Iosegun sheet
44	Banff-Jasper National Parks
45	Calgary Urban Perimeter
46	Warner county
47	County of Beaver
48	Cardston M.D.
49	County of Paintearth
50	Pincher Creek-Crowsnest Pass area
51	County of Flagstaff
82H/NW	Lethbridge
82H/NE	Lethbridge
72L	Medicine Hat (maps)
58-1	Preliminary
59-1	Preliminary
60-1	Preliminary
61-1	Preliminary
62-1	Preliminary
63-1	Preliminary
64-1	Preliminary
64-2	Preliminary

Note: Reports published prior to 1942 are out of print but may be obtained on loan from the Alberta Soil Survey.

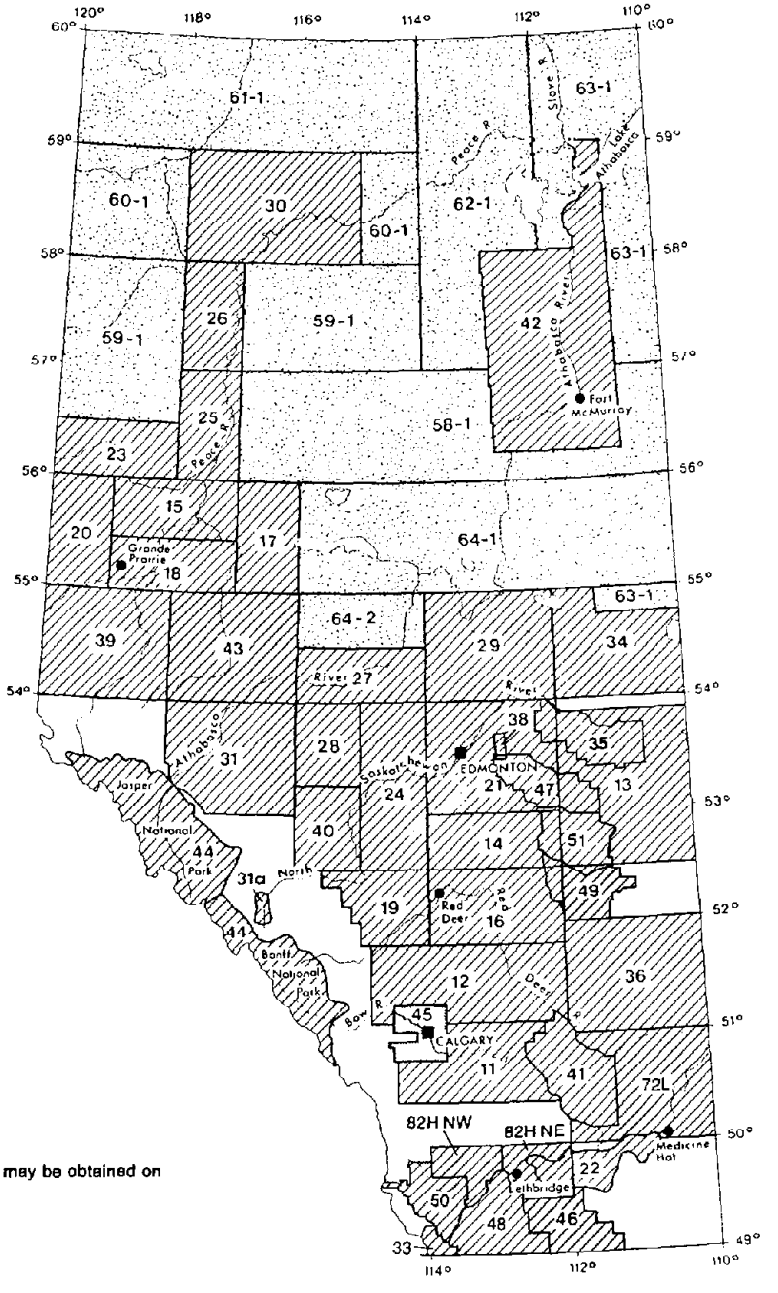


Figure 1. Location map of the Pincher Creek-Crowsnest Pass area, and other soil surveys in Alberta.

PHYSIOGRAPHY AND BEDROCK GEOLOGY

The Pincher Creek-Crowsnest Pass survey area spans or touches six physiographic districts, based on the physiographic subdivisions of Alberta (Pettapiece 1986). The six districts (Fig. 2) are: Front Ranges, Clark Range, Southern Foothills, Cardston Plain, Porcupine Hills, and Three Rivers Plain. Eight additional subdivisions, called subdistricts, were differentiated for this project (Fig. 2). They were distinguished on the basis of different geologic, geomorphic, topographic, and soil patterns.

The Front Ranges and Clark Range belong to the Rocky Mountains Region, the Southern Foothills to the Rocky Mountain Foothills Region. All three are part of the Canadian Cordilleran Division (Pettapiece 1986). The Cardston Plain, Porcupine Hills, and Three Rivers Plain belong to the Southern Alberta Upland Region which is part of the Interior Plains Division.

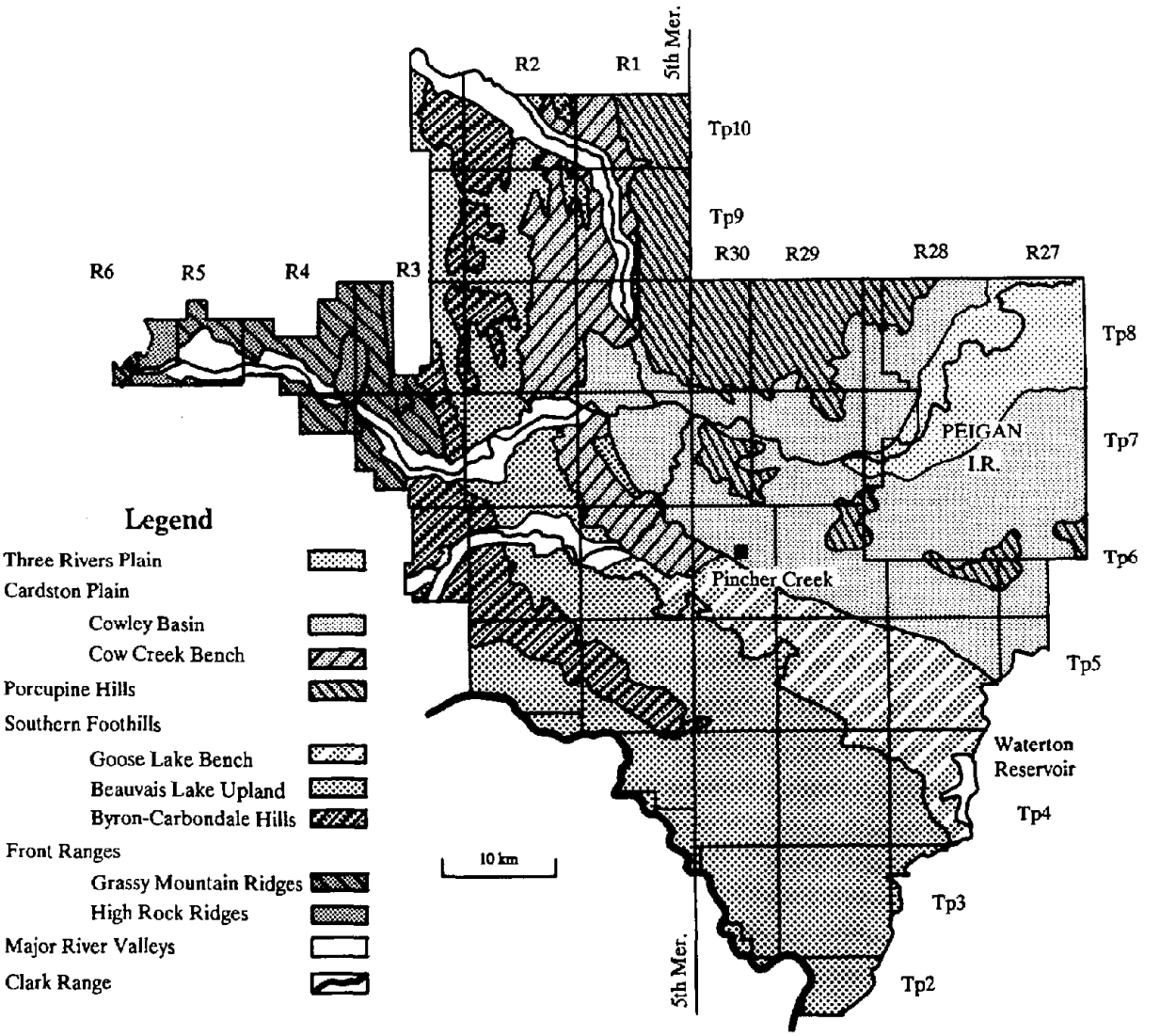


Figure 2. Physiographic subdivisions of the Pincher-Crowsnest area (modified from Pettapiece 1986).

Climate, soils, topography, and surficial materials are extremely variable due to the physiographic extremes across the survey area (Fig. 3). Nowhere else in Alberta do Dark Brown soils of the semi-arid plains exist within 50 km of well developed Luvisolic soils on subhumid mountain slopes under coniferous forest.

The Cardston Plain District

The Cardston Plain (Pettapiece 1986) is an extensive, level to gently sloping plain (Fig. 2). It stretches westward from the Brocket and Springridge areas past Pincher Creek townsite (Fig. 4) to the Cowley-Lundbreck area, then northward in the Oldman R. basin to the Maycroft area.

Elevations range from about 1050 m (3500 ft) in the Brocket area to 1350 m (4500 ft) in the Maycroft area. Despite this overall range, local relief ranges from a few meters to about 90-120 m (300-400 ft) next to deeply incised river valleys. Relatively soft bedrock strata, belonging to the Willow Creek, Brazeau and Porcupine Hills formations (Fig. 5; Green 1972), contribute to the very subdued terrain. Prominent bedrock controlled ridges and hills, like the ridge southwest of Cowley, exaggerate local relief, but are actually outliers of the Southern Foothills and Porcupine Hills.

The Cardston Plain district can be subdivided, on the basis of surficial materials and soil patterns, into lower and upper sectors or subdistricts.

The **Cowley Basin**, or lower sector, subtly rises to an elevation of nearly 1200 m (3900 ft), equivalent with the 2HA-3H agroclimate boundary (Fig. 14). This glacial lake basin is dominated by fine textured glaciolacustrine sediments. Local relief is negligible across the level, undulating and inclined landform surfaces, except where cut by deeply incised river valleys. Virtually all of the area is cultivated, and its dominant soils are eroded Black and Dark Brown. Native vegetation, although rarely present, is fescue grassland. Lakes and sloughs are not common; most occur in the Fishburn area near Rouleau Lake.

The **Cow Creek Bench**, or upper sector, extends northward from Lundbreck to the Maycroft area, above about 1200 m (3900 ft). Major surficial materials are glaciolacustrine sediments in low lying basins, mixed till plus glaciolacustrine deposits, glaciofluvial and related ice contact deposits near river valleys, and till on the flanks of adjacent districts. Landforms have undulating, inclined, ridged, and, occasionally, hummocky or rolling surface expressions. Cultivation is common, and a variety of Black soils are characteristic, including some which have been eroded. Native vegetation, where present, is fescue grassland. Very few lakes and sloughs are present.

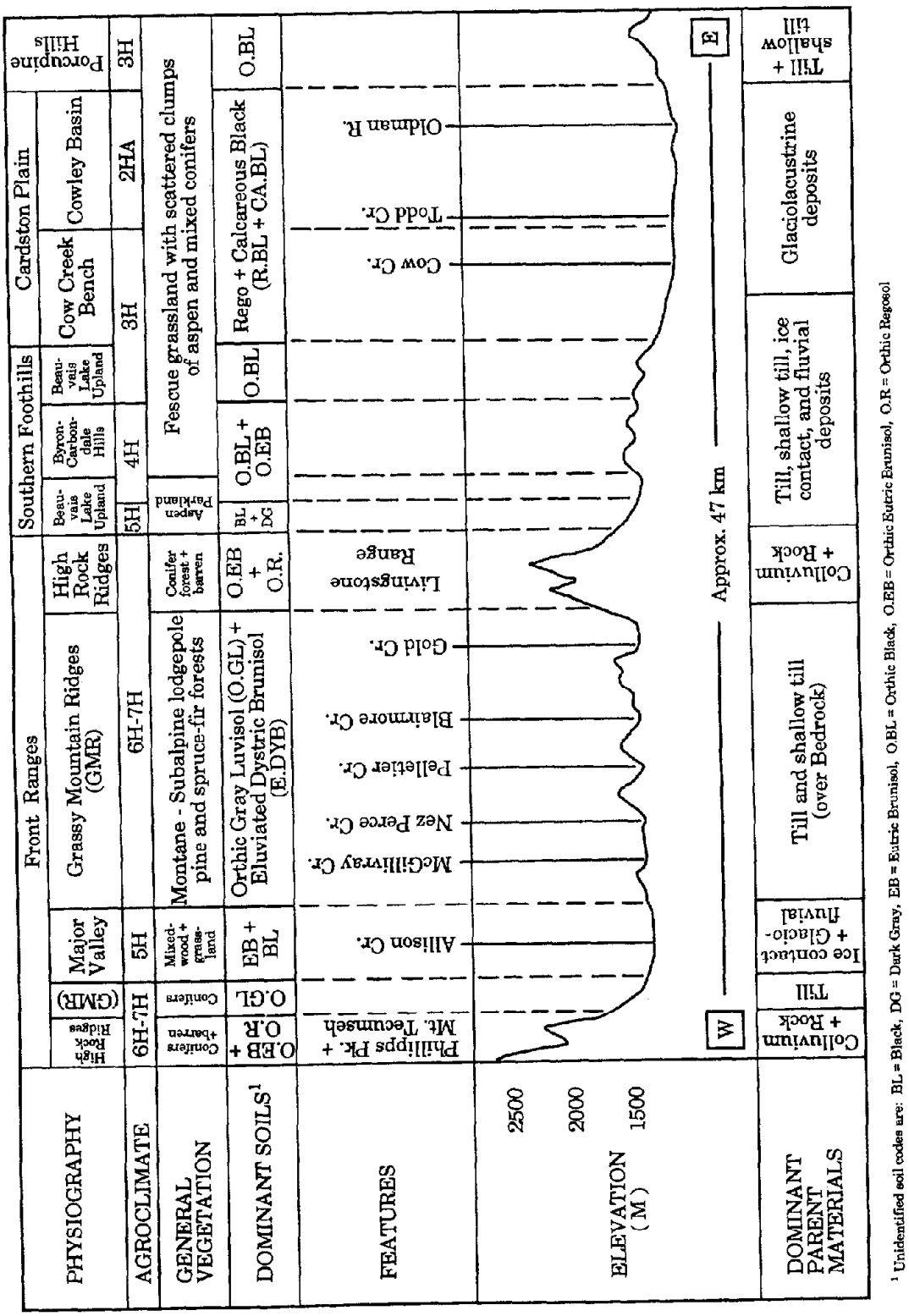
The Three Rivers Plain District

The Three Rivers Plain is much like the Cardston Plain, differing mainly in surficial materials. Medium textured fluviolacustrine and fluvial deposits or medium to fine textured glaciolacustrine sediments, sometimes overlying till, are important. Only the northwestern tip touches the survey area, at about 1050 m elevation in the Brocket area (Fig. 2). Most is cultivated and the soils are eroded Dark Brown.

The Porcupine Hills District

The Porcupine Hills (Pettapiece 1986) form a conspicuous rasp-like cluster of hills (Fig. 6) in the northeastern part of the survey area (Fig. 2). Very gently dipping sandstone and

shale strata of the Porcupine Hills Formation underlie the area (Fig. 5; Green 1972, Beaty 1975). The relatively thin, nearly horizontal beds, often with alternating resistances to erosion, impart a characteristic terraced or "stair-step" pattern to individual hills.



[1] Unidentified soil codes are: BL = Black, DG = Dark Gray, EB = Eutric Brunisol, O.BL = Orthic Black, O.EB = Orthic Eutric Brunisol, O.R = Orthic Regosol

Figure 3. Schematic west to east cross-section showing physiographic, climatic, and soil variability across the survey area.

Elevations range from about 1200 m (3900 ft) where the Porcupine Hills meet the Cardston Plain to 1650 m (5400 ft) along the M.D. boundary at the head of Cabin Creek. Local relief varies from about 250 m (800 ft) near the M.D. boundary to 150 m (500 ft) around the margin of the Porcupines and on outliers. A dense network of small, usually seasonal streams drain the area. Very few sloughs and lakes are present; many streams have been dammed to provide water for livestock.

A discontinuous veneer to blanket of mixed till covers the ridges and hills. Deeper tills, sometimes with fluvial fan and apron overburden, occupy many of the valleys. The tills are medium textured with variable coarse fragment content (2-35%). Mixed glaciolacustrine and till deposits extend from the Cardston Plain into valleys and benchlands around the margin of the Porcupines. These are fine to medium textured.

Native vegetation for most of the southern Porcupine Hills is fescue grassland. Most of gentler sloping terrain in the valleys and benchlands at the edge of the Porcupine Hills has been cultivated. A variety of Black soils, including some which have been eroded, are characteristic of grassland and cultivated sectors. In the driest windiest locales across the south end of the Porcupines, soils often have very thin topsoil (Ah horizon).

Relatively steep, north- to east-facing slopes along the M.D. boundary are covered by Douglas fir forest that includes spruce on the moistest sites. Associated soils, Orthic Dark Grays and Dark Gray Luvisols, have weakly leached, grayish topsoil (Ahe horizon).

The Southern Foothills District

The Southern Foothills (Pettapiece 1986) feature long, low, roughly parallel ridges with a general southeast-northwest orientation (Fig. 7). Intricately faulted and folded rocks of the Brazeau Formation, Alberta Group and various other Mesozoic formations (Fig. 5; Green 1972) control this ridged pattern. Faulted and folded bedrock is the result of tectonic activity - the same if perhaps less powerful mountain-building forces that formed the more impressive mountain structures to the west. The foothills constitute the eastern fringe of this orogenic zone (Fig. 2).

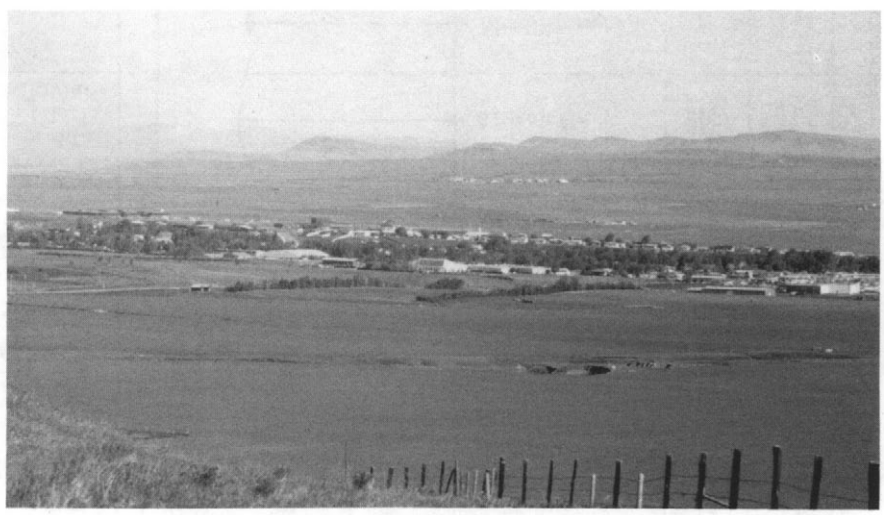
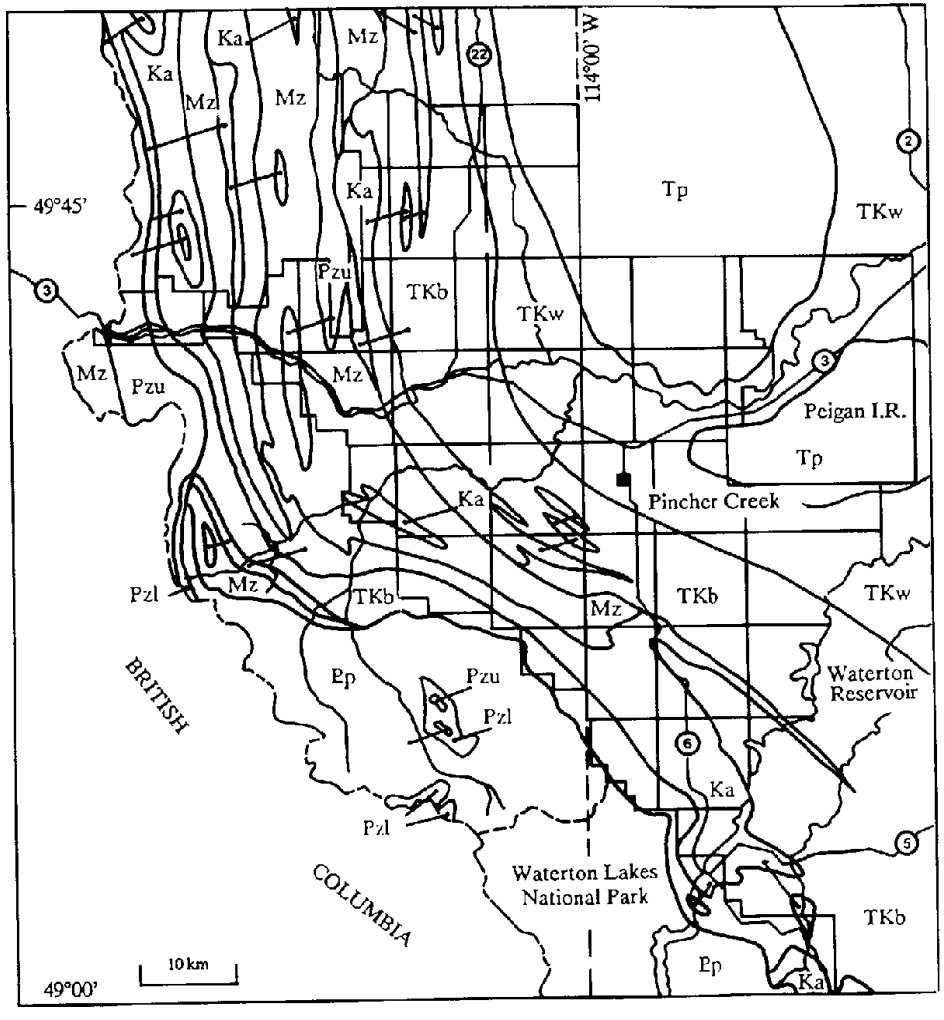


Figure 4. Pincher Creek townsite on the Cardston Plain. Note the Porcupine Hills in the right background.



LEGEND

Tertiary (T) (youngest rocks)

- Porcupine Hills Formation — Tp
- Willow Creek Formation — TKw
- Brazeau Formation (includes Belly River, Bearpaw & St. Mary River formations) — TKb

Cretaceous (K)

- Alberta Group — Ka

Mesozoic (M)

- Lower Cretaceous, Jurassic & Triassic (includes Blairmore & Fernie groups, Kootenay Formation) — Mz

Paleozoic (P)

- Upper Paleozoic (includes Livingstone, Exshaw, Banff, Palliser & other formations) — Pzu
- Lower Paleozoic — Pzl

Proterozoic (P) (oldest rocks)

- Purcell Group — Ep

Figure 5. Generalized bedrock geology of Southwestern Alberta, after Green (1972).

Weathering and erosion, including glacial activity, have further modified landscapes by wearing down uplifted structures. Sandstones tend to be more resistant to erosive forces than are shales and other fine-grained rocks, and generally form the ridges in the foothills. Bedrock under the highest, most rugged parts of the Southern Foothills, called the Byron-Carbondale Hills subdistrict, is dominantly sandstones of the Alberta and Blairmore groups (Price 1962). These are shown as the Alberta Group and undivided Lower Cretaceous plus Jurassic rocks in Fig. 5.

Valleys, benchlands and other lower lying areas tend to be cut into shales and other recessive rocks. The most muted or subdued foothills topography occurs on the Beauvais Lake Upland and Goose Lake Bench (Fig. 2). They are underlain by Brazeau Formation and Alberta Group rocks (Fig. 5), dominantly shales. In the Southern Foothills, Green's (1972) Brazeau Formation is equivalent to the Belly River Formation identified by Price (1962).

The **Goose Lake Bench Subdistrict** (Fig. 2) is the most subdued part of the Southern Foothills. Elevations range from about 1200 m (3900 ft) at the edge of the Cowley Basin to nearly 1300 m (4300 ft) on the few bedrock controlled ridges. Local relief is about 60 m, ranging up to about 90 m along the Waterton R. valley. With these features the Goose Lake Bench resembles, and is transitional to, the Cardston Plain. However, a deep mantle of unconsolidated deposits, mainly continental till, overlying slightly faulted or folded bedrock are traits shared with the foothills belt. An extensive hummocky to undulating moraine, dotted with numerous potholes and sloughs, is a major feature of the subdistrict. Till-glaciolacustrine mixtures are also common.

The Goose Lake Bench is characterized by fescue grassland occurring under various Black soils. But favorable topographic, climatic and soil conditions have promoted extensive cultivation, more than in any other part of the foothills.

The **Beauvais Lake Upland Subdistrict** is slightly more rugged than the Goose Lake Bench. Average local relief, crudely estimated from incised valley bottoms to the tops of ridges and hills, is about 200 m (700 ft). Elevations range from about 1250 m (4100 ft) at the edge of the Cow Creek Bench to 1600 m (5300 ft) on some ridges. Bedrock is often partially masked by deep to shallow tills of continental, mountain or mixed origin. Till-glaciolacustrine mixtures and ice contact deposits are also important. Most surficial materials are calcareous. However, low lime materials are common in the Gladstone Valley and Pecten areas.

Vegetation and soils vary substantially across the Beauvais Lake Upland. The eastern fringes, being driest and warmest, are characterized by fescue grassland with various Black soils. Westward, the grasslands grade into aspen parkland with mixtures of Black and Dark Gray soils. As conditions become still cooler and moister to the west, parkland grades to lush aspen forest, then to mixedwood forest, and eventually to lodgepole pine forest. Leaching in the topsoil also increases, and the soils grade from Orthic Dark Gray to Dark and Orthic Gray Luvisols.

The **Byron-Carbondale Hills Subdistrict** is by far the most rugged part of the Southern Foothills. Average local relief is 300-400 m (1000-1300 ft), maximum relief about 520 m (1700 ft). Maximum elevations are 1842 m (6043 ft) on Byron Hill, about 1860 m (6100 ft) on an unnamed hill near Maycroft. Shallow to deep tills, mainly of mountain origin, mantle the bedrock hills and ridges and occupy the valleys. These tills tend to be non- to weakly calcareous in the Burmis area and south, weakly to strongly calcareous north of Burmis to the Maycroft area. Discontinuous colluvial and fluvioeolian deposits thinly cover the till in the steepest, noncalcareous terrain.

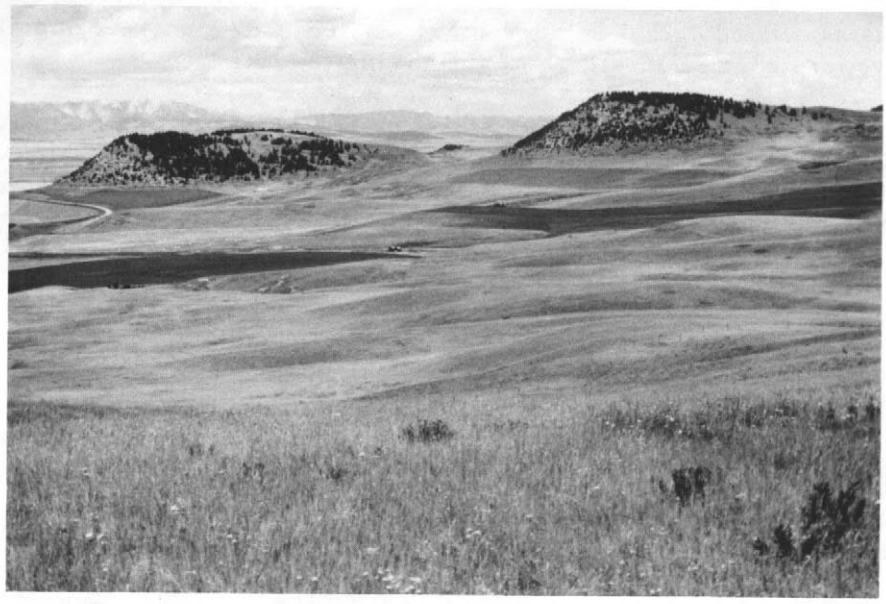


Figure 6. Southwestern margin of the Porcupine Hills near Tanner.

Figure 7. Southern Foothills landscape near Maycroft.

South of Burmis, the Byron-Carbondale Hills are characterized by an intricate, strongly contrasting pattern of vegetation and soils (Fig. 8). Steep northerly to easterly aspects are dominated by Douglas fir or mixed coniferous forest and Dystric Brunisols. Steep south- to west-facing slopes have shallow soils, mainly Dark Browns, and Montane grassland vegetation. Gentler slopes that skirt the ridges are generally covered by mixedwood or mixed coniferous forest. Associated soils are mainly Gray Luvisols or Dark Grays.

North of Burmis, both the Beauvais Lake Upland and Byron-Carbondale Hills are much drier (Fig. 9), on an equal elevation basis, than counterparts to the south. Grassland as-

sociated with Black and similar soils dominate this "rain shadow" area. Aspen and mixed-wood forest plus associated "gray" soils occur in small isolated pockets and in a narrow strip along its western edge on the flank of the Livingstone Range.

A dense network of small to large streams drain the Southern Foothills. This district also contains more lakes and sloughs than any other in the survey area. Lees Lake and Beauvais Lake are some of the important recreational lakes. Other named lakes represent include Horseshoe Lake, Kesler Lake, Fish Lake, Daigle Lake, Margaret Lakes, Harland Lakes, Marr Lake, Marna Lake, Lynch Lakes, Goose Lake, and Hudson Bay Lake.

Figure 8. Characteristic vegetation pattern of the Byron-Carbondale Hills: coniferous forest on northerly aspects, grassland on steep southerly aspects where the soils are shallow.

The Front Ranges District

The Front Ranges (Pettapiece 1986) feature long, high, roughly parallel ridges with a general southeast-northwest orientation. The western end of the survey area lies in the Front Ranges (Fig. 2). As in the foothills, bedrock has been faulted and folded. In the Front Ranges, powerful tectonic forces have moved slabs of sedimentary rock several kilometers east or northeast, usually causing older rocks to overlap younger (Beaty 1975). Subsequent erosive processes have left most of the area with moderately steep slopes and moderate relief, mainly where underlain by relatively soft bedrock.

The **Grassy Mountain Ridges Subdistrict** is characterized by such subdued topography, and resembles the Byron-Carbondale Hills of the foothills. Relief ranges from about 250 to 500 m (800 - 1600 ft).

Underlying bedrock is mainly Lower Cretaceous plus Jurassic rocks with lesser amounts of Alberta Group and Brazeau Formation (Fig. 5; Green 1972). Most rocks are non- to weakly calcareous sandstones and shales. Shallow to deep, non- to weakly calcareous medium textured, gravelly tills are draped over the bedrock ridges.

The Grassy Mountain Ridges are almost completely vegetated, in sharp contrast to the more rugged limestone ridges (Fig. 10). The vegetation is predominantly lodgepole pine or

lodgepole pine-Douglas fir forest on lower slopes, Engelmann spruce-subalpine fir forest at the highest elevations. Grassland and shrubby grassland patches may be present on some southerly aspects in association with shallow soils. Orthic Gray Luvisols dominate the lower slopes, Dystric Brunisols the higher slopes.

Figure 9. Grassland dominates the driest part of the Byron-Carbondale Hills up to the edge of the Front Ranges, here the Livingstone Range north of Burmis.

The **High Rock Ridges Subdistrict** represents the most striking features in the Front Ranges. These are the rugged mountain ridges and peaks associated with hard limestone and related rocks, mainly of Upper Paleozoic age (Fig. 5). Steep sides and substantial relief, ranging from about 500 to 1100 m (1600-3600 ft), are typical. The maximum elevation in the survey area, 2549 m (8364 ft), occurs in this subdistrict, on Mount Tecumseh. Mountain tops are normally rugged and rocky with little or no vegetative cover. The mountain walls have a mantle of colluvium on upper to mid slopes, till on lower slopes; both are calcareous. Shrubby vegetation, often with scattered trees, near the mountain tops grades to closed coniferous forest below. Associated soils are mainly Eutric Brunisols in the colluvium, Gray Luvisols in the till.

A dense network of small to large streams, all tributary to the Crowsnest River, drain the Front Ranges portion of the survey area. Very few lakes are present; most occur near Crowsnest Pass. Island Lake, Crowsnest Lake and an unnamed lake on the northwest arm of Allison Cr. are some important recreational lakes.

The Clark Range District

The Clark Range (Pettapiece 1986) is like the Front Ranges, differing mainly in bedrock types and structure. Various Precambrian formations, combined as the Purcell Group (Fig. 5), dominate the area. Rock units include limestones, argillites, sandstones, siltstones, and minor andesites (lava). Geologic structures are also complex. The area is dominated by a great mass of high mountain structures carved at different angles by deeply incised valleys. Also, the southeast-northwest trend of mountain ridges and valleys found in the Front Ranges is not at all apparent in the Clark Range.

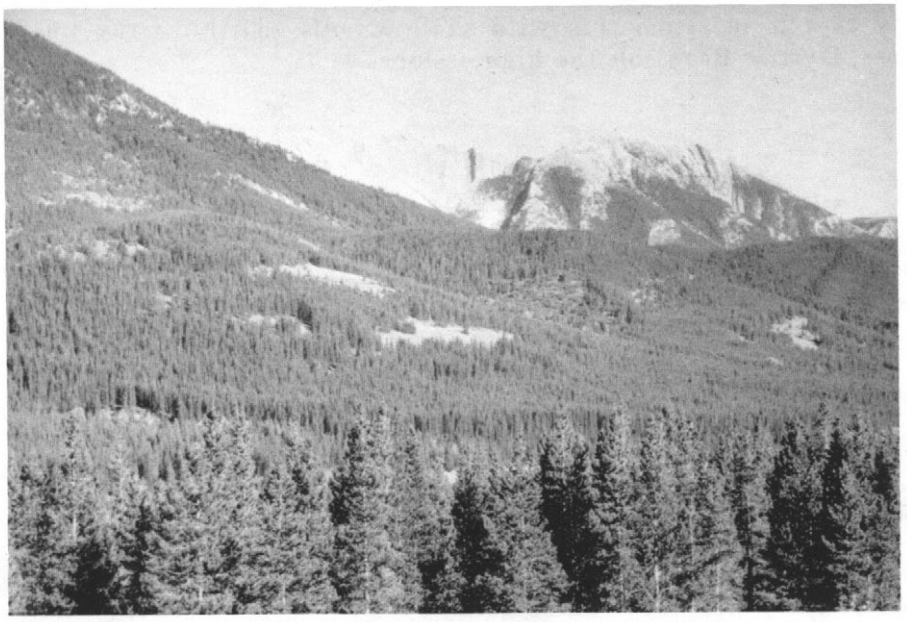


Figure 10. Rounded forest covered hills underlain by Mesozoic strata (middle ground) are contrasted with the rugged limestone ridge (Livingstone Range) behind (background and left middle ground).

The irregular southwestern boundary of Pincher Creek M.D. touches the Clark Range in several localities. The boundary crosses long, lower mountain slopes at about 1500 to 1600 m (5000-5500 ft) elevation. Most of these areas are covered in mixedwood or lodgepole pine forest and have Dark Gray Luvisol soils.

Major River Valleys

The Municipality of Crowsnest Pass straddles the Crowsnest River valley, a major erosional-depositional feature that slices across the Southern Foothills and Front Ranges structures (Fig. 11). Other major disruptions to the general continuity of the foothills and mountains include the Oldman and the Castle-Carbondale river valleys (Fig. 2). Several other creek valleys, too small to show on the generalized map, also cut across these structures. In the Front Ranges, several smaller valleys, oriented roughly parallel to the mountain structures, are tributary to the Crowsnest.

Glaciofluvial terraces and modern fluvial floodplains dominate the valley floors that comprise this subdistrict. Benchlands, best expressed in the upper segment of the Crowsnest valley, are characterized by hummocky ice contact deposits, sometimes overlying bedrock at shallow depths. Most materials are strongly to extremely calcareous, except in the Castle-Carbondale valley. Terrace risers and the steep erosional scarps between benchlands and bottomlands are also evident.

Grassland vegetation with Rego, Calcareous and Orthic Black soils dominate the glaciofluvial terraces and many of the ice contact landforms. Regosolic soils and weakly developed Eutric Brunisols are common in the recent deposits, usually occurring under cottonwood-aspen-grassland vegetation. The benchlands of the upper Crowsnest valley are characterized by Douglas fir and mixedwood forest dotted with patches of grassland. Associated soils are Eutric Brunisols and various Blacks. Lodgepole pine forest and Orthic Gray Luvisols characterize the upper benchlands and extend onto lower mountain walls.

Figure 11. Town of Coleman nestled in the Crowsnest River valley which cuts across the Front Range structures. Mountain peaks of the Flathead Range dominate the background.

DRAINAGE SYSTEMS

The Pincher Creek-Crowsnest Pass area drains eastward into the Hudson Bay via the South Saskatchewan River system. Drainage waters exit the survey area via two subsystems, the Oldman and Waterton river drainages, that join near Ft. Macleod. A subtle divide extending northeast from Pincher Ridge near Pecten to the Springridge area separates the two drainages (Fig. 12).

The southeastern quarter of the survey area is drained by the Waterton River and several tributary creeks. Some major creeks that emanate from the Clark Range are Galwey, Cottonwood, Dungarvan, Yarrow, and Drywood. Foothills Cr. begins in the foothills. A major on-stream reservoir, the Waterton Reservoir, occurs in this drainage, just east of Twin Butte on the Waterton R.

The northern and western three-quarters is drained by the Oldman River and two major tributaries, the Crowsnest and Castle rivers. Numerous streams, emanating from all physiographic districts above the Cardston Plain join these rivers. A dam is presently being constructed on the Oldman River near Summerview. When completed in the near future, parts of the Oldman, Crowsnest and Castle river valleys will be flooded to create the Three Rivers Reservoir.

The whole area is strongly dissected by the intricate network of rivers and creeks (Fig. 13). Many are deeply incised into surficial materials and underlying bedrock, and cut across the physiographic structures. Problems arise in providing adequate access among the various isolated localities. Transportation routes must be carefully planned. Numerous bridges are often required, usually at substantial expense.

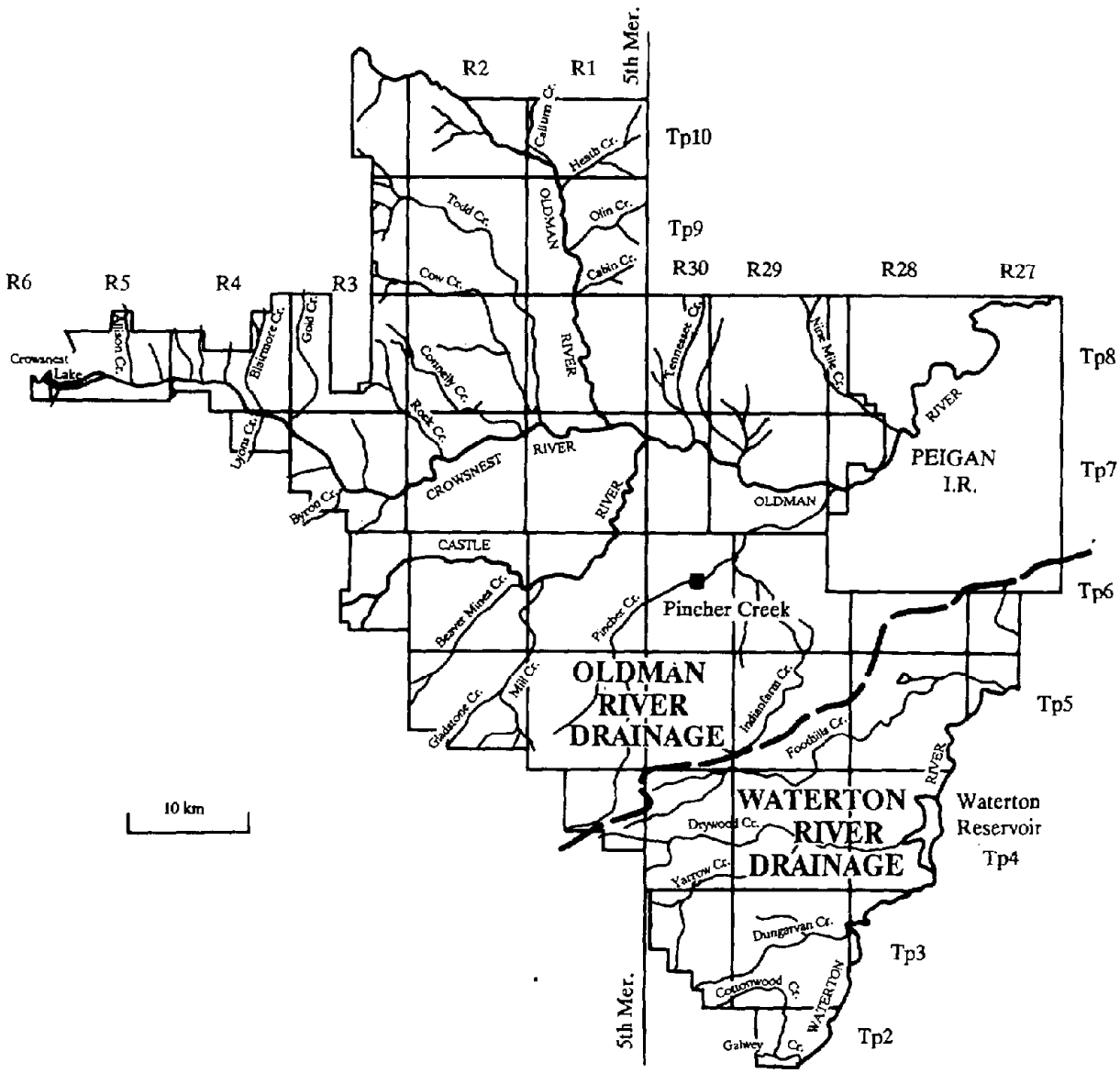


Figure 12. Drainage systems of the Pincher-Crowsnest area.

CLIMATE

Climatic data for the Pincher-Crowsnest area are scarce, especially considering its physiographic complexity (Fig. 3). Data from ten long term stations in southwestern Alberta clearly indicate that the area has a continental macroclimate - one with short, cool summers and long, cold winters. Extreme temperature differences[2] of about 75 to 88 ^{o}C, and precipitation regimes characterized by summer maxima at most stations, indicate con-

2. Difference between extreme maximum and extreme minimum temperatures recorded for each station.

tinental climate. Frequent chinook winds, however, offset the severe cold of winter, and the area has milder mean winter temperatures than others to the north and east.

Air masses and weather systems that migrate across western Canada at mid latitudes control the macroclimate. However, the predominant southeast-northwest orientation of mountainous terrain significantly modifies it. Distribution of precipitation, winds, radiant energy, and local air masses is influenced, creating substantial climatic variation over short distances.

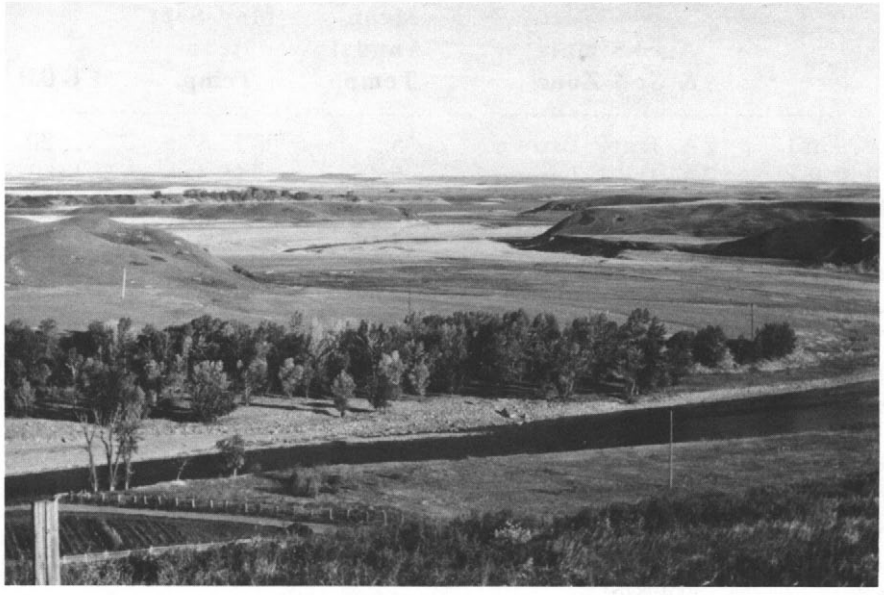


Figure 13. Valleys like that of the Waterton R. have esthetic appeal but dissect the area into isolated parcels.

Tables 1 and 2 show selected temperature and precipitation data for ten long term stations in southwestern Alberta. Unfortunately, much of the physiographic and climatic variability is poorly represented. Extrapolation of climatic information is therefore necessary to map soils, vegetation or other entities based on climatic parameters. Conversely, soil, vegetation and physiographic information can be used to infer climatic parameters. Such a cyclic sequence was used in the Pincher-Crowsnest area to create a generalized map of agroclimatic classes (Fig. 14).

Agroclimatic Classes

Agroclimatic classes provide the basis for a new land capability classification for arable agriculture in Alberta (A.S.A.C. 1987). The classes are based on an energy component and a moisture component. The energy component is termed "effective growing degree days" shortened to EGDD. EGDD is defined (A.A.A.C. 1987) as accumulated growing degree days above $5^{o}C$, beginning on the first of five consecutive days with mean temperature above $5^{o}C$, and ending on the average date of the first fall frost ($0^{o}C$). Calculations include adjustments for daylength (latitude) and diurnal temperature range.

The moisture component is termed "growing season precipitation minus potential evapotranspiration", shortened to P-PE. P-PE is defined as monthly total precipitation (P) minus monthly potential evapotranspiration (PE) from May 1 to August 31 (A.A.A.C. 1987). Calculations include adjustments for timing and water use curves.

Lands in the survey area belong to one of seven agroclimatic classes or subclasses. The classes indicate degree and kind of limitations for arable crop production. A number between 2 and 7 shows degree of limitation, measured against the standard, class 1, which has no limitations. There are no class 1 lands in Alberta. Limitations are due to aridity (A) or lack of adequate heat units (H), or both when equally limiting (AH or HA).

Table 1. Selected temperature ($^{\circ}$C) and growing season data for ten southwestern Alberta stations (Atmospheric Enviroment N.d., 1982b[1]).

Station & Elevation	Agroclimate[2] & Soil Zone	Mean Annual Temp.	May-Sept. Mean Temp.	EGDD[3]	FFP[4] (days)
Lethbridge A (929 m)	2A, Dark Brown	5.3	15.6	1520	124
Fort Macleod (950 m)	2A, Dark Brown	5.4	15.3	1483	125
Cardston (1154 m)	2AH, Black	4.8	14.2	1273	111
Pincher Creek (1155 m)	2AH, Black	4.4	13.6	1231	106
Cowley (1189 m)	3H, Black	3.8	12.9	1088	83
Caldwell (1311 m)	3H, Black	4.2	13.1	1079	96
Carway (1359 m)	4H, Black	3.9	12.7	1016	87
Coleman (1341 m)	5H, "Black"	3.2	11.9	730	46
Castle RS (1364 m)	6H, Gray Luvisol	2.9	11.5	622	39

Notes: 1. Computer extracted in 1985 by Alberta Energy and Natural Resources personnel.
2. Agroclimatic classes as defined by A.S.A.C. (1987).
3. EGDD = effective growing degree days, defined and calculated by A.A.A.C. (1987).
4. FFP = Frost-free period; mean days between the last spring and first fall frosts (0°C), recorded from 1951 to 1980 (Atmospheric Environment 1982b).

Agroclimatic class 2AH is slightly limiting to arable agriculture. For this survey, class 2AH was divided into two subclasses - **Subclass 2AH** in which aridity is slightly more limiting than heat units, and **Subclass 2HA** in which the energy factor is slightly more limiting than aridity.

Table 2. Selected precipitation data (mm) for ten southwestern Alberta stations (Atmospheric Environment N.d.).

Station & Elevation	Agroclimate & Soil Zone	Mean Annual Precip.	May-Sept. Mean Precip.	P-PE[1]	% as Snow
Lethbridge A (929 m)	2A, Dark Brown	423	257	-410	36
Fort Macleod (950 m)	2A, Dark Brown	434	262	-400	34
Cardston (1154 m)	2AH, Black	550	312	-345	42
Pincher Creek (1155 m)	2AH, Black	543	304	-362	45
Cowley (1189 m)	3H, Black	515	262	-410	39
Caldwell (1311 m)	3H, Black	723	362	-250	51
Beaver Mines (1286 m)	4H, Black	645	314	-305	47
Carway (1359 m)	4H, Black	515	285	-318	47
Coleman (1341 m)	5H, "Black"	569	265	-378	38
Castle RS (1364 m)	6H, Gray Luvisol	852	325	-363	50

Notes: 1. P-PE = seasonal precipitation minus potential evapotranspiration, defined and calculated by A.A.A.C. (1987).

Subclass 2AH is the driest, warmest part of the Pincher-Crowsnest area. Aridity is the main climatic parameter, with P-PE values ranging from roughly -400 to -425. EGDD index is about 1250 or greater. Subclass 2AH is associated with the western-most extension of Dark Brown soils into the survey area, as shown in the generalized maps (Figs. 14 and 23). The vast majority of soils associated with this subclass are cultivated, mainly for the production of cereal grains.

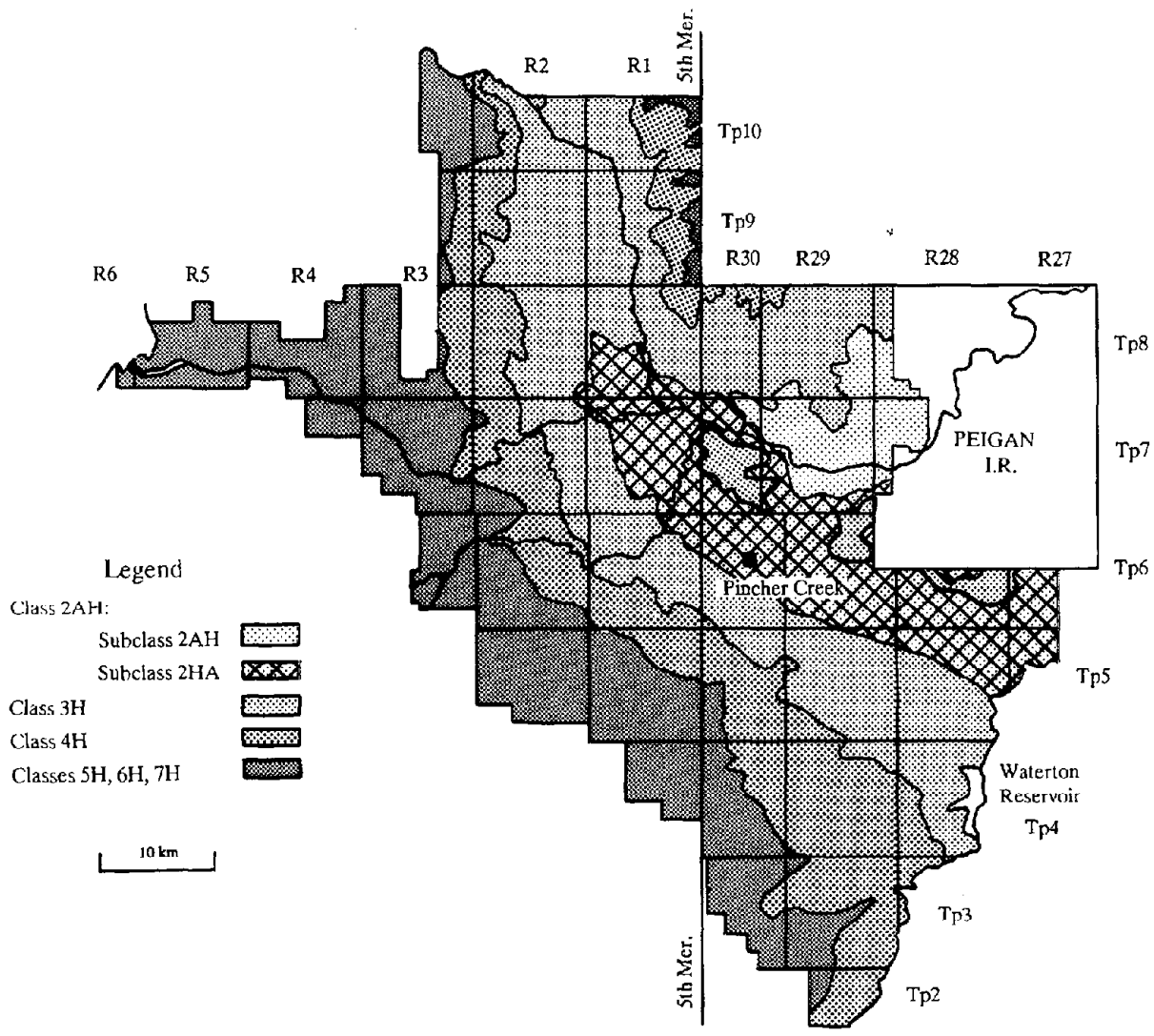


Figure 14. Generalized agroclimatic classes and subclasses of the Pincher-Crowsnest area.

Subclass 2HA is slightly cooler and moister than subclass 2AH, shown by a change to dominantly Black soils. EGDD index ranges from about 1180 to 1250. P-PE index ranges from roughly -300 to -400 over most of the area. A strip of land extending west and north from Tennessee Cr., along the Oldman and Crowsnest valleys, is drier than -400 (Fig. 15). The boundary between subclass 2HA and class 3H, on the generalized map (Fig. 14), was placed at about 1150 to 1200 m (3800-3900 ft) elevation. This elevational range encompasses the Cowley Basin, separating it from the Cow Creek Bench to the northwest, the Porcupine Hills to the north, and the Goose Lake Bench to the south (Fig. 2). The

majority of soils associated with this subclass are cultivated, mainly for the production of cereal grains.

Agroclimatic class 3H has a moderate heat limitation, with an EGDD index of 1050 to 1180. The limitation affects mainly spring wheat, and includes risk of damaging frosts. Class 3H is separated from 4H, on the generalized map (Fig. 14), along a boundary that approximates the Goose Lake Bench-Beauvais Lake Upland boundary in the south, the "thin" versus "thick Black" soil separation north of Beaver Mines. Substantial areas of soils classed as 3H are cultivated for production of cereal grains, mainly barley, and forages, including greenfeed.

P-PE index ranges from -260 to -400 over most of the area classed as 3H. An unusually dry area, with P-PE drier than -400, extends northward from the Cowley area, along the Oldman R. basin (Fig. 15). Wind patterns and interception of precipitation by the Livingstone Range (rain shadow effect) are partly responsible. This dry strip mirrors a regional trend evident in Fig. 15 and Table 2 that climate is substantially drier north of the Castle R. than south. Circumstantial evidence suggests that particularly moist air masses which affect the eastern slopes of the Flathead drainage often spill northeastwards across the Continental Divide. Excess moisture is dumped over Waterton Lakes National Park and adjacent areas to the northeast. This theory is supported by supplementary precipitation data (Atmospheric Environment N.d., Jablonski 1987) which show the Waterton area to be one of the wettest in Alberta, on an equal elevation basis.

Agroclimatic class 4H has a severe heat limitation, with an EGDD index of about 950 to 1050. The limitation affects the range of crops that can be grown. Generally, less than 50% of cultivated lands classed as 4H are used for cereal crops, mainly oats and barley. Most are used for the production of forages, including greenfeed. A large proportion of total class 4H lands in the Pincher-Crowsnest area is used as pasture. A soil-vegetation distinction was used to separate class 4H from 5H lands on the generalized map (Fig. 14). Class 4H lands are associated with grassland and Black soils. Most class 5H lands have over 50% forest cover, mainly aspen in the south and mixedwood in the north, with significant amounts of Dark Gray soils.

P-PE index ranges from about -260 to -300 over the drier lands classed as 4H north of the Castle R. Significantly moister conditions, with P-PE values moister than -260, prevail on class 4H lands located to the southeast of Beaver Mines (Fig.14). Moist air masses from the Glacier-Waterton parks region provide the extra precipitation in the southern part of the survey area.

Agroclimatic class 5H has a very severe heat limitation, with an EGDD index of only about 700 to 950. Sustained arable agriculture is inhibited, and roughly 15% or less of lands classed as 5H are cultivated. Most cultivated land is used for forage production, including greenfeed. The dominant proportion of all lands classed as 5H is used as pasture. Because of P-PE values moister than -260, moisture is not limiting in most areas classed as 5H. The exception is an unusually dry strip of land along the floor of the Crowsnest valley where P-PE is drier than -260 (Fig. 15). Physiographic effects on regional and local air movement, wind patterns and precipitation distribution likely account for the unusual aridity in this locality.

No reliable physiographic, soil or vegetation features could be used to consistently separate class 5H from 6H lands on the map (Fig. 14). Elevation and aspect become important where relief is substantial in the Southern Foothills and Front Ranges. Class 5H lands occur at the lowest elevations in these areas, dominating most valleys.

Agroclimatic classes 6H and 7H are too cold to support arable agriculture. Class 6H has an EGDD index of about 450 to 700 and is associated with mixedwood and coniferous forests. Class 7H is colder than 450 EGDD and is dominated by coniferous forest. Moisture is not limiting; P-PE index is substantially moister than -260. Data from long term (Table 2) and supplementary stations (Atmospheric Environment N.d., Jablonski 1987) show that precipitation regimes in the mountains and adjacent high foothills are characterized by winter-spring maxima. Summer season maxima typify the lower foothills and plains areas to the east.

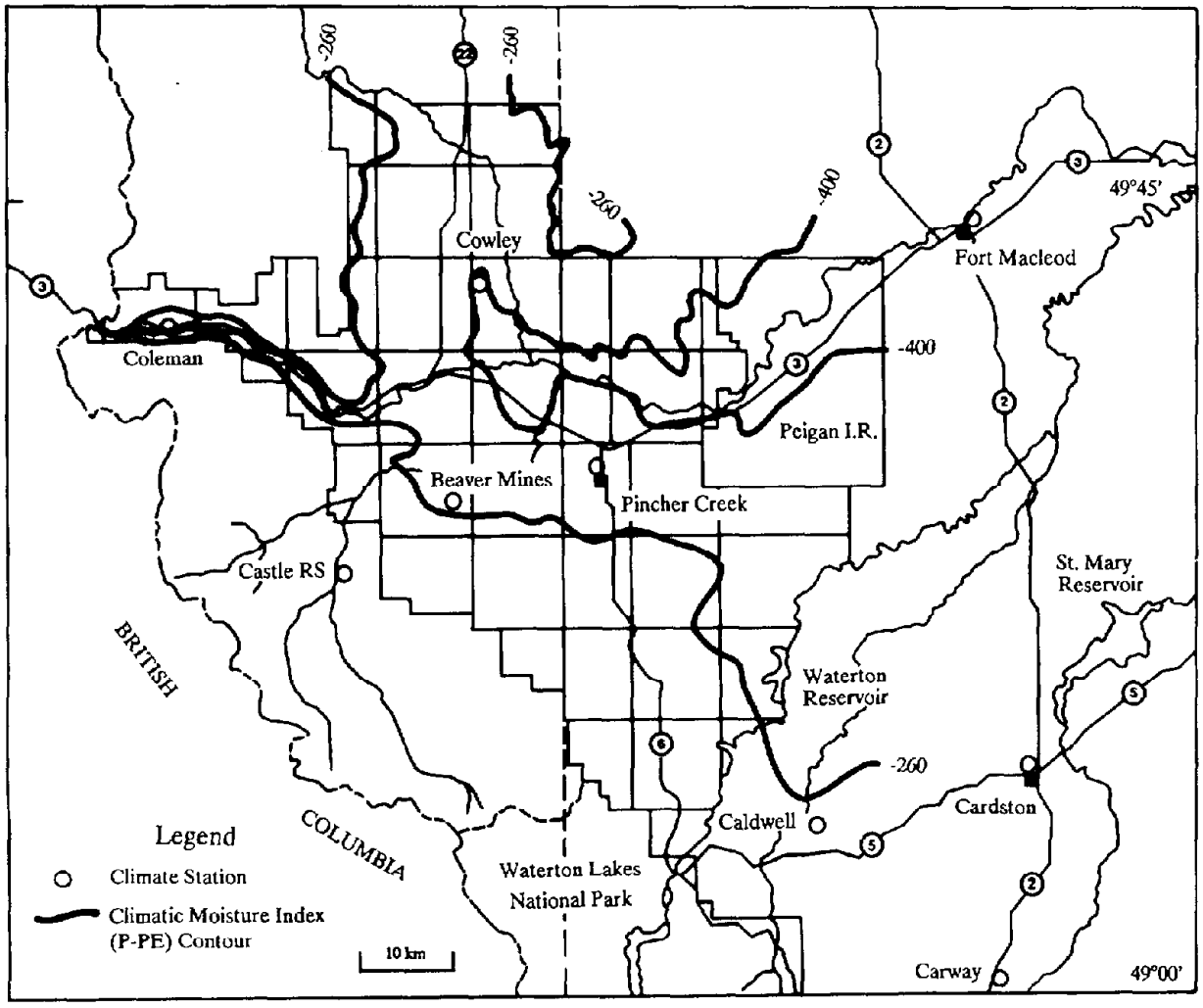


Figure 15. Climatic moisture index contours and climate stations in southwestern Alberta.

Class 6H and 7H lands occur in the high relief areas of the Front Ranges and Southern Foothills. Elevation and aspect are important. Areas classed as 7H occur at high elevations, and certainly higher on southerly than northerly aspects. No associated features could be used to consistently separate class 6H from 7H lands on the map (Fig. 14).

Wind

Southwestern Alberta is known for its frequent, strong, westerly winds, yet wind data are very scarce. Wind has a visual presence (Fig. 16), being the primary cause of soil erosion in the survey area. There is, in fact, circumstantial evidence to suggest that wind has played an important part in soil formation. Soils of the Crowsnest-Oldman corridor east of Lundbreck and of the southern Porcupine Hills tend to have unusually thin topsoil (Ah horizons). When cultivated, these soils have been quite severely eroded.

Figure 16. Frequent and strong winds are typical of the area, and soil erosion is a major problem of cultivated lands.

Table 3 lists comparable wind data for a few Alberta stations. The southwestern stations, with mean yearly wind speeds of about 20 km/hr, tend to be the windiest in Alberta (Atmospheric Environment 1982a.). October, November, December, and, occasionally, January and February are the windiest months in the southwest. Elsewhere, April and May are usually windiest. Also in the southwest, high wind speeds may be sustained over an hour or more as indicated by maximum hourly wind speeds.

Table 3. Selected wind data (km/hr) for a few Alberta stations (Atmospheric Environment 1982a).

Station & Elevation	Mean Yearly Wind Speed	Prevailing Direction (Yr)	Maximum Hourly Speed
Lethbridge A (929 m)	20.4	W	121
Pincher Creek, old (1155 m)	19.8	W	137
Pincher Creek, new (1155 m)	21.5	W	92
Cowley A (1182 m)	19.1	N	106
Medicine Hat A (717 m)	16.1	SW	105
Calgary Int'l A (1084 m)	16.2	W	90
Edmonton Int'l A (715 m)	13.4	S	87
Rocky Mountain House (1015 m)	8.9	NNW	60
Banff (1397 m)	7.8	SW	40

The Banff and Rocky Mountain House data are included to show that forested mountain and foothill areas are much less windy than the plains. Similar relationships likely exist in the southwestern part of the province. The Crowsnest valley may be an exception; it likely funnels winds through the mountains and foothills to the Cardston Plain.

Prevailing wind direction at most of the southwestern Alberta stations clearly oscillates from west to southwest. The strongest winds come from the same directions in most cases. Prevailing northerly winds at the Cowley A station (Fig. 15) suggest a tendency for air to frequently move down the Oldman R. basin between the Southern Foothills and Porcupine Hills. However, the records for Cowley A (Atmospheric Environment 1982a) clearly indicate that winds from the west and southwest are also important.

VEGETATION

Information on vegetative cover, natural or cultivated, was not scientifically collected during the survey. However generalized soil and vegetation relationships, like those presented in ecoregion approaches (Strong and Leggat 1981), were usually evident. Informal survey notes provided additional information on soil-vegetation patterns.

Grassland

Elements of the Mixed Grassland Ecoregion (or Prairie), characterized by spear grass (*Stipa comata*), may extend into the Dark Brown soil area (agroclimate subclass 2AH). However, native range was not encountered in this area of predominantly cultivated soils.

The Fescue Grassland Ecoregion (or Prairie), characterized by rough fescue (*Festuca scabrella*) with Parry oat grass (*Danthonia parryi*), june grass (*Koelaria kristata*) and northern wheatgrass (*Agropyron dasystachyum*), is associated with Black soils, both thin and thick (Fig. 23). Black soils dominate the Cardston Plain, Goose Lake Bench, Beauvais Lake Upland, and southern Porcupine Hills. Associated agroclimatic subclasses or classes are 2HA, 3H and 4H (Fig. 14). Most areas of native range, particularly in the foothills and Porcupines Hills, have been modified by grazing. Most of the Cardston Plain and adjacent low relief terrain is under cultivation or has been cultivated in the past.

Aspen Parkland

Narrow strips of aspen parkland, too small to consider in generalized studies, are transitional between the grasslands to the east and aspen or mixedwood forest to the west. The majority occurs between Beaver Mines and Waterton. Its patchwork vegetation pattern (Fig. 17) is characterized by aspen (*Populus tremuloides*) groves on moist well drained sites and fescue grassland on warmer drier sites. Willow (*Salix* spp.) is important in some localities, replacing or occurring with aspen in the moister sites.

Agroclimatic classes associated with aspen parkland are 4H and 5H. Associated soils are mainly Black; but weakly leached Dark Gray soils are common under well established aspen stands, in areas classed as agroclimate 5H.

Aspen and Mixedwood Forest

Towards the mountains aspen parkland grades to aspen and mixedwood forest in the climatically moist southern regions of the survey area. This is the wettest portion of an area labelled Montane Ecoregion (Strong and Leggat 1981).

Besides aspen, forest stands include cottonwood (*Populus trichocarpa*) or balsam poplar (*Populus balsamifera*), white spruce (*Picea glauca*), lodgepole pine (*Pinus contorta*), and scattered Douglas fir (*Pseudotsuga menziesii*). The forest understory, composed of shrub and herb layers, is typically lush and diverse, a reflection of the moist climatic conditions. Associated soils are weakly to moderately leached Dark Grays and Dark Gray Luvisols in areas classed as having agroclimates 5H to 6H.

Douglas Fir Forest

Aspen parkland grades to Douglas fir (*Pseudotsuga menziesii*) or Douglas fir-lodgepole pine (*Pinus contorta*) forest in drier areas and on cool, steep, rocky slopes. Patches of grassland are also common, and contribute to a vegetation pattern typical of the Montane Ecoregion (Strong and Leggat 1981). This distinctive vegetation pattern occurs near the M.D. boundary in the Porcupine Hills, in the Byron-Carbondale Hills (Fig. 9), along major valleys, and on about half of the Grassy Mountain Ridges. Associated agroclimatic classes are 5H to 6H, and sometimes 7H at high elevations on northerly aspects.

Figure 17. The patchwork pattern of the aspen parkland is conspicuous after a snow storm.

The forested segments may include scattered aspen or aspen groves and white spruce in moist localities, limber pine (*Pinus flexilis*) on steep rocky exposures. Associated soils include Dark Grays, Dark Gray Luvisols, Dystric Brunisols, and Eutric Brunisols.

The Montane grasslands are similar to Fescue Grassland communities but with different species composition, sometimes including low and dwarf shrubs and scattered Douglas fir trees. Soils under the grasslands range from Blacks and Dark Browns to Brunisols with thin Ah horizons. Parent materials are either coarse textured gravel, or shallow till and colluvium on steep southerly aspects.

Lodgepole Pine Forest

A third major portion of the Montane Ecoregion is lodgepole pine (*Pinus contorta*) forest. This successional post-fire forest is prevalent in the mountain areas, mainly on benchland

and mountain wall terrain in the Front Ranges. Douglas fir is commonly included to an elevation of about 1800 m (6000 ft), possibly the upper limit for the Montane Ecoregion in the survey area. Engelmann spruce (*Picea engelmanii*) and, occasionally, subalpine fir (*Abies lasiocarpa*) may be included above 1800 m in the Subalpine Ecoregion. Associated soils are strongly leached Orthic Gray Luvisols; agroclimatic classes are 6H to 7H.

Spruce-fir Forest

Successionally mature stands of Engelmann spruce-subalpine fir, likely well over a century old, are not common in the survey area. While spruce-fir is typical of the Subalpine Ecoregion (Strong and Leggatt 1981), lodgepole pine forest is far more extensive because of the area's fire history. Spruce-fir stands may occasionally be found at high elevations on northerly aspects in remote localities of the Front Ranges. The top of Grassy Mountain for example has substantial spruce-fir forest with false azalea (*Menziesia glabella*) and rhododendron (*Rhododendron albiflorum*) above about 1800 m (6000 ft). Associated soils are Brunisolic and agroclimate is classed 7H. Forest vegetation, whether closed or open, ends rather abruptly at high elevations where the more stable slopes meet the steep, rocky, unvegetated, mountain tops.

SURFICIAL GEOLOGY

Soil development is influenced by landform. Landform is described according to surficial material, surface expression and modifying process components (E.C.S.S. 1987b). Material is most important because it provides the framework with which to classify and interpret other properties of the landscape. Thus surficial materials, herein considered the same as soil parent materials, are emphasized in the descriptions that follow. Additional detail, particularly on surface form and modifying processes, is provided in the map unit descriptions in Appendix B. Fig. 18 illustrates textural groups, classes and their modifiers. Table 4 lists the calcareousness classes used with soil parent materials. The distribution of surficial materials, generalized from the soil map units, is presented in Fig. 19.

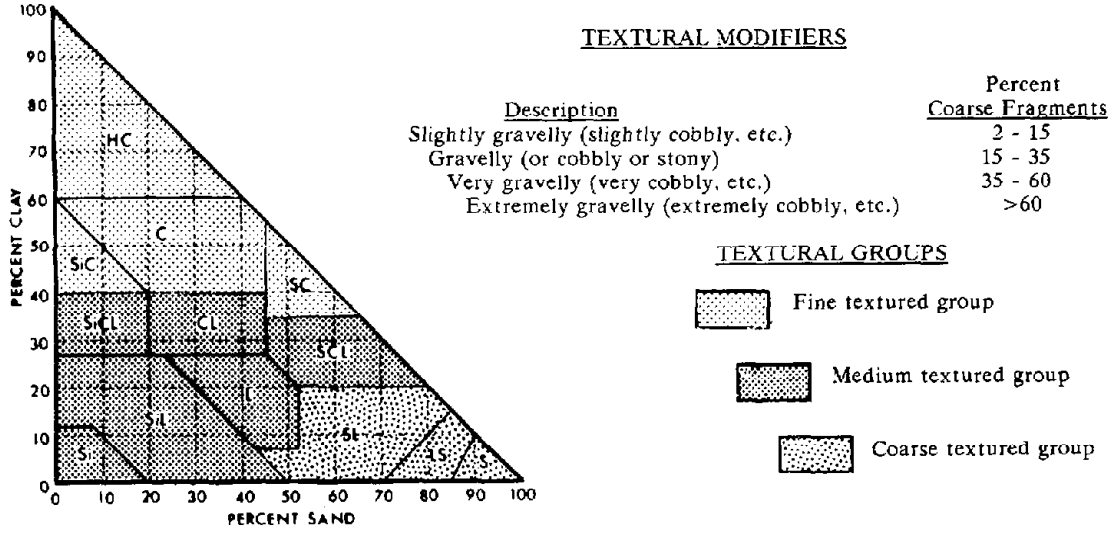


Figure 18. Textural triangle showing textural groups, classes and their modifiers.

A wide variety of complex surficial deposits cover the Pincher Creek-Crowsnest Pass area. Horberg (1954) provides a comprehensive description of surficial deposits in the Waterton

area, emphasizing geomorphic processes and chronology. Stalker (1959, 1962) mapped surficial deposits of the area, again emphasizing process and chronology. Beaty (1975) describes geomorphic processes from a physiographic-landscape point of view.

Glaciation played a major role in shaping the landscape of southwestern Alberta (Beaty 1975). The glacial history of the survey area is presented in several stratigraphic studies (Stalker 1963, Alley 1973, Alley and Harris 1974). Recent information (Dyke and Prest 1987) estimates the last deglaciation of the area at 18 000 to 14 000 years before present. This is more than adequate time for landform stabilization and subsequent soil development in all glacial deposits. Thus, parent material textural and chemical characteristics are more important to soil development than geomorphic chronology. These characteristics, emphasized below, reflect local bedrock properties over much of the area.

Table 4. Calcareousness classes for soil parent materials (E.C.S.S 1983).

Calcareousness Class	Calcium Carbonate Equivalent, %
Weakly calcareous	1 - 5
Moderately calcareous	5 - 15
Strongly calcareous	15 - 25
Very strongly calcareous	25 - 40
Extremely calcareous	>40

Tills

Till (or morainal) deposits dominate the Porcupine Hills, Southern Foothills and Front Ranges (Figs. 2 and 19). There are many tills with a variety of textural and chemical properties. Some have been unofficially recognized with the identification of soil series.

Firstly, continental till of the Laurentide glaciation can be separated from mountain tills of the Cordilleran glaciation. The approximate boundary is shown on Fig. 20. Continental till is uniformly heterogeneous, being predictably moderately calcareous and medium textured (CL-L) with 2-15% coarse fragments. Variations occur locally in the Porcupine Hills and outer foothills and are usually shallow. Although characteristics vary according to local bedrock type, these variations usually have more coarse fragments, slightly coarser or siltier textures, and, sometimes, higher carbonate contents than continental till.

The mountain tills are characterized by variability. Coarse fragment content (15-35%) is the most consistent and characteristic feature. Textures vary from sandy loam to silty clay loam but are mostly clay loam or loam. Calcareousness is most variable. Tills associated with Mesozoic strata in the Grassy Mountain Ridges, Byron-Carbondale Hills, and southwestern part of the Beauvais Lake Upland are mainly non- to weakly calcareous. North of Burmis the tills vary, locally, from non- to strongly calcareous. Mountain till on the benchlands and lower wall of the Crowsnest valley is strongly to very strongly calcareous. Tributary valleys may have moderately calcareous till.

Fine textured (C) till-like deposits found in the Marna Lake, Spread Eagle and Pecten areas may be clay till derived from argillaceous bedrock or glaciolacustrine sediments of supraglacial origin. Near the mountains, these deposits are non- to weakly calcareous and have substantial coarse fragments (15-35%). On the eastern Beauvais Lake Upland, coarse fragment content is low (2-15%) and carbonate content moderate.

Tills are shallow across much of the roughest terrain (Figs. 2 and 19). Underlying materials may be consolidated bedrock or weathered bedrock (residuum). Residual materials range from non- to very strongly calcareous, nongravelly to fragmental (0-100% coarse fragments), and medium to coarse textured, depending on the source bedrock.

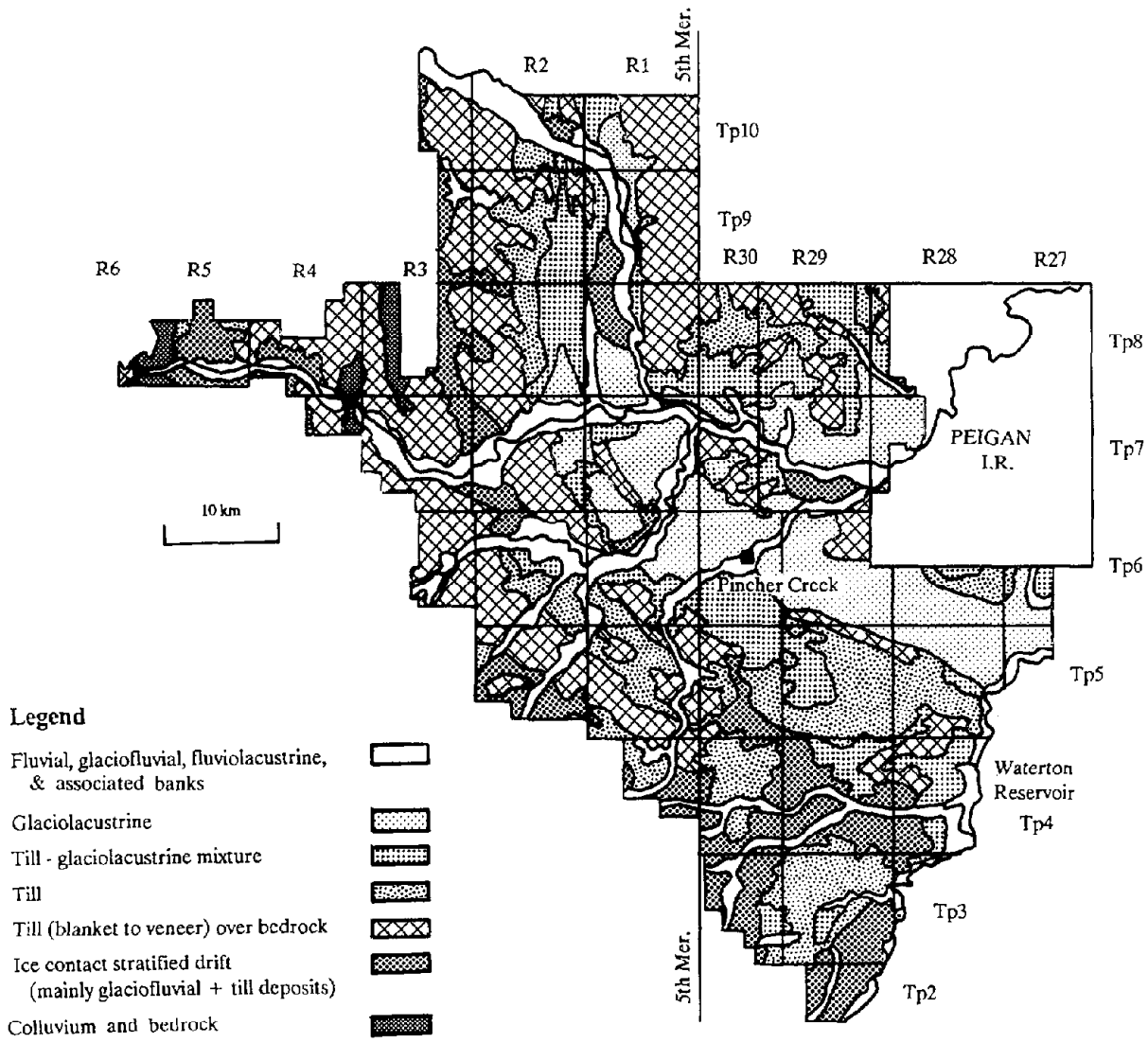


Figure 19. Generalized distribution of surficial deposits in the Pincher-Crowsnest area.

Colluvium

Discontinuous, shallow and locally deep, colluvial deposits occur on the steep slopes of the High Rock Ridges (Figs. 2 and 19). The colluvium varies from very gravelly to cobbly (35-60% coarse fragments), coarse to medium textured (mainly SL-L-SiL), and weakly to extremely calcareous. Strongly to extremely calcareous deposits are most abundant.

Coarse fragments and underlying bedrock are mainly limestones, but ashy loess may contribute significantly to the fine earth size fraction. Well sorted particle sizes, low bulk density, and low carbonate content suggest eolian origin for the fine earths at some sites.

Ice Contact Stratified Drift

Ice contact deposits occur in all physiographic areas (Figs. 2 and 19) but are most extensive in the foothills and mountains. Most form moraine-like landforms that consist of till plus very to extremely gravelly or cobbly glaciofluvial deposits. In some cases the glaciofluvial component may in fact be ablated mountain till; in others it may be mudflow material. Other types of variably textured and stratified proglacial deposits were also considered ice contact. In summary, ice contact materials have extreme lateral and vertical textural variability over shorter distances than can be mapped at the scale of this survey.

As an example, many hummocky to ridged ice contact landforms are dominated by till, which occurs on slopes and in depressions. But most sharp ridge and knoll tops have much coarser, usually quite gravelly, soils. The ridges may be eskers, the hummocks kames, and the depressions kettles in these stagnant or dead-ice moraines. Similar relationships occur where the dominant materials are sandy loam or loam water-laid deposits; the significant materials are gravelly to very gravelly or sandy glaciofluvial layers. In other cases, gravel soils may dominate but be associated with finer textured till-like deposits. In some stony ice contact terrain, small localized deposits of medium to fine textured glaciolacustrine sediments can be found.

Calcareousness of ice contact deposits also varies substantially. Weakly calcareous deposits can often be found near the mountains in the south part of Pincher M.D. In the other extreme, ice contact materials of the Crowsnest valley floor tend to be very strongly to extremely calcareous. Moderately to strongly calcareous deposits are common in other parts of the survey area.

Glaciolacustrine Deposits

Glaciolacustrine sediments dominate the Cardston Plain and extend into the adjoining fringes of the Porcupine Hills and Southern Foothills (Fig. 19). The vast majority are fine textured, often grading from silty clay or silty clay loam near the surface to clay or heavy clay at depth. Some of these sediments are nongravelly (2% or less coarse fragments) and varved; a substantial proportion contains some coarse fragments (listed as 2-15% but rarely more than 10%) and has been called lacustro-till in other studies (Kjearsgaard *et al.* 1986, Brierley *et al.* In press). Medium textured (CL-SiCL) glaciolacustrine deposits occur in some localities.

As with most other water-laid deposits, glaciolacustrine deposits tend to have slightly higher carbonate content than surrounding till. Moderate to strong calcareousness is the rule, often varying appreciably between layers within profiles.

Mixtures of glaciolacustrine sediment plus till occur on the Cow Creek Bench, and on adjacent parts of the Porcupine Hills and Southern Foothills (Fig. 19). The two materials usually grade one into the other with no clear sequences or contacts. Only in a few localities does glaciolacustrine material clearly occupy only depressional to lower slope positions, or form sharp contact with underlying till. The glaciolacustrine component can be either fine or medium textured. In several localities this mix of materials is rather shallow (less than 5 m) over bedrock.

Glaciofluvial Deposits

Glaciofluvial materials occur along major rivers and creeks in the survey area (Fig. 19). Within the larger valleys, middle to upper terraces may be of glaciofluvial origin. Glaciofluvial deposits also form hummocky to ridged landforms in some localities. On a smaller scale, glaciofluvial sediment is an intricate component of most ice contact terrain.

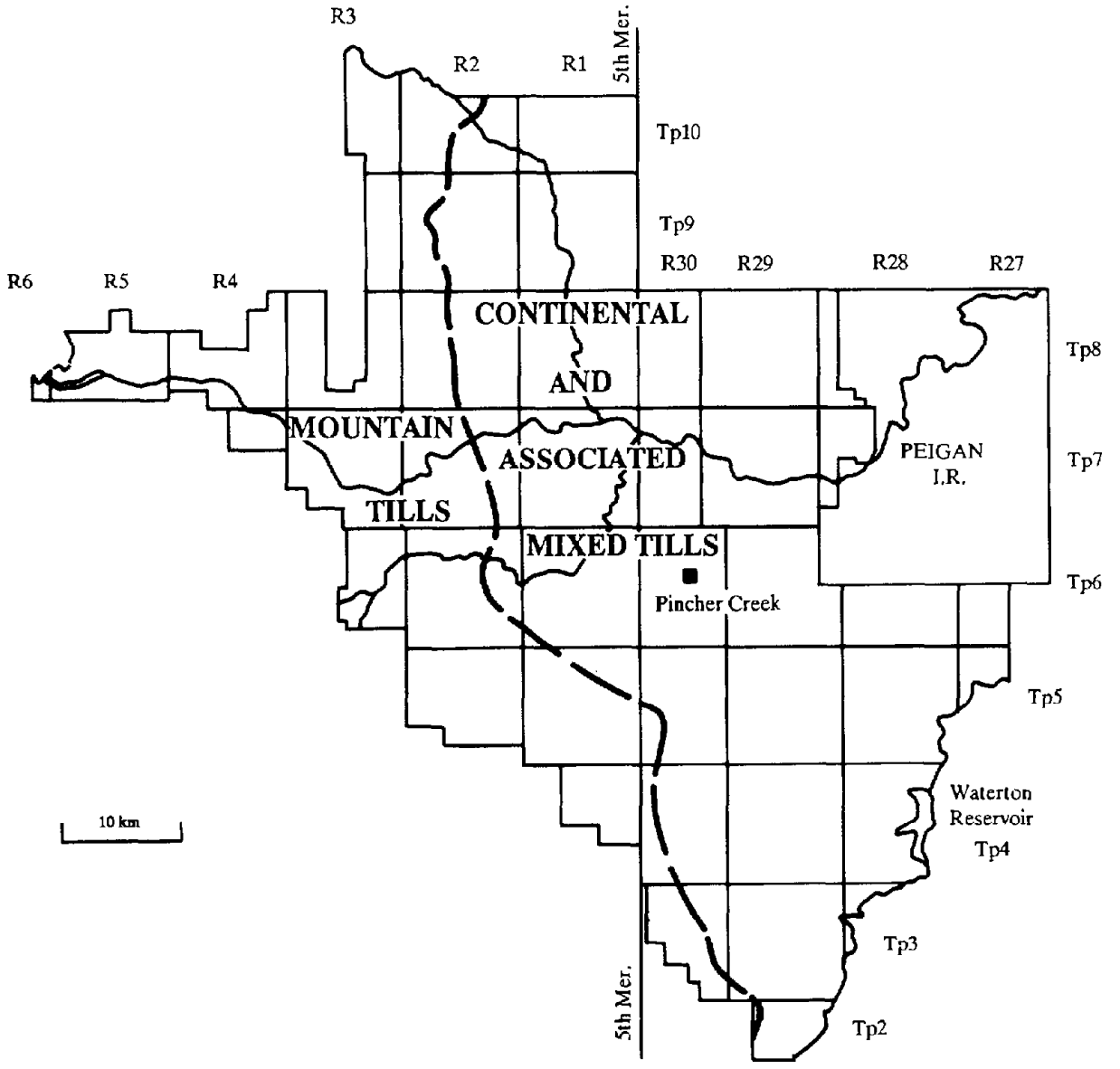


Figure 20. Approximate boundary between continental (Laurentide glaciation) and mountain tills (Cordilleran glaciation).

The majority of glaciofluvial deposits are extremely gravelly to cobbly (>60% coarse fragments), coarse textured (LS-S) gravel, also sometimes called outwash. Sometimes the gravel contains only 40-50% coarse fragments and has some sandy lenses or bands. Other less common glaciofluvial sediments are coarse textured (SL-LS-S) with few if any coarse fragments. The gravel is often discontinuously covered by some type of veneer or blanket. These vary from medium to coarse textured and nongravelly to very gravelly.

Veneer and blanket deposits likely represent waning glaciofluvial influence and a shift to fluvial regimes.

Glaciofluvial deposits have appreciably higher carbonate content than surrounding till. Weakly calcareous deposits can sometimes be found near the mountains in the southern part of Pincher M.D. In the other extreme, glaciofluvial materials of the Crowsnest valley tend to be extremely calcareous. Moderately to very strongly calcareous deposits are also very common.

Fluvial and Related Deposits

Lower terraces and floodplains along rivers and creeks (Fig. 19) are dominated by recent fluvial deposits. Fans and aprons associated with till in valleys of the Porcupine Hills, Southern Foothills and Front Ranges are also mainly of fluvial origin.

Texturally, fluvial deposits are extremely variable and often stratified. Most range from medium (CL-L-SiL-SiCL-SCL) to coarse (SL) textured, sometimes with a few gravels. Very coarse textured (LS-S) deposits are also sometimes present. Gravel deposits, with discontinuous coarse to medium textured veneer, occur along major rivers like the Waterton and Oldman. Fine-grained (CL-SiCL-SiL) fluvial deposits, similar to some glaciolacustrine sediments, may represent fine textured source materials or slow water deposition. These have sometimes been called fluviolacustrine materials, and include some slopewash deposits.

Fluvial deposits have highly variable carbonate contents that reflect surrounding source materials, but are usually higher than in the till. Weakly calcareous deposits can sometimes be found in parts of the Southern Foothills. Most fluvial deposits range from moderately to very strongly calcareous.

Fluvioeolian Deposits

Fluvioeolian deposits are too small and sporadic to show on generalized maps. Most occurrences are associated with the shallow to deep tills in the Southern Foothills and Front Ranges (Fig. 19). Here, a discontinuous fluvioeolian veneer or blanket mantles till on steep northeasterly aspects of the prominent ridges.

The relatively soft material originated as wind blown detritus picked up from exposed surfaces on windward slopes. After deposition on lee (northeasterly) slopes, the material was subjected to slopewash flow, slumping, wind throw of trees, and soil creep.

Fluvioeolian sediment is medium to coarse textured (mainly L-SL), sometimes with a few fine gravels and channers, and quite well sorted. In the mountains and Byron-Carbondale Hills, it tends to be non- to weakly calcareous. On the Beauvais Lake Upland, fluvioeolian deposits range from weakly to strongly calcareous.

THE SOILS: A GENERALIZED DESCRIPTION

INTRODUCTION

The soil resources of the Pincher Creek-Crowsnest Pass area are exceptionally diverse (Fig. 3). The first extensive soil survey of the area mapped soils at a generalized scale (Wyatt *et al.* 1939). The Pincher-Crowsnest survey, one of Cardston M.D. (No. 6) to the southeast (Brierley *et al.* In press), and another of the Lethbridge sheet to the northeast (Kocaoglu 1977) represent updates of the earlier work. Soil surveys of Waterton Lakes National Park (Coen and Holland 1976) and of the East Kootenay area in British Columbia (Lacelle 1990) border parts of the Pincher-Crowsnest area. A detailed soil survey exists for Beauvais Lake Provincial Park (Greenlee 1974). Land irrigability surveys exist for the Pincher Creek-Summerview area (Hardy Assoc. Ltd. 1986), the Cowley area (Hardy BBT Ltd. 1987), and the Peigan Indian Reserve (Harron 1982).

Such a variety of soil inventories illustrate that information about soil classification and distribution can be presented in a number of different ways. Following is a brief, generalized discussion on the major soil groups of the survey area as they relate mainly to the physiographic subdivisions and agroclimatic classes. First, soil mapping and classification procedures are outlined.

Appendices A, B and C provide expanded descriptive and interpretive information for readers requiring more technical data. Soils are described at the most detailed level of classification, the series level, in Appendix A. In Appendix B, the 78 soil units and 12 miscellaneous units comprising the 139 map units are described in some detail. Appendix C contains interpretive and land capability information for selected agricultural land uses, namely arable agriculture, irrigation and grazing.

MAPPING PROCEDURES

A soil survey is done to quantify and show, on maps, the different types of soils within an area. To conduct a soil survey, personnel systematically subdivide the landscape into repeating unit areas with similar patterns of soils. These areas are drawn on maps and interpreted in terms of suitability for certain land uses. Methodology used in preparation of the Pincher-Crowsnest soil maps is briefly explained below.

Field Activities

The whole survey area was traversed on road allowances in accessible areas, on trails and by foot in inaccessible areas. Soil profiles and site features were examined at intervals along these traverses. In reasonably accessible areas, approximately 100 sites per township, or 2 to 3 shared digs per quarter section, were inspected. The inspection density decreased dramatically in areas with limited access.

Several soil and site characteristics were measured and recorded at each inspection site. The soil features, observed in profiles often dug to about 1 m depth, included type, thickness and arrangement of horizons; textures; type and calcareousness of parent material. Soil structure, color, pH (acidity), consistence, depth to bedrock, salinity, drainage, depth to water table, and mottling were also recorded if important. The site characteristics, observed around each pit, included slope length, aspect and steepness; landform and relief; and site position in the landscape. Erosion, salinity, stoniness, seepage, and rockiness were

also noted where encountered. Generalized vegetation notes were taken on an informal basis.

Aerial photographs serve as important tools in the survey process. They were used to plan traverses and locate sites; to extrapolate site data; to identify repeating landform, soil and vegetation patterns; and to delineate (draw) these patterns on a map. In the Pincher-Crowsnest area, 1:63 360 scale aerial photos flown in 1973 were used extensively. Site inspection locations, topography notes, polygon boundaries, and other map related information was recorded on 1:30 000 scale township plans made from enlargements of 1982 aerial photos.

Legend Building

Soil-landform-vegetation groupings were identified from an analysis of the information sources described above. Different soils could then be related to different landscape features. As part of the analysis, the soils were classified according to accepted standards. (E.C.S.S. 1978b). Recurring combinations of classified soils became **soil units**, for example BZR1 (Beazer 1). Soil units were subdivided according to repeating topographic classes to become map units, for example BZR1/3 and BZR1/4. Thereby, the combination of a soil unit plus a topographic class is referred to as a **map unit**. Both soil and map units are defined in more detail in Appendix B.

Map units represent segments of the landscape that can be seen on the ground and delineated (drawn) on a map. For example, a **tract** of land classed as agroclimate 3H and dominated by Orthic Black soils developed in medium textured till with an undulating surface and slopes of 2-5% (slope class 3) can be recognized on the ground and on aerial photos. This tract becomes a **polygon** when drawn on a map. The polygon is identified by a shorthand label or **map unit symbol**, in this case BZR1/3.

Information on each polygon were recorded in the field and later computerized in a database management system. These data included polygon number, soil and map unit symbols, legal location, tract size, agroclimatic class, physiographic district, landform, parent material, texture, calcareousness, dominant and significant soils, dominant and significant topography classes, soil and topographic inclusions, and any special features. These data were entered for the BZR1/3 polygon of the example above. This polygon, however, represents only one of many labelled BZR1/3. Thus all BZR1/3 polygon records were sorted and analyzed to build and fine tune a BZR1/3 map unit concept. Similarly, all polygon records on BZR1/3, BZR1/4, BZR1/4D, BZR1/4R, and BZR1/5D were examined to formulate a BZR1 soil unit concept. The polygon data and township workplans are archived at Agriculture Canada's Soil Survey office in Edmonton, Alberta.

As the mapping progressed and the legend evolved, the number of map units and the total area of each were periodically scrutinized. Map units of limited area and similar composition were sometimes combined. For example, former map units DVBV9/4 and DVBV9/5 became DVBV9/4-5. Unique tracts of limited area that really didn't fit any map unit were often lumped with the closest matching map unit of substantial area. For example, two small tracts dominated by LNB soils and class 5 topography were mapped as OTP1/5 rather than keep a LNB1/5 map unit for about 50 ha (130 ac) of land.

Also as the survey progressed and the legend evolved, previous mapping was checked for accuracy and consistency, and updated where necessary. Some updates were the result of legend reviews and subsequent decisions about certain map units. In return, some checks

resulted in fine tuning of the legend. The whole cyclic feedback process, oscillating between mapping and legend development, is a normal part of soil survey projects.

As a final step, the polygons and their map unit symbols were transferred to four 1:50 000 scale planimetric base maps. These were digitized for electronic data handling systems, and prepared for publication. The four maps are labelled by their directional quadrant: northwest, southwest, southeast, and northeast.

SOIL CLASSIFICATION

Soils are classified for much the same reasons as most other things around us are classified - to organize the soil universe into logical, usable order, and to have shorthand names to identify different soils. The shorthand names are mandatory in this survey so that information about the soils can be more easily communicated. It is much simpler, for example, to refer to BZR (Beazer soil series) than to repeatedly describe a "grassland soil developed in medium textured till in areas classed as agroclimate 3H and having thin black topsoil". In the accepted Canadian system (E.C.S.S. 1987b), soils are classified according to their inherent genetic properties rather than some interpretation of those properties for various uses.

Soil formation (or pedogenesis) is a function of five environmental factors: climate, living organisms, topography (slope gradient and surface expression), parent material, and time. The interaction of these factors is complex and the importance of each differs from place to place. The resulting soils form a continuum with properties varying across the landscape. A soil classification system organizes this variability into a logical form.

The Soil Profile and Horizons

An important visual indication of soil formation is the presence of one or more pedogenic layers called **horizons**. A sequence of horizons makes up the **solum** (Fig. 21) which extends from the ground surface to the parent material. Type, sequence and thickness of horizons are characteristics examined when classifying soils.

An exposure showing the vertical sequence of soil horizons is called a soil **profile**. Soil scientists measure properties of soil horizons and classify the soils by examining soil profiles. A schematic soil profile with all master horizons is shown in Fig. 21. A real life example is shown in Fig. 22. Master horizons and some of their subdivisions are described below. No soil contains all of these horizons, but every soil has some of them.

L, F and H or O - are organic horizons. The organic material is raw in L (Of), partly decomposed in F (Om), and well decomposed in H (Oh). L, F and H horizons are derived from forest litter in upland sites, the O horizons from mosses, sedges and other wetland vegetation.

A - is a mineral horizon at or near the surface. In the majority of soils worldwide, the A represents a light colored zone of leaching (Ae) with the loss of clay, iron and humus to lower horizons. Across the prairie grasslands, the A is dark colored (Fig. 22) because of the accumulation of humus (Ah). Intergrades (Ahe) are common in the survey area.

AB and BA - are transitional horizons.

B - is a mineral horizon altered substantially compared to the parent material (or C horizon) and often enriched by products leached from the A horizon. Some have been enriched by clay (Bt), iron and other sesquioxides (Bf), or humus (Bh). Most carbonates (lime) and salts have been removed, resulting in color and structure changes due to oxidation in non-saturated environments (Bm), or reduction under saturated conditions (Bg). Some B horizons have hard columnar structure in association with significant amounts of exchangeable sodium (Bn) and clay (Bnt).

BC - is a transitional horizon.

C - is a mineral horizon that is comparatively unaffected by the soil forming processes operative in the A and B horizons. Exceptions include gleying (Cg) and the accumulation of carbonates (Cca) or salts (Csa). Most C horizons on the prairies have moderate levels of carbonate (Ck).

R - is a geologic layer composed of consolidated bedrock. It may occur close to the ground surface or many meters below.

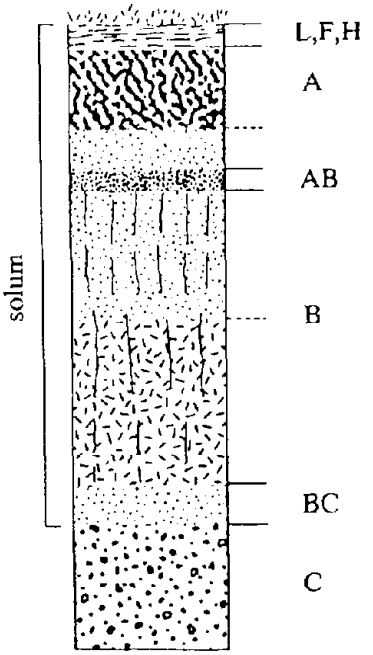


Figure 21. Schematic soil profile showing master soil horizons.

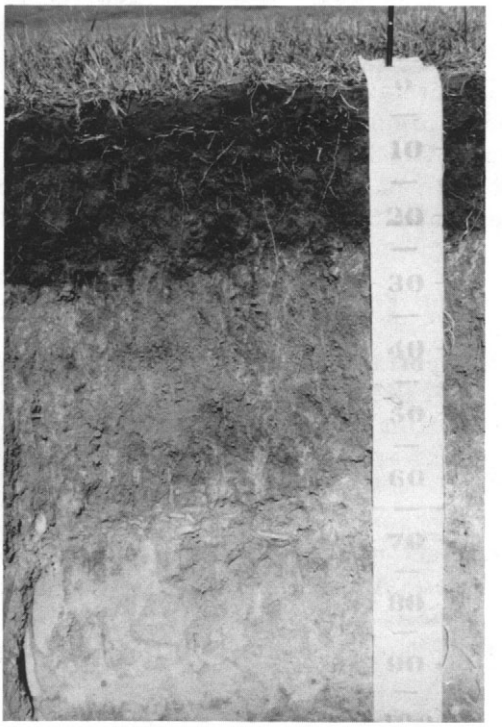


Figure 22. A typical soil profile of the prairie grasslands showing the A, B and C master horizons.

Soil Characteristics

Many soil characteristics are used to differentiate soil horizons and to classify soil bodies. Many interpretations of soils for various land uses depend on measurable properties. Some of the characteristics mentioned frequently in this report are described below.

Soil texture refers to the proportions of sand, silt and clay relative to all particles less than 2 mm in diameter (ie. fine earth). These have been organized into textural classes

and groups, with modifiers, as shown in Fig. 18. The modifiers express **coarse fragment content** (particles larger than 2 mm) as a proportion of total soil volume.

Soil color is determined and described according to the Munsell soil color system. The range and kinds of colors in soil horizons are often good indicators of organic matter content, drainage, aeration, and leaching - properties that can not be measured analytically at each site.

Soil structure is a feature that indicates pedogenic development and may influence plant growth, water movement, and soil stability. The form, size and durability of soil aggregates affect pore space, moisture-holding capacity, and distribution of roots within the soil mass. A soil horizon may have granular, blocky, platy, prismatic, or columnar structure, or it may be structureless (nonaggregated).

Soil reaction is expressed in pH values and is a measure of the acidity or alkalinity of a soil mass. It may range from extremely acid (below pH 4.5) to strongly alkaline (pH 8.5 and higher). Most soils of the survey area fit the medium acid to mildly alkaline range, pH 5.6 to 7.8.

Soil calcareousness is a measure of the amount of carbonates, mainly of calcium and magnesium, in a soil mass. Calcareousness is expressed as percent calcium carbonate equivalent and is grouped into classes (Table 4). Carbonates, also termed lime, commonly occur in soil parent materials (Ck horizons) in Alberta. However, lime may also be present in solum horizons due to incomplete leaching or to incorporation resulting from erosion.

Soil consistence, depth to bedrock, salinity, drainage, depth to water table, and mottling were also recorded if important, particularly in profiles that were sampled for laboratory analyses. Soil samples were collected and analyzed to check horizon designations and classification decisions, and to characterize some of the major soils. A total of 239 samples from 57 sites, 21 detailed pedons and 36 random sites, were sampled and analyzed in the lab. The analytical methods are outlined in Appendix A. Profile descriptions and analytical data for the detailed pedons, and for other soil series of southern Alberta, are available from Agriculture Canada's Soil Survey office in Edmonton, Alberta.

The Canadian System of Soil Classification

The Canadian system of soil classification (E.C.S.S. 1987b) is a hierarchical system with five formal taxonomic levels: order, great group, subgroup, family, and series. Classes at the order level have the broadest range of characteristics; classes at the series level the narrowest, most refined range of properties. A class separated at a more detailed level must fit within the broader classes above it in the ranking.

The Pincher-Crowsnest maps and legend were built using the series level of classification. Identified and named soil series and their equivalents - taxadjuncts and variants - are described in Appendix A. The remainder of this section will instead stress the broader levels of classification as they apply to soils of the survey area. Firstly, some important characteristics of the seven orders found in the Pincher-Crowsnest area are presented.

Brunisolic Order soils:

* have Bm horizons from which most carbonate has been removed, resulting in structure and color changes due to oxidation.
* lack B horizons that meet the criteria for Bt, Bf or Bg.

* occur under grassland to forest vegetation communities in a variety of areas, primarily in moderately well to rapidly drained parts of the landscape.
* include the base-rich **Eutric Brunisol** and acid **Dystric Brunisol** great groups.

Chernozemic Order soils:

* have dark colored (color value and chroma darker than 3.5 moist), organo-mineral surface horizons (Ah) at least 10 cm thick (15 cm if cultivated or otherwise disturbed).
* have 1-17% organic carbon and a carbon:nitrogen ratio less than 17 in the humus-rich A horizons.
* are base-rich (more than 80% base saturated) with calcium as the dominant cation.
* have a mean annual soil temperature of 0 ^{o}C or higher.
* do not have Bf, Bg, Bn, or Bnt horizons.
* include **Dark Brown**, **Black** and **Dark Gray** great groups, differentiated according to color of the A horizon.

Gleysolic Order soils:

* are characterized by dull colors and/or mottles which indicate periodic or sustained reducing conditions (gleying) during their development.
* develop in poorly to very poorly drained depressions such as slough bottoms, potholes and drains.
* develop under hydrophytic (wetland) vegetation.
* include **Gleysol**, **Humic Gleysol** and **Luvic Gleysol** great groups, differentiated according to the thickness of Ah horizon and the type of B horizon, if present.

Luvisolic Order soils:

* have Bt horizons enriched with clay leached from the horizons above, usually an Ae.
* occur in cool, moist areas under mixedwood and coniferous forest.
* feature only the **Gray Luvisol** Great Group in the Pincher-Crowsnest area.

Organic Order soils:

* are dominated by peat materials at least 40 cm thick if moderately or strongly decomposed, as is normal in the survey area.
* have O horizons with at least 17% organic carbon (30% organic matter).
* occur in very poorly drained depressions under hydrophytic vegetation such as sedge fen.
* feature mainly the **Mesisol** Great Group in a few localities of the survey area.

Regosolic Order soils:

* have little or no profile development other than depositional layers, and particularly have no B horizon.
* occur in recent deposits where there has been insufficient time to develop soil horizons, or in severely eroded sites where horizons have been destroyed.
* include **Regosol** and **Humic Regosol** great groups, separated on thickness of Ah horizon, if present.

Solonetzic Order soils:

* have hard columnar B horizons with significant amounts of exchangeable sodium (Bn) and clay (Bnt).
* have a calcium:sodium ratio in exchangeable cations of 10 or less in the B horizon.
* are associated with saline parent materials high in sodium.
* include **Solonetz**, **Solodized Solonetz**, and **Solod** great groups in a few localities in the Pincher-Crowsnest area.

A GENERALIZED SOILS MAP

A generalized soils map, extracted from the 1:50 000 scale soil maps (in the back pocket), shows broad trends in soil distribution (Fig. 23). These trends can be linked to different soil forming factors taking precedence in different areas.

In the eastern and central parts of the survey area, climatic parameters, especially moisture, appear to influence soil (and vegetation) distribution. Overall climate is cooler and moister in the foothill-mountain complex to the west. Here various elements of topography - slope gradient, aspect, relief - locally modify the climate to produce complex soil and vegetation patterns. These patterns are also influenced by different parent material characteristics, especially calcareousness, which may affect the direction and degree of soil development.

Following is a discussion of the broad groups of soils (Fig. 23), proceeding from the warmest, driest areas in the east to the coolest, moistest in the west.

Dark Brown Soils

Dark Brown soils belong to the Chernozemic Order and are distinguished from Blacks by the color of topsoil, called Ah or Ap horizon (E.C.S.S. 1987b). The major area of Dark Brown soils occurs in the east central part of the survey area (Fig. 23), on the Cowley Basin (Fig. 2).

The Dark Brown soils are associated with agroclimatic subclass 2AH (Fig. 14), defined as having a moisture index drier than -400 P-PE. A strip of land extending west and north from Tennessee Cr., along the Oldman and Crowsnest valleys, is drier than -400 (Fig. 15). Both Black and Dark Brown soils are present amongst the eroded soils of this locality, but the boundary between them is transitional and not strongly apparent. Consequently, Tennessee Cr. valley was chosen as a boundary of convenience to separate Dark Brown from Black soils in the Oldman R. basin.

Moist elements of the Mixed Grassland Ecoregion (Strong and Leggat 1981) may extend into the area of Dark Brown soils, but no native range was encountered. Heat units (1250 EGDD or more) and topography are favorable for the production of most cereal crops, thus most of the land has been cultivated, or affected by cultivation (Fig. 24).

Rego and **Calcareous Dark Brown** are the two major subgroups found in the area of Dark Brown soils. Rego Dark Brown soils have no B horizon; Calcareous Dark Brown soils have a calcareous Bmk horizon (E.C.S.S. 1987b). Both are the product of erosion. There is, however, some circumstantial evidence which suggests that the majority of soils, in their native state, had unusually thin topsoil (Ah horizons) and possibly incomplete removal of lime from the B horizon. Orthic Dark Brown soils, characterized by noncalcareous Bm horizons, are nearly nonexistent in the area.

The majority of Dark Brown soils occur on fine textured glaciolacustrine sediments (Fig. 20). **BKE (Brocket)** is the dominant soil series of the area. It is developed in the fine textured glaciolacustrine deposits and is classed Rego Dark Brown. Shallow till overlying bedrock occurs at the upper edge of the glaciolacustrine plain where it skirts the Porcupine Hills.

Coarse textured glaciofluvial and related ice contact deposits, including gravel, are important along the Oldman R. valley. Several series and variants occur in these complex

deposits. Fig. 25 shows a **MAC (Macleod)** profile developed in glaciofluvial gravel; Fig. 26 shows one of the many terraces, along the Oldman R., that contain MAC soils.

Black Soils

Black soils belong to the Chernozemic Order and are distinguished from Dark Browns and Dark Grays by the color of topsoil, called Ah or Ap horizons (E.C.S.S. 1987b). Black soils dominate the Pincher-Crowsnest area, but show substantial diversity in response to climatic gradients, topography factors, parent materials, and man's activities. Differences can best be examined by subdividing the area of Black soils as shown in Fig. 23. Eroded thin Black soils dominate the Cowley Basin. A variety of thin Black soils occur on the Cow Creek Bench and adjoining fringes of the Southern Foothills and Porcupine Hills. Thick Black soils dominate the foothills, extending well into the aspen parkland.

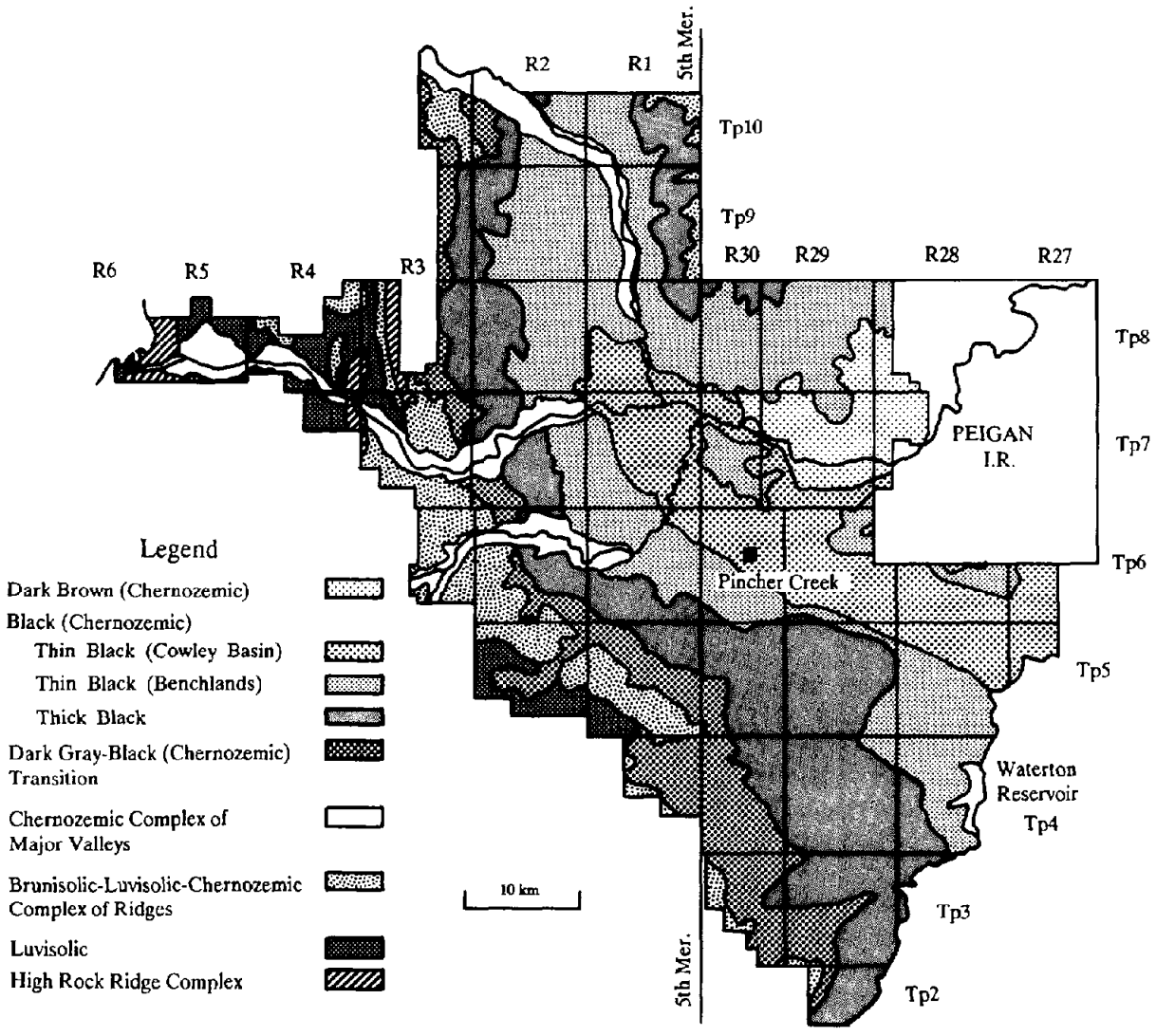


Figure 23. Generalized soil map of the Pincher-Crowsnest area.

Figure 24. Nearly level glaciolacustrine terrain dominated by BKE soils (BKE1/2 map unit) and used for production of cereal grains.

Thin Black Soils of the Cowley Basin

Eroded thin Black soils dominate the large glaciolacustrine plain called the Cowley Basin (Figs. 2 and 23). This area belongs to the Fescue Grassland Ecoregion (Strong and Leggat 1981) although there is not much native range to be found. Climatic and topographic conditions are favorable for the production of most cereal crops, thus most of the land has been cultivated, or affected by cultivation (Fig. 27).

This lower elevation thin Black soil area is associated with agroclimatic subclass 2HA (Fig. 14). EGDD index ranges from about 1180 to 1250. P-PE index ranges from roughly -300 to -400 over most of the area. A strip of land along the Oldman and Crowsnest valleys which is drier than -400 (Fig. 15).

Soil development, however, has likely been responsive to the moderately dry conditions. Topsoil (Ah horizon) is thin at 10-15cm, or 15-20 cm if cultivated (Ap horizon). Sola of the better developed, uneroded soils are less than 50 cm thick. Thus these Black soils are labelled thin.

Figure 25. A Calcareous Dark Brown, called MAC (Macleod) series, developed in glaciofluvial gravel.

Calcareous and **Rego Black** are the two major subgroups found in the area. Calcareous Black soils have a calcareous Bmk horizon; Rego Blacks have no B horizon (E.C.S.S. 1987b). Erosion over much of the area has been a factor in their formation. However, circumstantial evidence suggests that some soils had, in their native state, unusually thin topsoil (Ah horizon) and possibly incomplete removal of lime from the B horizon. Thus some of the Calcareous Black soils may be natural , particularly those along the Oldman and Crowsnest valleys. **Orthic Black** soils, characterized by noncalcareous Bm horizons, are significant in the area.

The majority of soils in the Cowley Basin occur in fine textured glaciolacustrine sediments. CWY (Cowley) series (Plate IA) classed as Calcareous Black, and a Rego Black variant are developed in these deposits. Medium textured water-laid deposits are important in some localities. Till occurs locally on the highest parts of the Basin. Coarse to medium textured glaciofluvial and fluvial deposits occur along major streams that dissect the area.

Saline and Solonetzic variants of the finer textured soils can be found in a few localities. Gleysolic soils are important in terrain with appreciable potholes and slough bottoms.

Thin Black Soils of the Benchlands

A variety of thin Black soils occurs on the Cow Creek and Goose Lake Bench subdistricts and benchlands (Fig. 23) comprised of adjoining parts of the Southern Foothills and Porcupine Hills (Fig. 2). This area belongs to the Fescue Grassland Ecoregion (Strong and Leggat 1981) and contains substantial rangeland, particularly on steeper terrain. Where soil and topographic conditions are favorable, the soils have been cultivated for production of cereal grains, mainly barley, and forage crops.

Figure 26. Terraces like this one along the Oldman R. contain gravel deposits and soils like MAC. In many cases, the gravel is mined for use as construction material.

This upper elevation area of thin Black soils is associated with agroclimatic class 3H (Fig. 14). EGDD index ranges from about 1050 to 1180, a moderate limitation that can affect spring wheat. P-PE index ranges from roughly -260 to -300 in the south, -300 to -400 in

the north of the survey area. An unusually dry area, with P-PE drier than -400, extends northward from the Cowley area along the Oldman R. basin (Fig. 15). In fact, the whole area north of the Castle R. is much drier, on an equal elevation basis, than the southern end of Pincher M.D.

While crops may be affected by the lack of heat units, soil development reflects the moderately to slightly dry conditions. Topsoil (Ah horizon) is thin at 10-15cm, or 15-20 cm if cultivated (Ap horizon). Sola of the better-developed uneroded soils are less than 50 cm thick. Thus these Black soils are labelled thin.

Figure 27. Very gently sloping glaciolacustrine terrain dominated by CWY soils (CWY1/3 map unit) and used for production of cereal grains.

Orthic Black is the dominant subgroup of the area. Orthic Blacks are characterized by noncalcareous Bm horizons. **Calcareous** and **Rego Black** soils dominate a belt that extends from the Lundbreck-Cowley area northward up the Oldman R. basin, and southeastward across the southern end of the Porcupine Hills. Calcareous Black soils have a calcareous Bmk horizon; Rego Blacks have no B horizon (E.C.S.S. 1987b). As in the Cowley Basin, some of the Calcareous and Rego Black soils are the products of erosion, and some are naturally occurring.

Till is an important surficial material of the benchlands area. **BZR (Beazer)** series, classified Orthic Black, occurs in the till. Vaguely similar soils occur on prominent ridges and hills where the till is shallow over bedrock. Fine and medium textured glaciolacustrine and related water-laid deposits occur in small basins or are mixed with the till. **CTN (Cardston)** and **CWY (Cowley)** series, classed Orthic and Calcareous Black respectively, occur in the fine textured sediments.

Coarse to medium textured glaciofluvial and fluvial deposits, including gravel, occur along major streams that dissect the area. Other coarse textured soils are associated with ice contact landforms scattered throughout the area. Several series and variants occur in these complex deposits.

Saline and Solonetzic variants of fine to medium textured soils can be found in a few localities. Gleysolic soils are important in terrain with appreciable potholes and slough bottoms, like those on the Goose Lake Bench.

Thick Black Soils

The thick Black soil belt (Fig. 23) occurs throughout much of the Porcupine Hills, Beauvais Lake Upland and Goose Lake Bench, and in the Byron-Carbondale Hills area north of Burmis. Its soils, parent materials and landforms are quite diverse.

Thick Black soils extend from the Fescue Grassland Ecoregion (Strong and Leggat 1981) into aspen parkland to the west. Aspen groves, or sometimes willow clumps, generally cover less than 50% of the landscape. The area is dominantly native or improved rangeland. In some localities where soil, climatic and topographic conditions are favorable, the soils have been cultivated for production of forages and cereal grains like oats and barley.

The Thick Black area is associated with agroclimatic class 4H (Fig. 14). EGDD index ranges from about 950 to 1050, a severe limitation on the range of crops which can be grown. P-PE index ranges from about -260 to -300 over the drier lands north of the Castle R. Significantly moister conditions, with P-PE values higher than -260, prevail in the Thick Black area located to the southeast of Beaver Mines (Fig.14). In this moist subarea, Thick Black soils actually extend northeastwards, well onto lands classed as agroclimate 3H on the Goose Lake Bench. Here the range of crops grown is wider than normal for Thick Black soils.

While crops may be limited by the lack of heat units, soil development reflects adequate moisture. Topsoil (Ah horizon) is 15 cm or more thick, 20 cm or more if cultivated (Ap horizon). Sola of most soils are 50 cm or more thick, except in parent materials with high carbonate content. Thus these Black soils are labelled thick.

Orthic Black is by far the dominant subgroup of the Thick Black soil area. Orthic Blacks are characterized by noncalcareous Bm or Bt horizons. **Calcareous** and **Rego Blacks**, and **Orthic** and **Cumulic Regosols**, occur in recent deposits associated with the streams that cut through the area. Calcareous Black soils have a calcareous Bmk horizon; Rego Blacks have no B horizon. **Orthic Eutric Brunisol** soils, with very thin topsoil (4-9 cm of Ah horizon), are important on steep, relatively dry terrain.

Till of various origins is the most important surficial material of the Thick Black belt. **DVG (Dunvargan)** series, classed Orthic Black, occurs in continental till. Vaguely similar soils occur on prominent ridges and hills where the till is shallow over bedrock. Paraskeletal (gravelly) variants of DVG and the shallow soils are characteristic of the mountain tills along the western side of the belt. Fine and medium textured glaciolacustrine and related water-laid deposits are sometimes mixed with the tills.

Ice contact landforms are scattered throughout the area, and are especially common in the Spread Eagle and Park View localities. Coarse textured Orthic Black soils such as OTP (Outpost) and CRW (Carway) series are associated with the ice contact deposits. Coarse to medium textured glaciofluvial and fluvial deposits occur along streams.

Gleysolic soils are important in terrain with potholes, slough bottoms and drains. Substantial area of such terrain exists in the Goose Lake to Twin Butte localities.

Dark Gray-Black Transition

West of the Thick Black soil belt, aspen parkland grades to aspen and mixedwood forest. Likewise the soils grade from Black to Dark Gray in response to weak leaching under well established aspen stands. The Dark Gray soils belong to the Chernozemic Order and are distinguished from the Blacks by the color of topsoil, called Ahe and Ah horizons (E.C.S.S. 1987b).

Most of the area is used as pasture and woodland grazing. In a few localities where soil, climatic and topographic conditions are favorable, the soils have been cultivated for production of forage crops.

The Dark Gray-Black transition area is associated with agroclimatic class 5H (Fig. 14). EGDD index ranges from about 700 to 950, a very severe limitation which inhibits arable agriculture. P-PE index is usually moister than -260, thus moisture is not limiting.

Soil development reflects more than adequate moisture. Topsoil (Ahe horizon) of the Dark Gray soils has grayish to brownish streaks and blotches ("salt and pepper" effect) associated with weak leaching. Topsoil (Ah horizon) of the Black soils is 15 cm or more thick. Sola in both great groups are 50 cm or more thick, except where parent materials have high carbonate content.

Orthic Dark Gray and **Orthic Black** are the dominant subgroups of the transition area. Both are characterized by noncalcareous Bm or Bt horizons. **Orthic Eutric Brunisol** soils, with very thin topsoil (4-9 cm of Ah horizon), are important on steep, relatively dry, grassland terrain. Similar soils occur in highly calcareous, coarse textured, glaciofluvial deposits around Lees Lake. **Calcareous** and **Rego Black** soils, and **Orthic** and **Cumulic Regosols**, occur in recent deposits associated with streams that cut through the area.

Till of mixed and mountain origin is the most important surficial material of the Dark Gray-Black transition. **BVA (Beauvais)** and **DVG (Dunvargan)** series plus their paraskeletal (or gravelly) variants occur in the tills. BVA is classified as Orthic Dark Gray, DVG as Orthic Black. Vaguely similar soils occur on prominent ridges and hills where the till is shallow over bedrock. Fine textured till-like material occurs in some localities, near Pecten for example.

Medium textured fluvial, fluviolacustrine and mudflow deposits occupy several valley bottoms. **MFT (Maycroft)** series, classed as Orthic Black, and **TDC (Todd Creek)** series, classed as Gleyed Dark Gray (Plate IB), occur in these materials. TDC and gleyed versions of MFT often occur under seepage affected mixedwood forest (Fig. 28).

Ice contact landforms are common throughout the area. Glaciofluvial and fluvial deposits occur along streams. Various coarse to medium textured soils are associated with these materials.

Gleysolic soils are important in terrain with appreciable potholes, slough bottoms and drains. Substantial areas of such terrain exists in the Pecten and Spread Eagle localities.

Valley Chernozemic Soil Complex

Three major river valleys cut across the southeast-northwest trending structures of the Front Ranges and Southern Foothills (Figs. 2 and 23). The floors of these valleys are dominated by Fescue and Montane grasslands, with groves of aspen, Douglas fir, and

Douglas fir mixedwood in some areas. Chernozemic soils dominate, and like the grasslands, reflect unusually arid conditions compared to surrounding landscapes. The three major river valleys are the Crowsnest (Fig. 29), Castle-Carbondale and Oldman.

Figure 28. Mixedwood forest affected by seepage and associated with TDC soils includes aspen, cottonwood and spruce.

Most land in the valleys is used for grazing. The Crowsnest valley floor, however, also contains lands that have been developed for urban, industrial and recreational uses. In a few localities where moisture and topographic conditions are favorable, the soils have been cultivated for forage crop production.

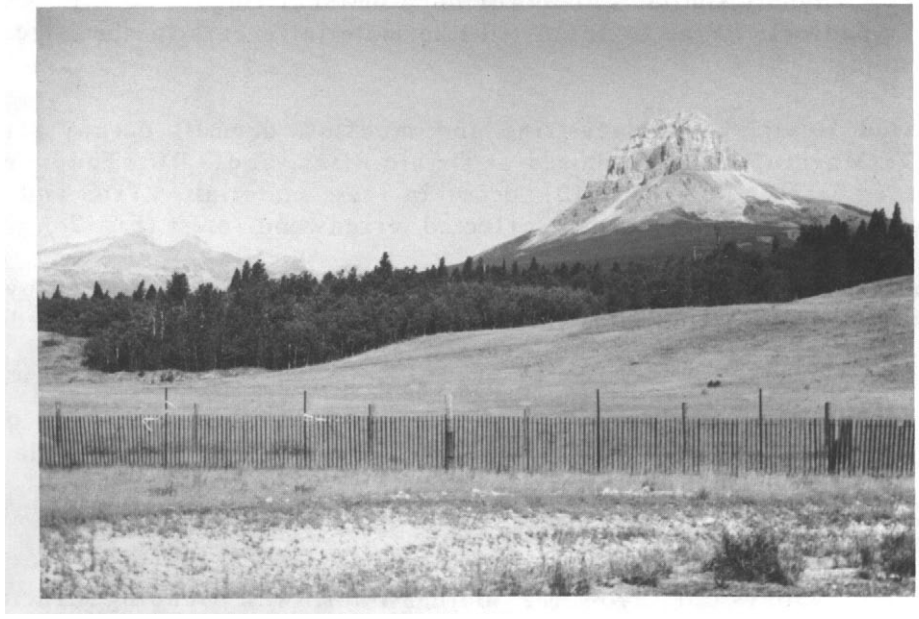


Figure 29. Montane grassland against a backdrop of aspen, Douglas fir and lodgepole pine forests in the Crowsnest valley.

The valley soil complex is associated with agroclimatic classes 5H to 3H. EGDD index ranges from about 700 to 1180. Based on values at Coleman, P-PE index is roughly -260 and drier, especially during the growing season (Table 2). Physiographic effects on air movement, wind patterns and precipitation distribution likely contribute to the aridity in these areas.

Glaciofluvial terraces (Fig. 30) and modern fluvial floodplains, plus associated risers and side slopes, dominate the valley floors. Benchlands, best expressed in the Crowsnest valley, are characterized by hummocky ice contact deposits, sometimes overlying bedrock at shallow depths. Most materials are strongly to extremely calcareous, except in the Castle-Carbondale valley.

Soil development reflects the dry conditions, intensified by the highly calcareous, coarse textured, very to extremely gravelly or cobbly, parent materials.

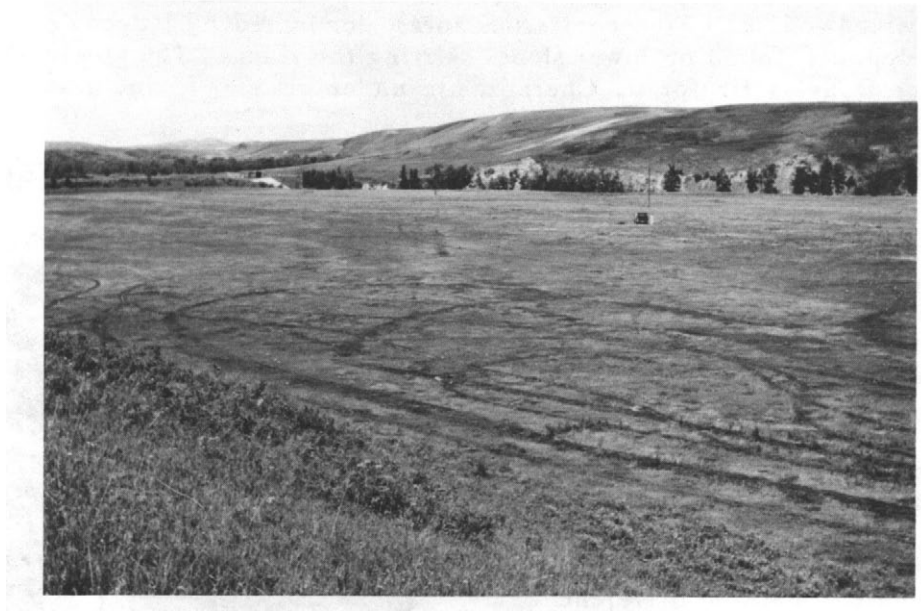


Figure 30. Terraces like this one along Drywood Cr. consist of gravel deposits and have soils like DRW. The gravel is often mined for use as construction material.

Terraced grassland terrain (Fig. 30), consisting of coarse textured glaciofluvial and fluvial gravel, is dominated by **Rego, Calcareous** and **Orthic Black** soils. **BUR (Burmis)** series, classified as Rego Black, occurs extensively in the Crowsnest R. valley. **DRW (Drywood)** and **LNB (Lundbreck)** series, classified as Orthic Black, are common in other valleys. Plate IC shows a DRW profile. Some of the higher elevation gravel deposits have **Orthic Eutric Brunisols** occurring under lodgepole pine and mixed coniferous forest.

Modern floodplains and terraces, with cottonwood or mixedwood forest and patches of shrubland and grassland, characterize the bottomlands. Soils in the recent deposits vary substantially according to drainage and texture. **Orthic** and **Cumulic Regosols** dominate well to rapidly drained, coarse textured deposits. Various Gleysolic soils, mainly **Orthic** and **Rego Humic Gleysols**, dominate poorly drained, water-laid deposits along the Crowsnest R. west of Blairmore. In well drained, medium to coarse textured, fluvial deposits, weakly developed **Orthic Eutric Brunisols** and various Regosolic soils are prevalent. Rego Blacks, **Gleyed Rego Blacks**, and Gleysolics are important in the Oldman R. valley.

Brunisolic soils are important in highly calcareous, ice contact deposits, particularly of the Crowsnest valley benchlands. **Eluviated** and **Orthic Eutric Brunisol** soils characterize the Douglas fir and Douglas fir mixedwood groves (Fig. 31). Eluviated Brunisols have thin and weakly leached A horizons (Aej or Ae); Orthic Brunisols have little or no Ah horizon. **MGV (McGillivray)** series, classed Eluviated Eutric Brunisol (Plate ID), occurs in medium textured skeletal materials. Orthic Black soils, occur in similar materials as part of an intricate Brunisolic-Chernozemic soil pattern. **Dark Gray** soils occur in some localities under aspen and mixedwood.

Brunisolic-Luvisolic-Chernozemic Soil Complex

Most of the Byron-Carbondale Hills and Grassy Mountain Ridges (Figs. 2 and 23) are characterized by an intricate, strongly contrasting pattern of vegetation and soils (Fig. 32). Coniferous forest dominated by Douglas fir characterizes steep northerly to easterly aspects. Patches of Montane grassland characterize steep south to west facing slopes with shallow soils. Mixedwood or mixed coniferous forest dominated by lodgepole pine occurs on the deepest deposits, found on lower slopes skirting the ridges. The dominant soils are Brunisolic under Douglas fir forest, Chernozemic under grassland, and Luvisolic under pine forest.

Microclimate varies dramatically across these southeast-northwest oriented ridges. Associated agroclimatic classes are 5H to 6H, and sometimes 7H at high elevations on northerly aspects. Overall, EGDD index is less than 950, P-PE index moister than -260. Locally, south facing grassland patches may be warmer and drier. Generally, the Montane grasslands are associated with class 5H, the forested sectors with 6H and 7H.

Soil development reflects microclimatic, vegetative and parent material differences. **Eluviated** and **Orthic Dystric Brunisols** are associated with Douglas fir and Douglas fir-lodgepole pine forest on steep north to east facing slopes (Fig. 33). Dystric Brunisols have acidic (pH less than 5.5) upper sola, a function of non- to weakly calcareous parent materials. The Eluviated Brunisols have thin, weakly leached A horizons (Aej or Ae); the Orthic Brunisols have no A horizon. Various slope processes like wind throw of trees, slumping and soil creep inhibit the development of strongly leached Ae horizons. **WLB (Willoughby)** series is an Eluviated Dystric Brunisol developed in fluvioeolian material overlying till (Plate IE). Bedrock commonly occurs within 5 m of the ground surface.

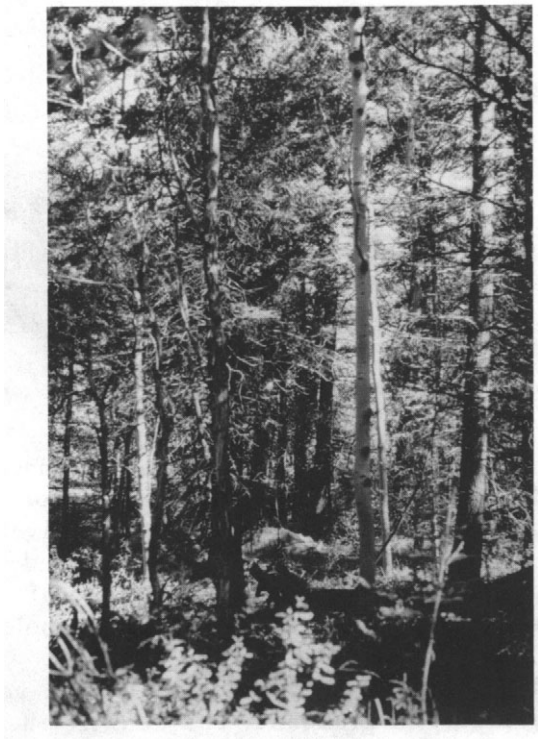


Figure 31. Dry mixedwood forest, associated with MGV soils, includes Douglas fir, lodgepole pine and aspen.

The Montane grassland segments of the landscape (Fig. 34) are dominated by **Orthic Dark Brown** soils, originally called "Mountain Chernozems" in earlier unpublished surveys. **BEV**

(Bellevue) series and related variants are developed in shallow, discontinous colluvium and till overlying solid or fractured bedrock (Plate IF). **Orthic Eutric Brunisols and Orthic Blacks** are sometimes associated with the BEV soils.

Figure 32. Intricate pattern of forest and grassland in the Byron-Carbondale Hills of the Southern Foothills.

Deep till deposits skirt many of the ridges and occupy small valleys within the ridged complex. Well established mixedwood or mixed coniferous forest, often dominated by lodgepole pine, are common on these segments. Moist climatic conditions, lush forest vegetation, and deep, stable parent materials have favored the development of weakly to moderately leached, humus-rich soils. **Orthic Dark Gray** and **Dark Gray Luvisol** are the characteristic subgroups. Orthic Dark Grays belong to the Chernozemic Order and have fairly thick topsoil (Ahe horizon) with grayish to brownish streaks and blotches. Dark Gray Luvisols, of the Luvisolic Order, have distinctly leached horizons (Ae) at least 5 cm thick beneath the humus-rich topsoil (Ahe horizon). **Orthic Gray Luvisols** and **Orthic Black** soils may also be found in this segment of the landscape.

Most land belonging to this "Montane ridge" complex is used for grazing. The esthetically attractive landscape is also desirable for various recreational uses, and for wildlife. Some localities have produced merchantable stands of timber.

Luvisolic Soils

The area dominated by Luvisolic soils (Fig. 23) includes lower valley walls, upper benchlands, and some moderate relief ridges in the Front Ranges, and similar landscapes in the Gladstone Valley area where the southern Foothills meet the Clark Range. Lodgepole pine or lodgepole pine-Douglas fir forest is the dominant vegetation (Fig. 35). Parent materials are mainly deep till and ice contact deposits, although some shallow till covered bedrock ridges are included.

The Luvisolic soil area is associated with agroclimatic classes 6H to 5H, and occasionally 7H at high elevations on northerly aspects. Overall, EGDD index is less than 950. P-PE

index is likely considerably moister than -260, except perhaps on a few south facing grassland patches.

Soil development reflects the cool, moist climatic conditions, well established coniferous forest cover, and deep stable parent materials. The majority of soils have distinctly leached topsoil with very low humus content (Ae horizons). Clay leached from the Ae has enriched the B horizon beneath to form a Bt. Such soils are classed **Orthic Gray Luvisol**, at one time called "Gray Wooded" soils. **SPR (Spruce Ridge)** series and several variants are the main Orthic Gray Luvisols of the area.

Dark Gray Luvisols are often associated with the SPR soils in the Gladstone Valley area. Dark Gray Luvisols are similar to Orthic Gray Luvisols but have dark gray, weakly leached, humus-rich topsoil (Ahe horizon) over the Ae horizon. **Dark Gray** soils also occur in a few localities.

The Luvisolic soil area includes, in the Front Ranges, bedrock ridges covered with shallow till. **Eluviated** and **Orthic Dystric Brunisols** often occur under coniferous forest on steep upper slopes. Small patches of Montane grassland may be present on steep southerly aspects in conjunction with shallow soils. These include **Orthic Dark Browns, Orthic Eutric Brunisols** and **Orthic Blacks.**

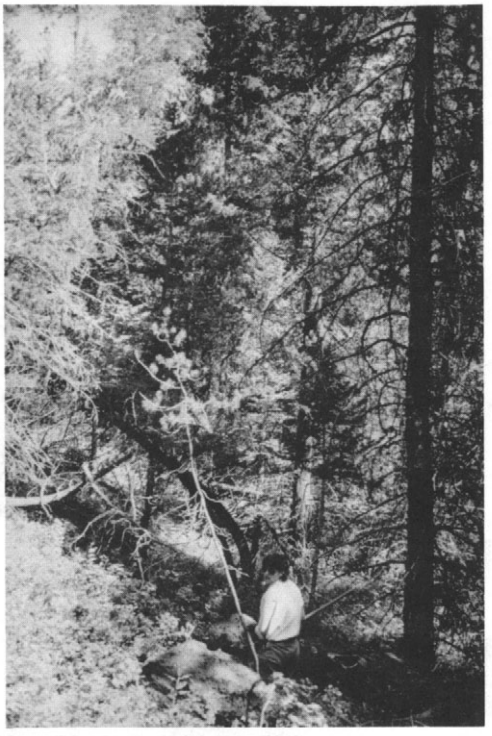


Figure 33. Douglas fir-lodgepole pine forest, associated with WLB soils, on a steep northeast facing slope in the Byron-Carbondale Hills.

A few other soils are occasionally present, usually on valley floors in ice contact, glaciofluvial or fluvial deposits. These include **Orthic Blacks, Orthic** and **Eluviated Eutric Brunisols** and **Gleyed** and **Orthic Dark Grays.**

Most of the Luvisolic soil area is used for grazing. The esthetically attractive landscape is also desirable for various recreational uses. For example, a network of snowmobile and cross-country ski trails has been developed in the Allison Cr. area. Some localities have produced merchantable timber stands.

The High Rock Ridge Complex

The most striking feature of the Front Ranges are the mountains like Turtle Mtn., Mt. Tecumseh, the Livingstone Range, and others which belong to the High Rock Ridge subdistrict (Fig. 2). Limestone bedrock forms the core of these high, steep structures. Mountain tops are normally rugged and rocky with little or no vegetative cover. The mountain walls have a thin mantle of colluvium on upper to middle slopes. The colluvium-bedrock complex extends to the Crowsnest valley floor near Blairmore and Crowsnest Lake.

Mesoclimate associated with this rugged mountain terrain is predominantly cool and moist, fitting agroclimatic classes 6H and 7H. Where colluvium predominates, vegetative cover ranges from closed and open coniferous forest to shrubland. Trees are mainly lodgepole pine and Douglas fir at lower elevations, Engelmann spruce and subalpine fir at higher elevations.

Figure 34. Montane grassland. associated with BEV soils. on a steep SW facing slope in the Byron-Carbondale Hills.

Orthic Eutric Brunisol is the major subgroup associated with the colluvial deposits. These base-rich, high pH soils reflect the calcareous parent materials. Leaching and humus enrichment are usually not evident, and the soils commonly have no A horizons. **FRK (Frank)** series and related lithic soils are characteristic of this landscape.

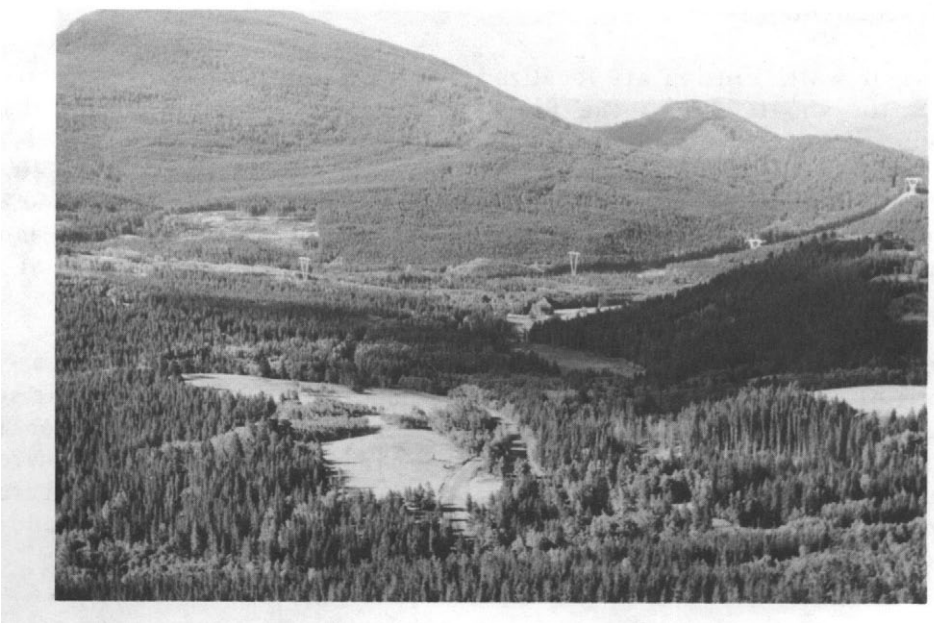


Figure 35. Forest dominated by lodgepole pine characterizes areas of Luvisolic soils in the foothills and mountains.

Regosolic soils are significant where colluvial processes, including avalanching, have recently disturbed the soil sola. **Orthic Regosol** and **Orthic Humic Regosol** subgroups, the latter with at least 10 cm of humus-rich topsoil (Ah horizon), occur on mid to upper slopes. Occasionally, **Cumulic Regosols** and **Cumulic Humic Regosols**, both with buried Ah horizons, occur in depositional sites on lower slopes.

The vegetated colluvial slopes often end rather abruptly at high elevations where the more stable slopes meet the steep, rocky, unvegetated mountain tops. Here, nonsoil consisting of consolidated bedrock, mainly limestones, is dominant. Regosolic soils, developed in a thin discontinuous mantle of colluvium, are significant.

These high mountain landscapes are far too steep and inaccessible for rangeland or timberland uses. But it is this same imposing ruggedness that is a major part of the area's esthetic appeal. Also, the high mountain ridges provide refuge for several species of wildlife, and may support light recreational activities like hiking and climbing.

SOIL DEGRADATION

Obvious degradation problems observed during the course of this survey are soil erosion and salinity. Soil erosion by wind has affected by far the most land, much of it severely.

Soil Erosion

Erosion by water and wind is evident in the survey area. The effects of water erosion are mainly local, with the development of rills and small gullies in sites of removal, tiny fans and aprons in depositional sites. If unchecked, gully erosion will eventually create large gullies that can dissect fields and hinder cultivation operations.

Serious erosion by water was noted once during this soil survey. In 1986, substantial snow cover left by a spring storm was melted in a matter of hours by the sudden warming of a chinook. Many bare fields were impacted, on a wide scale by sheet erosion, locally by rills and small gullies. Many ditches and other small depressions became catchments for "fluvial topsoil" sediment.

While the effects of water erosion are localized, wind erosion is extensive. Nearly 60 000 ha (149 000 ac), or about 22% of the Pincher-Crowsnest area, has been substantially modified by wind erosion. Roughly 48 000 ha (119 000 ac) of this total is severely eroded, featuring cultivated lands in which eroded soils dominate (at least 40%). The remaining 12 000 ha (30 000 ac) are moderately eroded, with subdominant (20-40%) eroded soils, usually located across the tops of knolls and ridges. Both severely and moderately eroded landscapes are prevalent on the Cardston Plain and southern fringe of the Porcupine Hills (Fig. 36).

The so-called eroded soils are more accurately defined as Rego and Calcareous Black or Dark Brown soils of the Chernozemic Order. They occur in areas where Orthic subgroups should otherwise prevail. Orthic subgroups have the "normal" A-B-C horizon sequence (Fig. 21 & 22) and noncalcareous sola. Rego subgroups have no B horizon; Calcareous subgroups have calcareous Bmk horizons. Soils of both subgroups often have calcareous topsoil (Apk horizons), either brought up from horizons below by cultivation, or added to the surface as wind-blown drift.

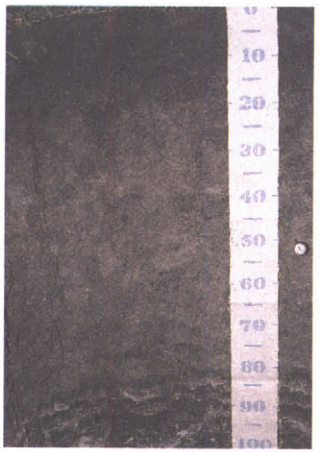


Plate I:

A. A Calcareous Black (CWY series) in fine textured glaciolacustrine material. Note varves below 80 cm.
B. A Gleyed Dark Gray (TDC series) developed in layered fluvial material that includes mudflow.
C. A thick Orthic Black (DRW series) developed in layered glaciofluvial deposits.
D. An Eluviated Eutric Brunisol (MGV series) developed in very gravelly to cobbly glacial material.
E. An Eluviated Dystric Brunisol (WLB series) developed in fluvioeolian veneer overlying till.
F. An Orthic Dark Brown (BEV series) developed in colluvium over till over fractured bedrock.

The edges of fields often provide conspicuous evidence of wind erosion (Fig. 37). Eroded soils may also be recognized by their light colored surfaces when dry (Fig. 38), usually due to the presence of carbonate and the loss of organic matter. Organic material binds soil particles and contributes greatly to soil fertility and tilth. Differences of up to 8 or 9% organic matter content between native black Ah horizons and eroded Apk horizons were measured in a few soils. The eroded Apk horizons often have about 5% organic matter (3% organic carbon).

Circumstantial evidence exists which suggests that some of the soils had, in their native state, very thin topsoil (Ah horizons) and incomplete removal of lime from the B horizons. Frequent strong winds funnel through the Crowsnest and Oldman river basins, past the southern fringe of the Porcupine Hills. The winds may have desiccated the soils of these areas, and deposited small amounts of calcareous material picked up from the river valleys, bedrock outcrops, and other exposed sites. Both desiccation and the added drift would retard soil development. Likely, these thin soils bordering the rivers quickly became eroded with the advent of cultivation.

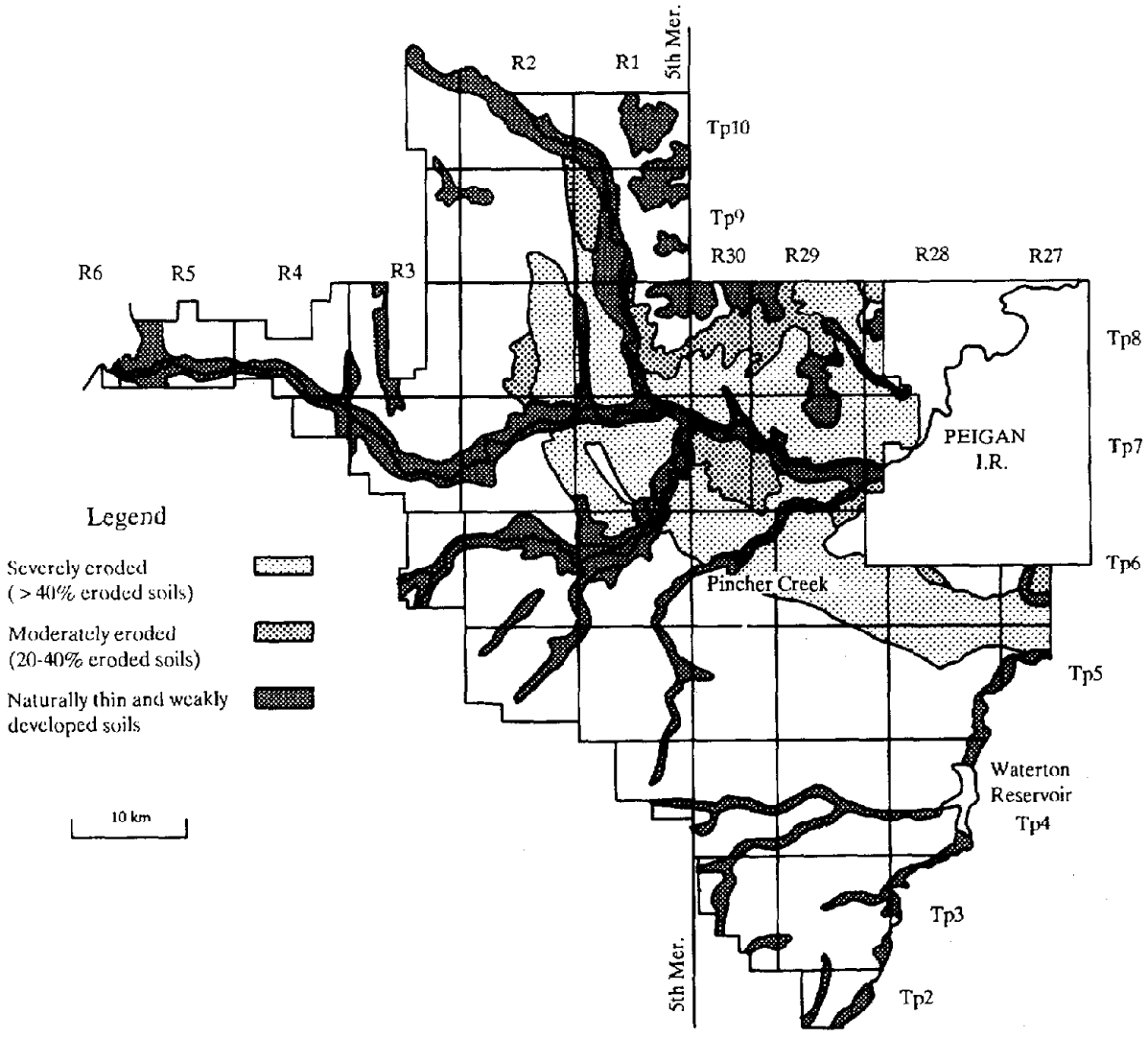


Figure 36. Generalized map showing eroded lands and other lands with naturally thin and weakly developed soils.

Fig. 36 includes a third group of naturally thin and weakly developed soils formed in recent deposits, on steep erosional slopes, or in highly calcareous parent materials. This group accounts for about 54 000 ha (133 000 ac) or 20% of the survey area. Besides the Rego and Calcareous subgroups, this group of soils includes Regosols, Humic Regosols, some Gleysolic soils, and weakly developed, calcareous, Eutric Brunisols. Cultivation likely contributes to the severity or amount of eroded soils along those stretches of river that cut through the Cardston Plain.

Another 25 000 ha (60 000 ac) of cultivated land could become moderately to severely eroded over the next few decades. Persistent losses of organic matter make soils more erodible. The problem intensifies when calcareous material is incorporated in the surface.

In recent years, new cropping systems and tillage techniques have helped reduce soil erodibility. These include continuous cropping, winter cover crops, conservation tillage, snow management, and chemical fallow. All are designed to keep substantial trash cover on the soil surface. Older methods like strip cultivation, manuring and wind breaks also reduce soil erosion. One technique by itself is often insufficient in the very windy Pincher Creek area. During the drought of the 1980's, materials for trash cover were in short supply, and even soils under standing stubble drifted.

Figure 37. Evidence of wind eroded soils is often observed along fence rows.

Soil Salinity

Soil salinity is a problem only on a local scale in the Pincher Creek-Crowsnest Pass area. There is no evidence to suggest that the problem has improved or worsened over the decades that arable agriculture has been practiced in the area. Roughly 8500 ha (21 000 ac), or 1% of the survey area, has significant (15-30%) saline (salt affected) soils. Land dominated by saline soils occupies about 150 ha (400 ac). About half the land with salinity problems also has substantial eroded soils. Another 3000 ha (7500 ac) has significant (15-30%) Solonetzic and solonetzic-like soils, developed in calcareous plus saline parent materials.

The vast majority of salt affected soils occur on the Cardston Plain, at the base of bedrock controlled terrain in the Southern Foothills and Porcupine Hills. The bedrock is the source of the salts. They are moved by groundwater flow and concentrated at or near the soil surface in discharge areas. Seeps and springs identify groundwater discharge areas. Obvious examples of saline soils and associated terrain occur near Summerview and Cowley.

Figure 38. Eroded soils have light colored surfaces due to additions of lime and loss of organic matter.

The occurrence and extent of saline soils was determined, during the survey, by the presence or absence of surface indicators such as salt tolerant vegetation, seeps, patchy crop growth, and visible (whitish) salt accumulations. In suspect localities, soil profiles were carefully examined for the presence of salt crystals at depth. Samples were taken at several sites to measure salinity levels.

Most salt affected soils in the area have weak to moderate levels of salinity, classed according to accepted standards (Eilers 1985). Measurements of 2 to 16 dS/m were recorded, with values of 8 or more usually occurring below about 50 or 60 cm. Strongly saline soils, with readings of 8-16 dS/m in the upper 60 cm, were occasionally found in the immediate vicinity of saline seeps.

The occurrence and extent of Solonetzic and solontezic-like soils could often be predicted by wavy patterns in crops and the ground surface itself. In suspect areas, soil profiles were examined for the presence of hard, columnar, clay and sodium enriched, B horizons (Bnt, Bn, Bnjt) below the thin topsoil. These B horizons tend to be very hard when dry, but swell to a sticky, nearly impermeable mass when wet. Sometimes called "claypan", these B horizons are difficult to cultivate and hinder root development of plants. Salts are present below the B horizons, in the parent material.

SOIL INTERPRETATIONS

Soils are usually classified and mapped according to their inherent properties. Such baseline inventories provide a wealth of information on many characteristics, grouped ac-

cording to consistent and standard criteria. The basic soil features and their distribution can then be regrouped, or interpreted, for a variety of uses.

Soil surveys and related land inventories have been useful in broad endeavors like land use planning, and in specific applications like planning of trails, campsites, or sewage disposal. Most applications involve regrouping the basic soil information into a few suitability, capability, or limitation classes segregated according to certain critical criteria. Sometimes the criteria are based on external parameters correlated with soil characteristics. Examples of capability applications include land capability for forestry, land capability for wildlife, land susceptibility to erosion, and land capability for recreation.

This soil survey was requested by the agricultural community, through its governmental agencies. Nevertheless, a conscious effort has been made to provide information equally applicable to agricultural and non-agricultural applications. Three specific applications are detailed in Appendix C. These are land capability classification for arable agriculture, land capability for irrigation, and land capability ratings for range productivity. Also, selected engineering data for some soil parent materials are listed in Appendix C.

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APPENDIX A
SOIL SERIES, TAXADJUNCT AND VARIANT DESCRIPTIONS

INTRODUCTION

The major soil series and taxonomic equivalents - taxadjuncts and variants (E.C.S.S. 1987a) - of the Pincher Creek-Crowsnest Pass area are described below. These are based on existing named soil concepts developed in southern Alberta since about 1960, including recent work in the Warner (Kjearsgaard *et al.* 1986), Calgary (MacMillan 1987) and Cardston (Brierley *et al.* In press) areas.

The descriptions reflect attempts to be more rigorous and definitive than in the past, without grossly violating or confusing accepted concepts. In some cases correlation decisions were required where series concepts differed from one survey project to another. Considering the tremendous soil variability across the survey area, only seven new series concepts were proposed and named. These were necessary to portray mapping concepts and usually covered substantial area.

Many variants and taxadjuncts of existing series were also identified. This approach prevented the proliferation of named series, most of which would likely be restricted to this exclusive corner of the province. Further, map concepts could be satisfactorily portrayed. Variants and taxadjuncts are normally defined as rigorously as series but often allow more legend flexibility by their broader connotations. Such tools also help clarify taxonomic relationships at the series level. Any of the variants and taxadjuncts can be named as series in the future if warranted.

Climatic parameters were the most difficult to correlate. Series concepts were constricted when connected with six new agroclimatic classes (A.S.A.C. 1987) rather than three classes of the original system (Bowser 1967). However, the series code, when part of a map unit, was not restricted to the agroclimatic class connected with the series concept. Thus a code can represent soils with a different agroclimatic class than the series concept; that is, a climatic variant of that series.

For example, SOF (Standoff) series is now associated with agroclimatic class 2AH (specifically subclass 2HA). MFT (Maycroft) series is a thicker but otherwise similar soil now associated with agroclimatic class 4H. A group of soils that is morphologically similar to SOF occurs in areas classed as agroclimate 3H. This soil group, also labelled SOF in map units such as SOF1/3, is in reality a climatic variant of SOF.

Climatic variants, with one exception, are not identified in this report. Soil interpretations that require agroclimatic input should be made with the map units, in conjunction with the generalized agroclimate map (Fig. 14) when necessary. For example, SOF1/3 can have two agricultural capability classes, one when it occurs in areas classed as agroclimate 2AH, a second when associated with class 3H.

METHODS

The following descriptions are abbreviated versions of official soil series descriptions (E.C.S.S. 1987a). Enough information is provided to formulate mental images of each soil, and to distinguish one from another.

The soils are classed into subgroups and families according to accepted Canadian standards (E.C.S.S. 1987b). Agroclimatic information includes approximate EGDD (effective growing degree days) and moisture indices (precipitation minus potential evapotranspiration or P-PE) for each soil (A.S.A.C. 1987). Information on drainage, texture, parent materials, and various other features are commonly based on accepted descriptive classes (E.C.S.S. 1983). Physiographic information is based on the physiographic subdivisions of Alberta at the district level (Pettapiece 1986) or subdivisions thereof.

Many of the soils described below are best illustrated by field and laboratory data from representative profiles. Important or definitive data are listed in a concise tabular format. A much larger pool of data for "representative" and other pedons has been archived with the Alberta Soil Survey Unit in Edmonton.

Analytical Methods: Information presented in the tables includes both field and laboratory data collected according to standard procedures (C.S.S.C. 1978, E.C.S.S. 1983). Field data includes Munsell color notations and volume estimates of coarse fragment (cf.) content. Laboratory procedures include the routine determination of:

$CaCl_2$ pH - with a pH meter using a 2:1 ratio of 0.01 M $CaCl_2$ solution to soil (Peech 1965) [3.11].[1]

Organic C (Carbon) - by difference between total carbon and inorganic carbon ($CaCO_3$ eq.). Total carbon was determined by dry combustion using an induction furnace (Allison *et al.* 1965) with gasometric detection of evolved CO_2 (Leco model CR12) [3.611].

$CaCO_3$ eq. (Calcium Carbonate Equivalent) - by the inorganic carbon manometric method of Bascombe (1961).

Total N (Nitrogen) - by a semi-micro version of the Kjeldahl-Wilforth-Gunning method (A.O.A.C. 1955). A mixture of HgO, $CuSO_4$ and K_2SO_4 (Kelpak) was used as catalyst. Ammonium-N in the distillate was detected with an ammonium ion electrode.

C.E.C. (Cation Exchange Capacity) - by displacement of ammonium with sodium chloride (Chapman 1965) except that an ammonium ion electrode was used to detect displaced ammonium ion [3.321].

Sand & Clay (Particle Size Distribution) - by the simplified hydrometer method of Gee and Bauder (1979) which excludes pretreatment to remove organic matter. Samples of A, B and transition horizons collected in 1986 and 1987 were pretreated to remove organic matter.

THE SOILS

Soil series, variants and taxadjuncts used in the Pincher Creek-Crowsnest Pass soil survey are listed in Table A1. The list is arranged in alphabetic order according to the upper case three letter code. Abbreviated descriptions of the listed soils follow. Very brief descriptions of some variants and taxadjuncts are contained within the descriptions of other soils, usually under the heading "**Major Variants**". Table A1 also helps locate soil descriptions contained within Appendix A.

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1. The number in [ ] indicates the method in C.S.S.C. (1978).

Table A1. List of soil series, variants and taxadjuncts of the Pincher Creek-Crowsnest Pass soil survey area.

Code	Name[1]	Sub-group[2]	Agro-climate[3]	Parent Material[4]	App. A Refer.[5]
kBDY	Birdseye paraskeletal variant	O.DG	5H	gravelly-cobbly, medium textured till	p. 63
BEV	Bellevue series	O.DB	5H	gravelly-cobbly colluvium / till / bedrock	p. 63
BEVv	Bellevue till variant	O.DB	5H	gravelly-cobbly, medium textured till / bedrock	p. 63
BFT	Blackfoot series	O.BL	3H	medium textured / gravel; glaciofluvial, fluvial	p. 63
rBFT	Blackfoot rego variant	R.BL	3H	medium textured / gravel; glaciofluvial, fluvial	p. 65
BKE	Brocket series	R.DB	2AH	fine textured glaciolacustrine	p. 65
BKEv	Brocket subgroup variant	CA.DB	2AH	fine textured glaciolacustrine	p. 65
cBKE	Brocket coarse taxadjunct	R.DB	2AH	slightly gravelly, fine textured glaciolacustrine	p. 65
sBKE	Brocket saline variant	R.DB	2AH	fine textured, saline glaciolacustrine	p. 65
kBRGv	Bragg Creek subgroup-skeletal v.	O.EB	6H	very gravelly / gravel; glaciofluvial, fluvial	p. 66
BUR	Burmis series	R.BL	4H	glaciofluvial or fluvial gravel	p. 66
BURv	Burmis subgroup variant	CA.BL	4H	glaciofluvial or fluvial gravel	p. 67
BVA	Beauvais series	O.DG	5H	medium textured till	p. 67
kBVA	Beauvais paraskeletal variant	O.DG	5H	gravelly-cobbly, medium textured till	p. 67
kfBVA	Beauvais clayey-paraskeletal v.	O.DG	5H	gravelly-cobbly, fine textured "till"	p. 68
BZR	Beazer series	O.BL	3H	medium textured till	p. 68
rBZR	Beazer rego variant	CA.BL	3H	medium textured till	p. 68
BZRv	Beazer thin variant	O.EB	3H	medium textured till	p. 68
sBZR	Beazer saline variant	O.BL	3H	medium textured, saline till	p. 68
rCFT	Crowfoot rego variant	CA.DB	2AH	medium textured / gravel; glaciofluvial, fluvial	p. 69
CIO	Chokio series	CA.DB	2AH	medium textured fluvio- or glaciolacustrine	p. 69
CONv	Connop subgroup variant	O.EB	5H	coarse textured glaciofluvial	p. 70
CRW	Carway series	O.BL	4H	coarse textured (SL) glaciofluvial	p. 70
cCRW	Carway coarse variant	O.BL	4H	coarse textured (LS-S layers) glaciofluvial	p. 71
fCRW	Carway fine variant	O.BL	4H	coarse / medium textured glaciofluvial	p. 71
CRWv	Carway high lime taxadjunct	O.BL	4H	coarse textured glaciofluvial	p. 71
CTN	Cardston series	O.BL	2HA	slightly gravelly, fine textured glaciolacustrine	p. 71
sCTN	Cardston saline variant	O.BL	2HA	fine textured, saline glaciolacustrine	p. 71
zCTN	Cardston solonetzic variant	SZ.BL	2HA	fine textured, saline glaciolacustrine	p. 71
CWY	Cowley series	CA.BL	2HA	fine textured glaciolacustrine	p. 72
rCWY	Cowley rego variant	R.BL	2HA	fine textured glaciolacustrine	p. 73
sCWY	Cowley saline variant	R.BL	2HA	fine textured, saline glaciolacustrine	p. 73
DIM	Diamond series	R.DB	2AH	medium textured fluvio- or glaciolacustrine	p. 73
DRW	Drywood series	O.BL	4H	medium textured / gravel; glaciofluvial, fluvial	p. 73
kDRW	Drywood gravelly taxadjunct	O.BL	4H	gravelly veneer / gravel; glaciofluvial, fluvial	p. 74
rDRW	Drywood rego variant	R.BL	4H	medium textured / gravel; glaciofluvial, fluvial	p. 74
DVG	Dunvargan series	O.BL	4H	medium textured till	p. 74
kDVG	Dunvargan paraskeletal variant	O.BL	4H	gravelly-cobbly, medium textured till	p. 74
FRK	Frank series	O.EB	6-7H	very gravelly-cobbly colluvium	p. 75
lFRK	Frank lithic variant	O.EB	6-7H	very gravelly-cobbly colluvium / bedrock	p. 76
kFSH	Fish Creek slightly gravelly t.	O.BL	4H	slightly gravelly, fine textured glaciolacustrine	p. 76
sFSH	Fish Creek saline variant	O.BL	4H	fine textured, saline glaciolacustrine	p. 76
JAT	Joanto series	R.HG	3H	fine textured lacustrine or glaciolacustrine	p. 77
KNT	Knight series	O.BL	3H	coarse textured (SL) glaciofluvial	p. 77
rKNT	Knight rego variant	R.BL	3H	coarse textured (SL) glaciofluvial	p. 77
cKNT	Knight coarse variant	O.BL	3H	coarse textured (LS-S layers) glaciofluvial	p. 77
LNB	Lundbreck series	O.BL	4H	glaciofluvial or fluvial gravel	p. 77
LTC	Leighton Centre series	D.GL	5H	medium textured till	p. 78
kLTC	Leighton Centre paraskeletal v.	D.GL	5H	gravelly-cobbly, medium textured till	p. 78

Table A1 continued.

Code	Name[1]	Sub-group[2]	Agro-climate[3]	Parent Material[4]	App. A Refer.[5]
MAC	Macleod series	CA.DB	2AII	glaciofluvial or fluvial gravel	p. 79
rMAC	Macleod rego variant	R.DB	2AH	glaciofluvial or fluvial gravel	p. 79
MFT	Maycroft series	O.BL	4H	medium textured fluvio- or glaciolacustrine	p. 80
rMFT	Maycroft rego variant	R.BL	4H	medium textured fluvio- or glaciolacustrine	p. 80
grMFT	Maycroft gleyed rego variant	GLR.BL	4H	medium textured fluvio- or glaciolacustrine	p. 80
MGV	McGillivray series	E.EB	5H	very gravelly-cobbly glaciofluvial	p. 80
MGVv	McGillivray subgroup variant	O.EB	5H	very gravelly-cobbly glaciofluvial	p. 81
NFK	North Fork series	O.EB	3H	gravelly-cobbly, medium-coarse textured till	p. 81
rOAS	Oasis rego variant	CA.DB	2AH	medium / coarse textured glaciofluvial	p. 82
ODM	Oldman series	R.BL	2HA	medium textured fluvio- or glaciolacustrine	p. 82
OKY	Ockey series	O.BL	3H	medium textured till / residuum / bedrock	p. 83
OKYv	Ockey climatic variant	O.BL	4H	medium textured till / residuum / bedrock	p. 83
kOKY	Ockey paraskeletal variant	O.BL	4H	gravelly-cobbly, medium textured till / bedrock	p. 84
rOKY	Ockey rego variant	R.BL	4H	medium textured till / residuum / bedrock	p. 84
OSN	Olsen series	CA.DB	2AH	coarse textured glaciofluvial	p. 84
rOSN	Olsen rego variant	R.DB	2AH	coarse textured glaciofluvial	p. 84
OTP	Outpost series	O.BL	4H	very cobbly-gravelly-stony glaciofluvial	p. 85
rOTP	Outpost rego variant	CA.BL	5H	very cobbly-gravelly-stony glaciofluvial	p. 86
PGN	Peigan series	BL.SS	2HA	fine textured, saline glaciolacustrine	p. 86
PNR	Pincher series	O.BL	2HA	fine textured glaciolacustrine	p. 86
POT	Pothole Creek series	O.HG	4H	fine textured glaciolacustrine or lacustrine	p. 87
rPPE	Porcupine rego variant	R.BL	4H	medium-coarse textured fluvioeolian	p. 87
PSO	Parsons series	R.BL	3H	medium textured till	p. 88
RFD	Rockford series	O.BL	3H	very cobbly-gravelly-stony glaciofluvial	p. 88
RND	Rinard series	O.BL	3H	glaciofluvial or fluvial gravel	p. 89
rRND	Rinard rego variant	CA.BL	3H	glaciofluvial or fluvial gravel	p. 89
SOF	Standoff series	O.BL	2HA	medium textured fluvio- or glaciolacustrine	p. 90
rSOF	Standoff rego variant	CA.BL	2HA	medium textured fluvio- or glaciolacustrine	p. 90
SPR	Spruce Ridge series	O.GL	6H	gravelly-cobbly, medium textured till	p. 90
SPRr	Spruce Ridge thin taxadjunct	O.GL	6H	gravelly-cobbly, medium textured till	p. 90
kSPR	Spruce Ridge loamy-skeletal v.	O.GL	6H	very gravelly-cobbly glaciofluvial	p. 90
SPRv	Spruce Ridge thick variant	O.GL	6H	gravelly-cobbly, medium textured till	p. 90
TDC	Todd Creek series	GL.DG	5H	medium textured / gravelly fluvial	p. 91
TDCv	Todd Creek subgroup variant	O.DG	5H	medium textured / gravelly fluvial	p. 91
kTDC	Todd Creek paraskeletal variant	O.DG	5H	gravelly veneer / very gravelly fluvial	p. 91
rVAC	Van Cleeve rego variant	R.DB	2AH	medium textured till / residuum / bedrock	p. 92
WLB	Willoughby series	E.DYB	6-7H	coarse-medium textured fluvioeolian / till	p. 92
WLBv	Willoughby subgroup variant	O.DYB	6-7H	coarse-medium textured fluvioeolian / till	p. 93
lWLB	Willoughby shallow lithic v.	E.DYB	6-7H	fluvioeolian / till / bedrock	p. 93

Notes:
1. Most series are named after geographic place names: variants (also v.) and taxadjuncts (also t.) take the name of the most closely related series plus a descriptive modifier.
2. Classification at the subgroup level using the accepted abbreviations (E.C.S.S. 1987b) which are written out in the descriptions below.
3. Agroclimatic classes and subclasses as described in the body of this report.
4. An abbreviated description of the parent material in which each soil is developed. Refer to the descriptions below for more details.
5. Page location in Appendix A for more detailed information, especially on distinguishing soils one from another.

BDY (Birdseye) Variant

Subgroup: Orthic Dark Gray (O.DG).
Agroclimate: class 5H (about 700 to 950 EGDD, usually moister than -260 P-PE); generally on northerly to easterly aspects under Douglas fir or mixedwood forest.
Parent Material: gravelly to cobbly (15-35% coarse fragments), medium textured (CL-L-SCL), strongly calcareous, mixed origin till overlying variable clastic bedrock or residual material.
Family: fine-loamy, shallow lithic, strongly calcareous, cold subhumid.
Drainage: well to moderately well drained.
Physiography: on bedrock controlled ridges and hills in the higher portions of the Porcupine Hills, and in the Byron-Carbondale Hills near Maycroft.
Comments: labelled kBDY (paraskeletal variant). A more acidic variant developed in non- to weakly calcareous mountain till occurs sporadically in the Southern Foothills. Upper solum sometimes mixed by earthworm activity.
Competing Series: BVA (Beauvais) differs because it is nonlithic and developed in moderately calcareous, medium textured till. BDY series, defined and sampled in Cardston M.D. (Brierley *et al.* In press), differs because it is a clayey paralithic soil derived from moderately calcareous shales; it was mapped however on a variety of materials.

BEV (Bellevue) Series and Variant

Subgroup: Orthic Dark Brown (O.DB).
Agroclimate: class 5H (about 700 to 950 EGDD, moister than -260 P-PE), but modified by steep, south- to west-facing slopes; warmer, drier mesoclimate reflected in the soil and the subxeric to mesic, grass-dominated vegetation types.
Parent Material: colluvium over till over bedrock (or fractured residuum) within 50-100 cm. Nonlithic materials are gravelly or channery (15-35% coarse fragments) and medium to coarse textured (SCL-L-SL). Chemical features - noncalcareous and neutral to slightly acid - reflect parent material and solum conditions. Table A2 lists some other features.
Family: fine-loamy, shallow lithic, noncalcareous, cold subhumid.
Drainage: well to rapidly drained.
Physiography: on steep, southerly to westerly aspects of the Byron-Carbondale Hills and Grassy Mountain Ridges.
Comments: one of the main soils called "Mountain Chernozem" in earlier unpublished surveys. Associates include soils with shallow and very shallow colluvium over bedrock, calcareous parent materials, coarser or finer textures, and Ah horizons of Black or Dark Gray colors. Extremely shallow lithic soils and bedrock outcrops often occur with BEV.
Major Variants: BEVv (till) variant was identified. It lacks the colluvial veneer of BEV and often contains less sand. BEVv is most often found on steep grassland patches within the Front Ranges. Similar soils with Black Ah horizons and calcareous parent material are often intimately associated.
Competing Series: Mesa Butte (MSB), defined and mapped in the Calgary area (MacMillan 1987), is found in similar terrain (colluvium over bedrock) but differs because it is an Orthic Black .

BFT (Blackfoot) Series and Variant

Subgroup: Orthic Black (O.BL).
Agroclimate: class 3H (about 1050 to 1180 EGDD, roughly -260 to -400 P-PE); under native grasses or cultivation.

Table A2. Selected features of a typical BEV pedon (PID No. AB-86-06)[1].

	Ah	Bm	IIBm1	IIBm2	IIIBC	R
Depth, cm	0-11	11-31	31-50	50-75	75-80	@ 80
$CaCl_2$ pH	6.4	5.9	6.1	5.4	NS[2]	NS
Organic C, %	5.0	1.7	0.9	0.9	NS	NS
Total N, %	0.34	---	---	---	NS	NS
CEC[3], cmol/kg	25.7	21.6	20.1	28.5	NS	NS
Sand, %	62	56	51	51	--	--
Clay, %	23	24	29	29	--	--
Cf.[4], %	30 all[5]	30 all	30 all	30 all	Frag.[6]	Rock

Notes: Ah horizon color (10YR2/2 moist and 7.5YR3/2 crushed dry) meets the criteria for Dark Brown (E.C.S.S. 1987b) and is typical of these high elevation grassland soils.

1. PID No. = Profile Identification Number; AB (Alberta) - 86 (1986) - number 06.
2. NS = not sampled.
3. CEC = Cation exchange capacity expressed as centimoles per kilogram.
4. Cf. = coarse fragment content expressed as percent by volume (estimated).
5. All = all shapes & sizes: gravels, channers, cobbles, flags, & stones.
6. Frag. = fragmental, ie. >80 or 90% coarse fragments.

Parent Material: moderately calcareous, layered, glaciofluvial or fluvial deposits; 30 to 100 cm of medium textured (mainly L-SiL-CL, <2% coarse fragments) veneer over extremely gravelly to cobbly (>60% coarse fragments), coarse textured (LS-S) gravel.
Family: loamy over sandy-skeletal, strongly calcareous, cold subhumid.
Drainage: rapidly to well drained.
Physiography: generally found on upper to lower terraces associated with larger streams on the Cardston Plain.
Comments: thin Ah horizons (10-15 cm) and solum (carbonates within 50 cm) are characteristic (Table A3). Map units based on BFT generally have widely varying surface textures (L-SiL-SL-CL-SiCL), sometimes with a few gravels. Underlying material may vary from moderately to very strongly calcareous and sometimes has only 40-50% coarse fragments.

Table A3. Selected features of a BFT pedon (Cardston M.D., PID No. AB-82-23).

	Ah	Bm	Cca	IICk
Depth, cm	0-11	11-34	34-67	67-110
$CaCl_2$ pH	6.9	6.2	7.6	7.6
Organic C, %	6.1	1.4	---	---
CEC, cmol/kg	23.9	20.1	---	---
$CaCO_3$ eq., %	0.1	---	19.6	10.2
Sand, %	40	29	40	66
Clay, %	17	19	15	7
Cf., %	<2 gr[1]	<2 gr	<2 gr	90 gr+cb[2]

Notes: Ah weakly contaminated with calcareous drift; Ck slightly finer textured than modal. Refer to Table A2 for explanation of abbreviations.

1. Gr = dominantly gravel size (and shaped) coarse fragments.
2. Gr+cb = mainly gravel and cobble sizes (and shapes) of coarse fragments.

Major Variants: rBFT (rego) variant is classed as Rego Black but has the same chemical and textural features as BFT. In mapping, this variant also represents Calcareous Blacks.
Competing Series: RND (Rinard) differs because it has less than 30 cm of loamy veneer over gravel. SOF (Standoff) differs because it is developed in nongravelly medium textured deposits; gravel if present occurs below 1 m. DRW (Drywood) differs because it has a thicker Ah and solum reflecting class 4H agroclimate.

BKE (Brocket) Series, Variants and Taxadjunct

Subgroup: Rego Dark Brown (R.DB).
Agroclimate: subclass 2AH (greater than 1250 EGDD, roughly -400 to -425 P-PE); under cultivation.
Parent Material: nongravelly (<2% coarse fragments), fine textured (C-SiC-HC), moderately calcareous, glaciolacustrine material.
Family: clayey, strongly calcareous, cool semiarid.
Drainage: moderately well drained.
Physiography: eastern edge of the Cowley Basin next to the Three Rivers Plain.
Comments: Textures commonly grade from SiCL at the surface to HC at depth (Table A4). Calcareousness may vary from moderate to strong, even amongst layers within a profile. BKE soils crack when severely dried out; cracks may extend to about 1 m and be several cm wide. Erosion has been severe in areas where BKE is mapped; and many soils have thin (<15 cm) Apk horizons. In some cases, a mixture of Apk plus underlying material to a total depth of 15 cm may not meet Chernozemic A horizon color criteria (E.C.S.S. 1987b).
Major Variants: three major variants and taxadjuncts were identified.

1) BKEv (subgroup) variant - is classed as Calcareous Dark Brown (has a Bmk horizon below the Apk) but has the same chemical and textural features as BKE.
2) cBKE (coarse) taxadjunct - is a fine-clayey soil developed in fine textured (SiC-C), glaciolacustrine (or lacustro-till) sediments. The till-like material contains some coarse fragments (usually about 2-15%). Calcareous Dark Browns are also developed in the material. The cBKE soils are usually found in slightly elevated areas next to the glaciolacustrine basin that contains BKE.
3) sBKE (saline) variant - is weakly to moderately saline with salts usually showing up below about 50 or 60 cm. It occurs on relatively long apron-like slopes with seeps and in some pothole depressions. Similar soils are classed saline Calcareous Dark Brown. Others with weak "solonetzic-like" B horizons (zBKE) may be associated.

Table A4. Selected features of a typical BKE pedon (PID No. AB-86-02).

	Apk	C+A	Ck1	Ck2	Ck3
Depth, cm	0-14	14-20	20-36	36-70	70-110
$CaCl_2$ pH	7.6	7.7	7.8	8.0	7.9
Organic C, %	2.5	1.7	---	---	---
Total N, %	0.23	0.17	---	---	---
$CaCO_3$ eq., %	11.1	19.2	20.1	11.5	18.3
Sand, %	34	20	6	4	10
Clay, %	31	38	50	61	55

Notes: Material has higher carbonate content than modal, but still within normal range for water-worked deposits in the area; carbonate content variability among layers also typical of such deposits. Refer to Table A2 for explanation of abbreviations.

Competing Series: CIO (Chokio) and DIM (Diamond) differ because they occur in medium textured water-laid sediments.

BRG (Bragg Creek) Variant

Subgroup: Orthic Eutric Brunisol (O.EB).
Agroclimate: class 6H bordering on 5H (roughly 450 to 700 EGDD, around -260 P-PE or moister); mainly under lodgepole pine or mixed coniferous forest.
Parent Material: extremely calcareous, layered, glaciofluvial or fluvial deposits; 30 to 50 cm of very gravelly to cobbly (35-60% coarse fragments), medium textured (mainly L) veneer overlying extremely gravelly to cobbly (>60% coarse fragments), coarse textured (S-LS) gravel (Table A5).
Family: sandy-skeletal, extremely calcareous, cold subhumid.
Drainage: rapidly to very rapidly drained.
Physiography: found on terraces and ice contact landforms along the Crowsnest R. and major tributaries within the Front Ranges.
Comments: labelled kBRGv (subgroup variant with a skeletal veneer). Most variations on this concept are textural: veneer may be very thin to absent or grade to nongravelly (BRGv); underlying material may have only 40-50% coarse fragments and sometimes contains less carbonates than modal. Other variants have weakly developed Aej or Ae horizons and are classed Eluviated Eutric Brunisol, including BRG series.
Competing Series: MGV (McGillivray) differs because it is an Eluviated Eutric Brunisol and occurs in finer textured ice contact deposits. BRG series, defined and mapped in the Calgary area (MacMillan 1987), occurs occasionally in this area. It differs because it is an Eluviated Eutric Brunisol and occurs in gravel material with a slightly gravelly veneer (30-100 cm).

Table A5. Selected features of a kBRGv pedon (PID No. AB-87-12).

	LFH	BA	Bm	BC1	BC2	Ck
Depth, cm	2-0	0-5	5-20	20-30	30-45	45-90
$CaCl_2$ pH	5.9	5.5	6.2	7.1	7.4	7.6
Organic C, %	41.2	2.0	1.9	4.0	3.3	---
CEC, cmol/kg	102.3	28.5	35.9	---	---	---
$CaCO_3$ eq., %	---	---	---	10.3	50.1	65.0
Sand, %	---	47	47	56	78	73
Clay, %	---	18	17	7	6	5
Cf., %	---	30 all	40 all	40 all	60 all	70 all

Notes: Ck horizon slightly finer textured than modal. Refer to Table A2 for explanation of abbreviations. Refer to Table A2 for explanation of abbreviations.

BUR (Burmis) Series and Variant

Subgroup: Rego Black (R.BL).
Agroclimate: class 4H (about 950 to 1050 EGDD, roughly -260 to -375 P-PE for type area, moister near Waterton park); occurs in driest parts of the foothills and mountains under native grasses.
Parent Material: extremely calcareous, extremely gravelly to cobbly (>60% coarse fragments), coarse textured (S-LS), glaciofluvial or fluvial gravel.
Family: sandy-skeletal, extremely calcareous, cold subhumid.

Drainage: very rapidly drained.
Physiography: majority occurs in the Crowsnest R. valley from Sentinel to Lundbreck, including type area and pedon (Table A6) near Burmis. Similar soils mapped on terraces and fans near Waterton Lakes NP at the south end of Pincher M.D.

Table A6. Selected features of a typical BUR pedon (PID No. AB-86-01).

	Ah	Ahk	AC	Ck1	Ck2	Ck3
Depth, cm	0-5	5-17	17-38	38-48	48-70	70-115
$CaCl_2$ pH	7.0	7.4	7.5	7.6	7.8	7.7
Organic C, %	9.4	5.2	3.4	---	---	---
Total N, %	0.72	0.45	0.22	---	---	---
CEC, cmol/kg	42.0	---	---	---	---	---
$CaCO_3$ eq., %	0.8	17.9	26.7	46.1	41.0	41.0
Sand, %	57	65	74	73	91	87
Clay, %	3	5	6	9	4	5
Cf., %	10 gr+cb	40 gr+cb	50 gr+cb	60 gr+cb	60 gr+cb	60 gr+cb

Notes: Refer to Table A2 for explanation of abbreviations.

Comments: Cca horizons sometimes present but discontinuous, existing as irregular to circular patches in upper Ck. Cca material may be weakly cemented. Carbonate and coarse fragment contents of parent material sometimes lower than modal.
Major Variants: BURv (subgroup) variant, classed as Calcareous Black was identified. It often occurs with BUR in the same materials, although a lower lime version is important near Waterton.
Competing Series: LNB (Lundbreck), differs because it is Orthic Black and occurs in moderately calcareous gravel.

BVA (Beauvais) Series and Variants

Subgroup: Orthic Dark Gray (O.DG)
Agroclimate: class 5H (about 700 to 950 EGDD and moister than -260 P-PE); generally under aspen forest.
Parent Material: moderately calcareous, medium textured (CL-L, 2-15% coarse fragments), continental till (Table A7).
Family: fine-loamy, strongly calcareous, cold subhumid.
Drainage: well to moderately well drained.
Physiography: BVA series found mainly on the Beauvais Lake Upland, paraskeletal and other variants common on the southwestern arm of the Upland and in the Byron-Carbondale Hills.
Comments: upper solum sometimes mixed by earthworm activity. Minor variants include a clayey soil developed in fine textured till or draped glaciolacustrine (lacustro-till) sediments and one developed in weakly calcareous materials.
Major Variants: two major variants were recognized.

1) kBVA (parasketetal) variant - developed in weakly calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain till; most common of several occurring in mountain tills. Similar versions developed in strongly to very strongly calcareous till (Rock Creek area) and in gravelly fine textured till (or lacustro-till). A stony version occurs in very cobbly to gravelly or stony, glaciofluvial (ice contact) materials.

2) kfBVA (clayey-paraskeletal) variant - developed in strongly calcareous, gravelly (15-35% coarse fragments), fine textured (C), mudflow material or reworked till; found in the Todd Creek area. A similar weakly calcareous version occurs in the Pecten area.

Competing Series: kBDY (paraskeletal Birdseye) variant differs because it is a shallow lithic soil.

Table A7. Selected features of a typical BVA pedon (Cardston M.D., PID No. AB-84-11).

	Ahe	Ae	Bt1	Bt2	BC	Ck
Depth, cm	0-13	13-17	17-50	50-90	90-120	120-?
$CaCl_2$ pH	5.9	5.0	5.4	4.9	5.2	7.1
Organic C, %	8.6	---	---	---	---	---
Total N, %	0.42	---	---	---	---	---
CEC, cmol/kg	28.9	12.3	21.8	23.6	23.2	---
$CaCO_3$ eq., %	---	---	---	---	---	10.3
Sand, %	51	53	38	32	35	35
Clay, %	17	14	24	31	22	26
Cf., %	10% gravels		(somewhat angular) throughout			

Notes: Ahe's C:N ratio of 20.5:1 is too high for a Chernozemic A horizon, but within the range found in similar soils of the area. Refer to Table A2 for explanation of abbreviations.

BZR (Beazer) Series and Variants

Subgroup: Orthic Black (O.BL).

Agroclimate: class 3H (about 1050 to 1180 EGDD, roughly -260 to -400 P-PE); under native grasses or cultivation.

Parent Material: medium textured (CL-L, 2-15% coarse fragments), moderately calcareous, continental till.

Family: fine-loamy, strongly calcareous, cold subhumid.

Drainage: well drained.

Physiography: occurs in morainal landforms of the Cow Creek and Goose Lake benches, the southern Porcupine Hills, and eastern edge of the Beauvais Lake Upland.

Comments: thin Ah horizons (10-15 cm) and solum (carbonates within 50 cm) are characteristic (Table A8). A minor variant, paraskeletal BZR (kBZR), is associated with ice contact deposits or mountain tills.

Major Variants: three major variants were recognized.

1) rBZR (rego) variant - classed as Calcareous Black and related to PSO (Parsons); developed in same material as BZR.

2) BZRv (thin) variant - has 4-9 cm of black to dark brown Ah and classed as Orthic Eutric Brunisol; common in exposed, windswept terrain of the southern Porcupine Hills; variations occur in strongly calcareous and gravelly tills.

3) sBZR (saline) variant - is weakly to moderately saline with salts usually showing up below about 50 or 60 cm. It occurs around seeps on some relatively long apron-like slopes.

Competing Series: DVG (Dunvargan) differs because of a thicker Ah and solum that reflects the moister class 4H agroclimate. CTN (Cardston) differs because it occurs in fine textured glaciolacustrine (or lacustro-till) material. SOF (Standoff) differs because it occurs in medium textured water-laid deposits. OKY (Ockey) differs because it is a shal-

low lithic soil. RFD (Rockford) differs because it is developed in coarser textured ice contact deposits.

Table A8. Selected features of a BZR pedon (Cardston M.D., PID No. AB-83-79).

	Ah	Bm	Ck1	Ck2
Depth, cm	0-17	17-36	36-74	74-100
$CaCl_2$ pH	7.0	7.1	7.5	7.8
Organic C, %	4.2	1.7	---	---
CEC, cmol/kg	34.5	26.0	---	---
$CaCO_3$ eq., %	---	---	14.5	15.9
Sand, %	36	39	37	21
Clay, %	26	29	27	30
Cf., %	5 gr	5 gr	10 gr	10 gr

Notes: The Ah is a bit thicker than modal but carbonates occur well within 50 cm, which is characteristic. Upper solum pH's perhaps a bit higher than normal. Refer to Table A2 for explanation of abbreviations.

CFT (Crowfoot) Variant

Subgroup: Calcareous Dark Brown (CA.DB).
Agroclimate: subclass 2AH (greater than about 1250 EGDD, roughly -400 to -425 P-PE); under native grasses or cultivation.
Parent Material: very strongly calcareous, layered, glaciofluvial or fluvial deposits; 30 to 100 cm of medium textured (mainly L, <2% coarse fragments) veneer overlying extremely gravelly to cobbly (>60% coarse fragments), coarse textured (LS-S) gravel.
Family: loamy over sandy-skeletal, strongly calcareous, cool semiarid.
Drainage: rapidly to well drained.
Physiography: in hummocky ice contact terrain and terraces along the Oldman River, on the eastern edge of the Cowley Basin and adjacent Three Rivers Plain.
Comments: labelled rCFT (rego variant). This designation was also used to represent Rego Dark Brown soils during the mapping exercise.
Competing Series: MAC (Macleod) differs because it has less than 30 cm of loamy veneer over gravel. CIO (Chokio) and DIM (Diamond) differ because they occur in nongravelly medium textured sediments; gravel if present occurs below 1 m.

CIO (Chokio) Series

Subgroup: Calcareous Dark Brown (CA.DB).
Agroclimate: subclass 2AH (greater than about 1250 EGDD, roughly -400 to -425 P-PE) in the survey area, class 2A to the east; under native grasses or cultivation.
Parent Material: moderately calcareous, medium textured (SiL-SiCL-L, <2% coarse fragments), fluviolacustrine or glaciolacustrine deposits.
Family: fine-loamy, strongly calcareous, cool semiarid.
Drainage: well drained.
Physiography: eastern edge of the Cowley Basin and adjacent Three Rivers Plain, in and above the Oldman R. valley.
Comments: carbonate content of the parent material often exceeds 15%, ranging to about 20-25%.
Competing Series: DIM (Diamond) usually occurs with CIO but differs because it is classified as Rego Dark Brown. The rCFT (rego Crowfoot) variant differs because it has

gravel within 30-100 cm of the surface. BKE (Brocket) differs because it occurs in fine textured glaciolacustrine material.

CON (Connop) Variant

Subgroup: Orthic Eutric Brunisol (O.EB)
Agroclimate: class 5H bordering on 4H (roughly 700 to 950 EGDD, about -260 to -375 P-PE); under Douglas fir and mixedwood forest.
Parent Material: very strongly calcareous, coarse textured (SL, <2% coarse fragments), glaciofluvial deposits (Table A9).
Family: coarse-loamy, strongly calcareous, cold subhumid.
Drainage: rapidly to well drained.
Physiography: type area and pedon located in complex ice contact terrain around Lees Lake in the Southern Foothills.
Comments: labelled CONv (subgroup variant). Many textural variations including soils with significant sandy or gravelly layers occur in the same landscape.
Competing Series: CON series, defined and mapped in the Calgary area (MacMillan 1987), differs because it is an Eluviated Eutric Brunisol and has a thicker more acidic solum.

Table A9. Selected features of a typical CONv pedon (PID No. AB-87-05).

	LF	Bmk	BC	Ck1	Ck2
Depth, cm	3-0	0-12	12-40	40-90	90-120
$CaCl_2$ pH	6.6	7.4	7.6	7.8	7.9
Organic C, %	49.6	2.3	1.9	---	---
Total N, %	1.11	0.14	0.12	---	---
$CaCO_3$ eq., %	---	5.9	20.0	31.1	28.9
Sand, %	---	63	56	59	87
Clay, %	---	8	10	11	4
Cf., %	---	1 gr	1 gr	0	0

Notes: Coarser than modal layers such as the Ck2 are quite common, especially at depth. Finer than modal layers may also occur occasionally. Refer to Table A2 for explanation of abbreviations.

CRW (Carway) Series and Variants

Subgroup: Orthic Black (O.BL).
Agroclimate: class 4H (about 950 to 1050 EGDD, moister than -260 P-PE except in the drier Lees Lake area); mainly under native grasses and aspen.
Parent Material: moderately calcareous, coarse textured (SL, <2% coarse fragments), glaciofluvial deposits.
Family: coarse-loamy, strongly calcareous, cold subhumid.
Drainage: well to rapidly drained.
Physiography: associated with ice contact stratified drift landforms, mainly on the Beauvais Lake Upland.
Comments: thick Ah horizons (>15 cm) and solum (carbonates below 50 cm) are characteristic (Table A10). The parent material is often stratified and most of the variants are textural.

Major Variants: three major variants and taxadjuncts were identified.

1) cCRW (coarse) variant - contains significant sandy (LS-S) layers, primarily in mid to lower parts of the profile. Another version (kCRW) also contains some gravelly layers.

2) fCRW (fine) variant - contains significant medium textured (SCL-CL) layers, mainly in mid to lower parts of the profile.

3) CRWv (high lime) taxadjunct - occurs in very strongly calcareous glaciofluvial materials, mainly in the Lees Lake area, and has a thinner solum than CRW series.

Competing Series: MFT (Maycroft) differs because it occurs in medium textured fluvial and related sediments. KNT (Knight) differs because of a thinner Ah and solum that reflects a drier agroclimate.

Table A10. Selected features of a typical CRW pedon (PID No. AB-87-06).

	Ah1	Ah2	Bm	Ck1	Ck2
Depth, cm	0-16	16-45	45-70	70-95	95-110
$CaCl_2$ pH	6.7	6.9	6.7	7.6	7.7
Organic C, %	4.2	2.1	1.4	---	---
Total N, %	0.26	0.13	---	---	---
CEC, cmol/kg	25.1	17.9	17.7	---	---
$CaCO_3$ eq., %	---	---	---	9.7	6.6
Sand, %	71	77	60	73	81
Clay, %	15	13	15	14	10
Cf., %	0	1-2 gr	0	0	0

Notes: Coarser than modal layers such as the Ck2 are quite common, especially at depth. Finer than modal layers may also occur. Refer to Table A2 for explanation of abbreviations.

CTN (Cardston) Series and Variants

Subgroup: Orthic Black (O.BL).
Agroclimate: subclass 2HA (about 1180 to 1250 EGDD and -300 to -400 P-PE); under cultivation or native grasses.
Parent Material: fine textured (C-SiC-HC, 2-15% coarse fragments), moderately calcareous, glaciolacustrine material (sometimes called lacustro-till).
Family: clayey, strongly calcareous, cold subhumid.
Drainage: moderately well drained.
Physiography: found primarily on the Cardston Plain but extends onto the Goose Lake Bench and into the Porcupine Hills.
Comments: thin Ah horizons (10-15 cm) and sola (carbonates within 50 cm) are characteristic (Table A11). Carbonate content often varies from moderately to strongly calcareous. Most CTN occurs in moister parts of the Cardston Plain and is uncultivated. Cultivated CTN sometimes cracks when severely dried out; cracks may extend well into the parent material.
Major Variants: two major variants were recognized.

1) sCTN (saline) variant - is weakly to moderately saline with salts usually showing up below about 50 or 60 cm. It occurs on relatively long apron-like slopes that have seeps.

2) zCTN (solonetzic) variant - is classified as Solonetzic Black and occurs with other solonetzic-like and Solonetzic soils in lower slope to depressional localities that have been affected by discharge of saline ground water.

Competing Series: kFSH (Fish Creek) taxadjunct differs because of a thicker Ah and solum that reflects the moister class 4H agroclimate. PNR (Pincher) differs because it occurs in nongravelly, usually varved, glaciolacustrine sediments. CWY (Cowley) differs because it is Calcareous Black. BZR (Beazer) differs because it is developed in medium textured till. SOF (Standoff) differs because it occurs in nongravelly, medium textured, water-laid sediments.

Table A11. Selected features of a CTN pedon (Cardston M.D., PID No. AB-83-25).

	Ap	Bm	Cca	Ck
Depth, cm	0-10	10-25	25-63	63-100
$CaCl_2$ pH	5.7	6.8	7.8	7.9
Organic C, %	4.3	2.0	---	---
$CaCO_3$ eq., %	---	---	12.4	8.6
Sand, %	22	11	8	6
Clay, %	43	47	46	46
Cf., %	roughly 2 to 5% gravels, cobbles & stones throughout			

Notes: The Ap horizon by itself does not meet the thickness criteria for Chernozemic A; but a 15 cm mixture of Ap plus underlying Bm would likely meet Chernozemic A horizon color criteria. Refer to Table A2 for explanation of abbreviations.

CWY (Cowley) Series and Variants

Subgroup: Calcareous Black (CA.BL).
Agroclimate: subclass 2HA (about 1180 to 1250 EGDD, roughly -300 to -400 P-PE); under cultivation.
Parent Material: moderately calcareous, fine textured (C-SiC-HC, 2-15% coarse fragments), glaciolacustrine deposits, sometimes called lacustro-till (Table A12).
Family: clayey, strongly calcareous, cold subhumid.
Drainage: moderately well drained.
Physiography: dominates the Cowley Basin; common on the Cow Creek Bench; extends into the southern Porcupine Hills.

Table A12. Selected features of a typical CWY pedon (PID No. AB-86-05).

	Apk	Bmk	Ck1	Ck2
Depth, cm	0-16	16-30	30-74	74-110
$CaCl_2$ pH	7.5	7.6	7.8	8.0
Organic C, %	3.2	1.9	---	---
Total N, %	0.26	---	---	---
$CaCO_3$ eq., %	1.7	7.3	14.9	12.8
Sand, %	15	8	8	8
Clay, %	44	54	58	59
Cf., %	2 gr+cb	2 gr+cb	2 gr+cb	<1 gr

Notes: Apk color (10YR3/1.5m, 10YR4/2d) too light for Black Great Group but lightened by additions of calcareous drift. Coarse fragment content at bottom of normal range, yet shows the typical decrease with depth. Refer to Table A2 for explanation of abbreviations.

Comments: calcareousness may vary from moderate to strong, even amongst layers within a profile. Sometimes deeper layers or the complete profile are nongravelly (<2% coarse fragments). Erosion has been severe in areas where CWY is mapped, and many soils have thin (<15 cm) Apk horizons. In some cases, a mixture of Apk plus underlying material to a total depth of 15 cm may not meet Chernozemic A horizon color criteria (E.C.S.S. 1987b).
Major Variants: two major variants were recognized.

1) rCWY (rego) variant - lacks a Bmk horizon and is classed Rego Black.
2) sCWY (saline) variant - is a weakly to moderately saline Rego Black and occurs near seeps on long slopes. Salts generally occur at depth. This variant is the most extensive saline soil in the area. Similar versions include saline Calcareous Black, saline Gleyed Rego Black, and saline Gleyed Calcareous Black.

Competing Series: CTN (Cardston) differs because it is classified as Orthic Black. PSO (Parsons) differs because it is Rego Black and developed in medium textured till. ODM (Oldman) differs because it is Rego Black and occurs in medium textured fluvial and related deposits.

DIM (Diamond) Series

Subgroup: Rego Dark Brown (R.DB).
Agroclimate: subclass 2AH (greater than 1250 EGDD, roughly -400 to -425 P-PE) in the survey area, class 2A to the east; mainly under cultivation.
Parent Material: moderately calcareous, medium textured (SiL-SiCL-L, <2% coarse fragments), fluviolacustrine or glaciolacustrine deposits.
Family: fine-loamy, strongly calcareous, cool semiarid.
Drainage: well drained.
Physiography: eastern edge of the Cowley Basin and adjacent Three Rivers Plain, in and above the Oldman R. valley.
Comments: carbonate content of the parent material often exceeds 15%, ranging to about 20-25%.
Competing Series: CIO (Chokio) usually occurs with DIM but differs because it is classified as Calcareous Dark Brown. rCFT (rego Crowfoot) variant differs because it has gravel within 30-100 cm of the surface. BKE (Brocket) differs because it is developed in finer textured glaciolacustrine material.

DRW (Drywood) Series, Taxadjunct and Variant

Subgroup: Orthic Black (O.BL)
Agroclimate: class 4H (about 950 to 1050 EGDD, moister than -260 P-PE except in drier area north of the Castle R.); mainly under native grasses or cultivation.
Parent Material: moderately calcareous, layered, glaciofluvial or fluvial deposits; 30-100 cm of medium to coarse textured (mainly L, <2% coarse fragments) veneer overlying extremely gravelly to cobbly (>60% coarse fragments), coarse textured (LS-S) gravel.
Family: loamy over sandy-skeletal, strongly calcareous, cold subhumid.
Drainage: rapidly to well drained.
Physiography: on upper to lower terraces associated with major streams that cut through the Southern Foothills and Front Ranges.
Comments: thick Ah horizon (>15 cm) and solum (carbonates below 50 cm) are characteristic (Table A13). Map units based on DRW generally have widely varying surface textures (L-SiL-SL-CL-SiCL), sometimes with a few gravels (kDRW). Underlying material may vary from weakly to very strongly calcareous and sometimes has only 40-50% coarse fragments.

Major Variants: two major taxadjuncts and variants were identified.

1) kDRW (gravelly) taxadjunct - like DRW but has up to 35% coarse fragments in the loamy veneer.

2) rDRW (rego) variant - classed Rego Black but has the same textural and chemical features as DRW, except more often strongly to very strongly calcareous. The designation was also used to denote Calcareous Blacks during mapping.

Competing Series: LNB (Lundbreck) differs because it has less than 30 cm of loamy veneer over gravel. MFT (Maycroft) differs because it is developed in nongravelly medium textured deposits; gravel if present occurs below 1 m. BFT (Blackfoot) differs because of a thinner Ah and solum that reflects the drier class 3H agroclimate.

Table A13. Selected features of a DRW pedon (PID No. AB-87-07).

	Ah	Bm1	Bm2	IIBC	IICk
Depth, cm	0-30	30-54	54-61	61-75	75-105
$CaCl_2$ pH	5.8	5.9	5.9	7.4	7.7
Organic C, %	3.9	1.2	1.4	1.7	---
Total N, %	0.26	---	---	---	---
CEC, cmol/kg	23.9	14.1	20.1	---	---
$CaCO_3$ eq., %	---	---	---	4.9	9.3
Sand, %	64	68	43	79	90
Clay, %	15	11	18	7	6
Cf., %	1-2 gr	1-2 gr	1-2 gr	50 all[1]	50 gr+cb

Notes: This profile has slightly fewer coarse fragments than modal at depth, but such variability is usually normal in these deposits. Large sand lens found below 105 cm. Refer to Table A2 for explanation of abbreviations.

1. All = gravel, cobble and stone sizes (and shapes) of coarse fragments.

DVG (Dunvargan) Series and Variant

Subgroup: Orthic Black (O.BL)

Agroclimate: class 4H (about 950 to 1050 EGDD, moister than -260 P-PE except in drier area north of the Castle R.); under native grasses or cultivation.

Parent Material: moderately calcareous, medium textured (CL-L, 2-15% coarse fragments), continental till.

Family: fine-loamy, strongly calcareous, cold subhumid.

Drainage: well to moderately well drained.

Physiography: majority on the Beauvais Lake Upland and Goose Lake Bench, some in the Porcupine Hills.

Comments: characterized (Table A14) by thick Ah horizon (>15 cm) and thick solum (carbonates below 50 cm).

Major Variants: kDVG (paraskeletal) variant developed in moderately calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured, mountain till; probably the most common of several occurring in mountain tills. Closely related versions occur in strongly to very strongly calcareous till (Rock Creek area), in weakly calcareous till throughout the foothills, and, occasionally, in gravelly fine textured till (or lacustro-till). A thick Ah horizon and thin solum (<50 cm) typifies the high lime version.

Competing Series: BZR (Beazer) differs because of a thinner Ah and solum that reflects the drier class 3H agroclimate. OTP (Outpost) differs because it is a loamy-skeletal soil developed in coarser textured ice contact deposits. The kFSH (Fish Creek) taxadjunct differs because it occurs in finer textured glaciolacustrine material. MFT (Maycroft) differs

because it occurs in medium textured fluvial and related sediments. The SPY (Spy Hill) series, defined and mapped in the Calgary area (MacMillan 1987), may be the same as the high lime version of DVG found in the Rock Creek area.

Table A14. Selected features of a typical DVG pedon (Cardston M.D.. PID No. AB-82-08).

	Ah1	Ah2	Bm	BC	Ck
Depth, cm	0-14	14-25	25-51	51-70	70-95
$CaCl_2$ pH	6.1	6.4	6.6	7.2	7.7
Organic C, %	6.0	4.1	1.1	---	---
Total N, %	0.48	0.33	---	---	---
CEC, cmol/kg	32.1	30.0	25.6	---	---
$CaCO_3$ eq., %	---	---	---	3.6	12.7
Sand, %	36	31	33	32	32
Clay, %	35	34	38	35	34
Cf., %	5 all	10 all	15 all	20 all	15 all

Notes: Gravel, cobble and stone content at top of normal range; may indicate mountain or ice contact influence on till origin. Refer to Table A2 for explanation of abbreviations.

FRK (Frank) Series and Variant

Subgroup: Orthic Eutric Brunisol (O.EB)
Agroclimate: classes 6H to 7H (colder than 700 EGDD, moister than -260 P-PE); under lodgepole pine and mixed coniferous forest.
Parent Material: very strongly calcareous, very gravelly to cobbly (35-60% coarse fragments), coarse to medium textured (SL-L-SiL) colluvium; coarser particles generally derived from limestones but ashy loess may contribute significantly to the fine earths (Table A15).
Family: loamy-skeletal (or ashy-skeletal), strongly calcareous, cold subhumid.
Drainage: rapidly drained.
Physiography: found on the steep walls of the High Rock Ridges.

Table A15. Selected features of a FRK pedon (PID No. AB-87-10).

	L	F	BA	Bmk	BC1	BC2	Ck
Depth, cm	7-3	3-0	0-2	2-30	30-45	45-55	55-110
$CaCl_2$ pH	4.9	5.9	6.7	7.2	7.5	7.7	7.7
Organic C, %	51.6	47.9	7.2	2.8	1.9	---	---
CEC, cmol/kg	96.5	116.0	36.8	---	---	---	---
$CaCO_3$ eq., %	---	---	---	4.1	4.1	3.1	5.2
Sand, %	---	---	38	36	26	26	38
Clay, %	---	---	8	8	13	4	11
Cf., %	---	---	40 all[1]	40 all	50 all	50 all	60 all

Notes: This pedon has much lower carbonate content than modal even though the coarse fragments are mainly limestones. Particle size distribution and low bulk density suggest an eolian origin for the fine earths. The BC2 and a small pocket in the Ck may be mainly volcanic ash. Refer to Table A2 for explanation of abbreviations.
1. All = all sizes and shapes: gravels, channers, cobbles, flags, & stones.

Comments: carbonate content of parent material likely the most variable feature of this and related soils; ranges from weakly to extremely calcareous. Profiles often reddish tinged as in the Bmk horizon (7.5YR4.5/4.5m) of the featured pedon (Table A15).
Major Variants: lFRK (lithic) variant is shallow lithic and occurs on exceedingly steep, rocky, mountain slopes under open coniferous forest and sparse shrubland. Its chemical and physical features are otherwise the same as FRK. Regosolic soils are often associated with lFRK.
Competing Series: none.

FSH (Fish Creek) Taxadjunct and Variant

Subgroup: Orthic Black (O.BL)
Agroclimate: class 4H (about 950 to 1050 EGDD, generally moister than -260 P-PE); under cultivation or native grasses.
Parent Material: fine textured (C-SiC-HC, 2-15% coarse fragments), moderately calcareous, glaciolacustrine material (sometimes called lacustro-till).
Family: clayey, strongly calcareous, cold subhumid.
Drainage: moderately well drained.
Physiography: mainly on the Beauvais Lake Upland and Goose Lake Bench; small amount in the Porcupine Hills.
Comments: labelled kFSH, the taxadjunct differs only slightly from the nongravelly (<2% coarse fragments) series defined for the Calgary area (Table A16). Thick Ah horizon (>15 cm) and thick solum (carbonates below 50 cm) are characteristic of kFSH. Normally associated with very gentle slopes, this or a very similar soil also occurs in gently to moderately sloping, hummocky to ridged, moraine-like terrain. Here the parent material is either clay till derived from argillaceous bedrock, or draped glaciolacustrine sediments of a supraglacial lake.
Major Variants: sFSH (saline) variant - is weakly to moderately saline with salts usually appearing below about 50 or 60 cm. It occurs on relatively long apron-like slopes that have seeps or in depressional localities of rougher terrain.
Competing Series: CTN (Cardston) differs because of a thinner Ah and solum that reflects a drier agroclimate. DVG (Dunvargan) differs because it is developed in medium textured till. MFT (Maycroft) differs because it occurs in nongravelly, medium textured, water-laid sediments.

Table A16. Selected features of a FSH pedon (Calgary, MacMillan 1987).

	Ah	Bm	Cca	Ck	IICk
Depth, cm	0-18	18-44	44-100	100-150	150+
$CaCl_2$ pH	6.1	6.8	7.8	8.0	8.0
Organic C, %	6.5	1.5	---	---	---
Total N, %	0.54	0.18	---	---	---
CEC, cmol/kg	37.1	26.0	---	---	---
$CaCO_3$ eq., %	---	---	21.8	15.4	17.1
Sand, %	4	2	6	2	14
Clay, %	42	40	39	55	35
Cf., %	0	0	1-2	1-2	5-10

Notes: Higher carbonate content closer to the surface than modal, but within normal range for water-worked deposits of the foothills. Cca horizons not often found in kFSH soils of the Pincher Creek area. Refer to Table A2 for explanation of abbreviations.

JAT (Joanto) Series

Subgroup: Rego Humic Gleysol (R.HG)
Agroclimate: class 3H (about 1050 to 1180 EGDD, roughly -260 to -400 P-PE); under prairie wetland vegetation, occasionally cultivated.
Parent Material: moderately calcareous, fine textured (C-SiC-SiCL, <2% coarse fragments), lacustrine or glaciolacustrine sediments.
Family: fine-clayey, strongly calcareous, cold subhumid.
Drainage: poorly drained.
Physiography: occurs in depressional sites within morainal and glaciolacustrine landforms of the Cardston Plain, Southern Foothills and Porcupine Hills.
Comments: one of several, intimately associated, very poorly to imperfectly drained soils plus water that occupy wet depressions. Other wet soils have Bg horizons (Orthic Humic Gleysols), little or no Ah (Orthic and Rego Gleysols), weak gleying (Gleyed subgroups, mainly of Black soils), salinity, or solonetzic tendencies. Any of these soils may be developed in lacustrine, glaciolacustrine, till, fluviolacustrine, or fluvial parent materials and exhibit different textural and chemical features.
Competing Series: POT (Pothole Creek) differs because it is an Orthic Humic Gleysol and is associated with class 4H agroclimate.

KNT (Knight) Series and Variants

Subgroup: Orthic Black (O.BL).
Agroclimate: class 3H (about 1050 to 1180 EGDD, roughly -260 to -400 P-PE); under native grasses or cultivation.
Parent Material: moderately calcareous, coarse textured (SL, <2% coarse fragments), glaciofluvial or fluvial sediments.
Family: coarse-loamy, strongly calcareous, cold subhumid.
Drainage: well to rapidly drained.
Physiography: associated with ice contact or terraced landforms on the Cow Creek and Goose Lake Benches.
Comments: thin Ah horizon (10-15 cm) and solum (carbonates encountered within 50 cm) characteristic. The parent material is often stratified, so many textural variations occur. Parent material may also vary from strongly to weakly calcareous.
Major Variants: two major variants were recognized.

1) rKNT (rego) variant - is classed Rego Black but has the same chemical and physical variability as KNT. This designation was also used to denote Calcareous Black soils during mapping.
2) cKNT (coarse) variant - contains significant sandy (LS-S) layers, primarily in mid to lower parts of the profile. Another version (kKNT) contains some gravelly layers.

Competing Series: SOF (Standoff) differs because it is developed in medium textured water-laid sediments. CRW (Carway) differs because of a thicker Ah and solum that reflects the moister class 4H agroclimate, but otherwise has similar features (refer to Table A10).

LNB (Lundbreck) Series

Subgroup: Orthic Black (O.BL)
Agroclimate: class 4H (about 950 to 1050 EGDD, moister than -260 P-PE except in drier area north of the Castle R.); mainly under native grasses.
Parent Material: moderately calcareous, extremely gravelly to cobbly (>60% coarse fragments), coarse textured (LS-S), glaciofluvial or fluvial gravel.
Family: sandy-skeletal, strongly calcareous, cold subhumid.

Drainage: rapidly drained.
Physiography: on upper to lower terraces associated with major streams that cut through the Southern Foothills and Front Ranges.
Comments: thick Ah horizon (>15 cm) and solum (carbonates below 50 cm) characteristic of LNB (Table A17). Parent material of LNB and closely associated soils may vary from weakly to extremely calcareous and sometimes has only 40-50% coarse fragments.
Competing Series: DRW (Drywood) differs because it has 30 cm or more of medium textured veneer over gravel. BUR (Burmis) differs because it is classified as Rego Black and occurs in extremely calcareous gravel. RND (Rinard) differs because of a thinner Ah and solum that reflects a drier agroclimate.

Table A17. Selected features of a typical LNB pedon (PID No. AB-86-07).

	Ah	Bm	BC	Ck
Depth, cm	0-18	18-55	55-85	85-150
$CaCl_2$ pH	5.5	5.4	7.3	7.6
Organic C, %	6.2	1.6	---	---
Total N, %	0.52	---	---	---
CEC, cmol/kg	25.1	11.0	---	---
$CaCO_3$ eq., %	---	---	2.3	11.4
Sand, %	62	76	85	91
Clay, %	9	11	3	3
Cf., %	20 gr+cb	40 gr+cb	60 gr+cb	60 all[1]

Notes: Upper solum pH's are lower than normally expected in native grassland soils but not uncommon in these coarse textured soils of the foothills. Refer to Table A2 for explanation of abbreviations.
1. All = gravel, cobble and stone sizes (and shapes) of coarse fragments.

LTC (Leighton Centre) Series and Variant

Subgroup: Dark Gray Luvisol (D.GL)
Agroclimate: class 5H (roughly 700 to 950 EGDD, moister than -260 P-PE); under coniferous or mixedwood forest.
Parent Material: moderately calcareous, medium textured (CL-L, 2-15% coarse fragments), continental or mixed till.
Family: fine-clayey (due to Bt) over loamy, strongly calcareous, cold subhumid.
Drainage: well to moderately well drained.
Physiography: variants generally more common than the series; all can be found in the Porcupine Hills and Southern Foothills.
Comments: upper solum often mixed by earthworm activity (Table A18). Similar versions have weakly or strongly calcareous parent materials, and gravelly or fine textures.
Major Variants: kLTC (paraskeletal) variant developed in weakly calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain till; most common of several occurring in mountain tills. Similar versions developed in strongly calcareous till (Porcupine Hills) and in very gravelly fine textured till (or lacustro-till).
Competing Series: Crooked Creek (CCR), the shallow lithic variant of LTC, was used in Cardston (Brierley *et al.* In press) but was found only in minor amounts in the Pincher-Crowsnest area.

Table A18. Selected features of a LTC pedon (Cardston M.D., PID No. AB-84-06).

	Aheu	Aeu	Bt1	Bt2	Ck
Depth, cm	0-8	8-18	18-42	42-80	80-100
$CaCl_2$ pH	6.0	5.2	5.5	5.6	7.4
Organic C, %	17.4	2.9	1.2	0.9	---
Total N, %	0.54	0.16	---	---	---
CEC, cmol/kg	47.4	19.5	19.4	22.5	17.6
$CaCO_3$ eq., %	---	---	---	---	13.6
Sand, %	32	35	38	29	32
Clay, %	24	25	26	33	29
Cf., %	Approximately	5-10%	gravels	throughout	

Notes: This profile is taxadjunct because the Bt's have less clay than normal. Mixing of the upper solum by earthworms has reduced the LFH to 1 cm in thickness, added organic matter to the Aheu, and camouflaged eluviation (Aeu). Refer to Table A2 for explanation of abbreviations.

MAC (Macleod) Series and Variant

Subgroup: Calcareous Dark Brown (CA.DB)
Agroclimate: subclass 2AH (greater than about 1250 EGDD, roughly -400 to -425 P-PE) in the survey area, likely class 2A to the east; under native grasses.
Parent Material: very strongly calcareous, extremely gravelly to cobbly (>60% coarse fragments), coarse textured (LS-S), glaciofluvial or fluvial gravel (Table A19).
Family: sandy-skeletal, strongly calcareous, cool semiarid.
Drainage: very rapidly to rapidly drained.
Physiography: in terraces and hummocky ice contact terrain along the Oldman River, on the eastern edge of the Cowley Basin and adjacent Three Rivers Plain.
Comments: Cca horizon sometimes present as discontinuous, irregular to spherical, weakly cemented patches in upper Ck. Parent material of MAC and closely associated soils may vary from strongly to extremely calcareous and may have only 40-50% coarse fragments.
Major Variants: rMAC (rego) variant lacks the Bmk and is classed Rego Dark Brown.
Competing Series: CFT (Crowfoot) differs because it has 30 cm or more of nongravelly, medium textured veneer over gravel.

Table A19 Selected features of a typical MAC pedon (PID No. AB-87-02).

	Ahk	Bmk	Ck1	Ck2
Depth, cm	0-10	10-24	24-29	29-140
$CaCl_2$ pH	7.5	7.6	7.7	7.8
Organic C, %	4.8	3.8	1.5	0.2
Total N, %	0.40	0.25	0.06	0.01
$CaCO_3$ eq., %	2.6	30.6	42.0	39.0
Sand, %	57	44	86	86
Clay, %	13	30	5	5
Cf., %	10 gr+cb	30 gr+cb	50 gr+cb	70 gr+cb

Notes: Lime pendants under fragments nearly continuous in Ck1 to form weakly cemented (dry only) hard mass of soil particles and carbonate. Refer to Table A2 for explanation of abbreviations.

MFT (Maycroft) Series and Variants

Subgroup: Orthic Black (O.BL).
Agroclimate: class 4H (about 950 to 1050 EGDD, moister than -260 P-PE except in drier area north of the Castle R.); under native grasses, cultivation or aspen forest.
Parent Material: moderately calcareous, medium textured (SiL-CL-SiCL-L, <2% coarse fragments), fluvial, fluviolacustrine or glaciolacustrine deposits (Table A20).
Family: fine-loamy, strongly calcareous, cold subhumid.
Drainage: well drained.
Physiography: found mainly in valleys of the Southern Foothills, Porcupine Hills and, occasionally, the Front Ranges.
Comments: thick Ah horizon (>15 cm) and solum (carbonates below 50 cm) characteristic of MFT; profiles often slightly stratified, showing variable calcareousness and texture among layers (Table A20). Similar soils may contain a few fine gravels, occur in weakly to strongly calcareous parent material, or be weakly gleyed.
Major Variants: two major variants were recognized.

1) rMFT (rego) variant - classed Rego Black but has the same chemical and physical variability as MFT. This symbol also denotes Calcareous Black soils in the mapping. Most rMFT is mapped in the Southern Foothills where it occurs with wetter soils.
2) grMFT (gleyed rego) variant - classed Gleyed Rego Black due to the presence of mottles and dull colors, mainly under imperfectly drained conditions; similar features as MFT and rMFT including stratification, calcareousness and textural variations. Commonly associated with rMFT and Gleysolic soils in the Southern Foothills.

Competing Series: SOF (Standoff) differs because of a thinner Ah and solum that reflects a drier agroclimate. DVG (Dunvargan) differs because it is developed in medium textured till. The kFSH (Fish Creek) taxadjunct differs because it occurs in fine textured glaciolacustrine material. DRW (Drywood) differs because it has gravel within 30-100 cm of the surface. SRC (Sarcee) series, used in the Calgary area (MacMillan 1987), differs because it occurs in strongly calcareous, water-laid material and has a thin solum.

Table A20. Selected features of a typical MFT pedon (PID No. AB-87-14).

	Ap	Ah	Bm	Ck1	Ck2	Ck3
Depth, cm	0-7	7-24	24-58	58-64	64-90	90-105
$CaCl_2$ pH	6.3	6.3	6.2	7.7	7.5	7.7
Organic C, %	7.6	6.5	1.3	---	---	---
Total N, %	0.56	0.48	---	---	---	---
CEC, cmol/kg	30.4	46.9	---	---	---	---
$CaCO_3$ eq., %	0.2	0.1	0.5	25.0	13.2	7.6
Sand, %	25	21	18	40	22	20
Clay, %	28	30	34	18	20	30
Cf., %	<1 gr	<1 gr	<1 gr	10 gr	0	0

Notes: Traces of carbonate in the solum a common feature. High carbonate content of the Ck1 likely depositional rather than pedogenic (ie. not a Cca). Refer to Table A2 for explanation of abbreviations.

MGV (McGillivray) Series and Variant

Subgroup: Eluviated Eutric Brunisol (E.EB).
Agroclimate: class 5H borderline to 6H (roughly 700 to 950 EGDD and around -260 P-PE); mainly under Douglas fir or Douglas fir mixedwood forest.

Parent Material: very strongly calcareous, very gravelly to cobbly (35-60% coarse fragments), medium to coarse textured (L-SL), till-like, glaciofluvial (ice contact) deposits.
Family: loamy-skeletal, strongly calcareous, cold subhumid.
Drainage: well drained.
Physiography: mainly in ice contact landforms on benchlands of the Crowsnest R. valley in the Front Ranges.
Comments: weak eluviation (Aej) and illuviation (Btj) are typical features (Table A21) but show the intergrading relationship to Orthic Gray Luvisols. A shallow lithic variant occurs occasionally.
Major Variants: MGVv (subgroup) variant classed as Orthic Eutric Brunisol was identified. It occurs with MGV in the same parent material.
Competing Series: kBRGv (Bragg Creek) variant differs because it is an Orthic Eutric Brunisol and occurs in gravel. SPR (Spruce Ridge) differs because it is an Orthic Gray Luvisol and is developed in gravelly medium textured till.

Table A21. Selected features of a typical MGV pedon (PID No. AB-87-11).

	LFH	Aej	AB	Btj	BC	Ck1	Ck2
Depth, cm	3-0	0-3	3-8	8-20	20-27	27-40	40-100
$CaCl_2$ pH	6.0	5.7	5.5	6.3	7.4	7.8	7.8
Organic C, %	47.5	2.0	1.1	1.3	2.3	---	---
CEC, cmol/kg	117.4	18.5	17.6	21.3	---	---	---
$CaCO_3$ eq., %	---	---	---	---	17.7	36.5	37.7
Sand, %	---	53	48	49	47	51	50
Clay, %	---	13	16	20	14	14	14
Cf., %	---	20 all	30 all	40 all	40 all	40 all	50 all

Notes: Aej discontinuous around pit and across landscape. Refer to Table A2 for explanation of abbreviations.

NFK (North Fork) Series

Subgroup: Orthic Eutric Brunisol (O.EB)
Agroclimate: class 3H (about 1050 to 1180 EGDD, roughly -260 to -400 P-PE); under native grasses and scattered shrubs or trees.
Parent Material: strongly calcareous, gravelly to cobbly (15-35% coarse fragments), medium grading to coarse textured (CL-L-SCL-SL) till overlying variable clastic bedrock or residual material, usually sandstone.
Family: loamy, shallow lithic, strongly calcareous, cold subhumid.
Drainage: well drained, occupies upper slope to crest positions.
Physiography: type location and pedon (Table A22) in the Porcupine Hills; series and variants are also common in the Southern Foothills, sometimes in the Front Ranges.
Comments: Ah horizon commonly about 4 to 9 cm thick, and may be either black or dark brown in color. The till parent material is predominantly medium textured (CL-L) but commonly has coarser layers (SL-SCL) where the underlying bedrock is sandstone. NFK is more prevalent on southerly to westerly windward aspects than on northerly or easterly lee slopes. Moderately and weakly calcareous variants are more prevalent in the colder climate areas to the west.
Competing Series: NFK vaguely resembles OKY (Ockey) series and rVAC (rego Van Cleeve) variant which differ because they have thicker Ah horizons and are classified Orthic Black and Rego Dark Brown, respectively.

Table A22. Selected features of a typical NFK pedon (PID No. AB-86-03).

	Ah	Bm	BC	Ck1	Ck2	R
Depth, cm	0-5	5-14	14-32	32-57	57-85	@ 85
$CaCl_2$ pH	7.1	6.8	7.6	7.7	7.9	NS
Organic C, %	7.0	2.6	1.5	---	---	NS
Total N, %	0.50	0.22	---	---	---	NS
CEC, cmol/kg	30.2	24.7	---	---	---	NS
$CaCO_3$ eq., %	---	0.2	20.5	18.8	16.6	NS
Sand, %	61	59	30	49	69	NS
Clay, %	22	21	33	23	10	NS
Cf., %	2 all	2 all	5-10 all	25 all	25 all	Rock

Notes: Increasing sand and coarse fragment contents with depth show the influence of underlying sandstone bedrock. Refer to Table A2 for explanation of abbreviations.

OAS (Oasis) Variant

Subgroup: Calcareous Dark Brown (CA.DB).
Agroclimate: subclass 2AH (greater than about 1250 EGDD, roughly -400 to -425 P-PE); under cultivation or grasses.
Parent Material: very strongly calcareous, layered, glaciofluvial deposits; 30-100 cm of medium textured (L-SiL) veneer overlying coarse textured (SL) sediments, all nongravelly (<2% coarse fragments).
Family: loamy, strongly calcareous, cool semiarid.
Drainage: well to rapidly drained.
Physiography: in ice contact terrain along the Oldman R. on the eastern edge of the Cowley Basin and adjacent Three Rivers Plain.
Comments: labelled rOAS (rego variant). A coarser variant has gravelly layers in the upper profile. In mapping, the rOAS symbol was also used to represent Rego Dark Browns which dominate under cultivation.
Competing Series: CFT (Crowfoot) differs because it has gravel at 30-100 cm from the surface. CIO (Chokio) and DIM (Diamond) differ because they occur in medium textured sediments with few if any coarse layers. OSN (Olsen) differs because it is dominantly coarse textured with less than 30 cm of medium textured veneer (refer to Table A25). OAS series, defined and mapped in the Warner area (Kjearsgaard *et al.* 1986), differs because it is classified as Orthic Dark Brown and occurs in moderately calcareous deposits.

ODM (Oldman) Series

Subgroup: Rego Black (R.BL).
Agroclimate: subclass 2HA (about 1180 to 1250 EGDD, roughly -300 to -400 P-PE or slightly drier in a few areas); mainly under cultivation.
Parent Material: strongly calcareous, medium textured (L-SiL-CL, <2% coarse fragments), fluviolacustrine or glaciolacustrine deposits (Table A23).
Family: fine-loamy, strongly calcareous, cold subhumid.
Drainage: well drained.
Physiography: in fluvial and ice contact terrain, mainly on the Cardston Plain.
Comments: may also occur in fluvial deposits; often slightly stratified with variable carbonate content and textures among layers (Table A23). Parent materials of ODM and its close associates vary from moderately to very strongly calcareous, or contain a few gravels

or coarser textured layers. Erosion has been severe in areas where ODM is mapped, and many soils have thin (<15 cm) Apk horizons. In some cases, a mixture of Apk plus underlying material to a total depth of 15 cm may not meet Chernozemic A horizon color criteria (E.C.S.S. 1987b).

Competing Series: SOF (Standoff) differs because it is Orthic Black. CWY (Cowley) differs because it occurs in fine textured glaciolacustrine deposits. PSO (Parsons) differs because it is developed in medium textured till. rPPE (rego Porcupine) variant differs because it has a very thick Ah horizon (>50 cm) and occurs in steeply sloping slopewash deposits in areas of cooler agroclimate (4H).

Table A23. Selected features of a typical ODM pedon (PID No. AB-87-04).

	Apk	AC	Ck1	Ck2	Ck3
Depth, cm	0-13	13-30	30-50	50-90	90-115
$CaCl_2$ pH	7.8	7.9	7.8	7.9	8.0
Organic C, %	3.3	1.5	1.0	---	---
Total N, %	0.25	0.18	0.08	---	---
$CaCO_3$ eq., %	3.3	14.3	19.4	17.4	14.6
Sand, %	46	33	34	32	36
Clay, %	16	21	16	22	16
Cf., %	1% or less gravel throughout				

Notes: The Apk horizon, a mixture of the original A plus calcareous drift and Bm material, had been slightly compacted. A mix of Apk plus underlying AC to a total depth of 15 cm would meet Chernozemic A horizon color criteria. Refer to Table A2 for explanation of abbreviations.

OKY (Ockey) Series and Variants

Subgroup: Orthic Black (O.BL)

Agroclimate: class 3H (about 1050 to 1180 EGDD, roughly -260 to -400 P-PE); mainly under native grasses.

Parent Material: moderately calcareous, medium textured (CL-L), 2-15% coarse fragments), continental till overlying strongly calcareous, gravelly to very gravelly (15-60% coarse fragments), residual material weathered from clastic bedrock, mainly sandstone and shale (Table A24).

Family: fine-loamy, shallow lithic, strongly calcareous, cold subhumid.

Drainage: well drained; located in upper slopes and crests.

Physiography: series found on the Cardston Plain but only on prominent ridges and hills that are outliers of the Southern Foothills and Porcupine Hills. Climatic and paraskeletal variants are common throughout the Southern Foothills and in the Porcupine Hills.

Comments: the residual parent material portion of OKY and closely related soils varies from weakly to very strongly calcareous, from nongravelly (paralithic version in soft bedrock) to skeletal.

Major Variants: three major variants were identified to deal with the variability of soils similar to OKY.

1) OKYv (climatic) variant - defined as occurring in areas classed as agroclimate 4H, but extended by mapping convenience into areas that may in fact be 5H. Its morphology and environmental setting resemble those of OKY, possibly due to a similar microclimate created by steep slopes and warm aspects. All or part of the Ah horizon may tend towards dark brown colors. OKYv may be the same as a lithic version of DVG (Dunvargan) described in the Calgary area (MacMillan 1987).

2) kOKY (paraskeletal) variant - developed in moderately calcareous, gravelly to cobbly (15-35% coarse fragments) tills, mainly in areas of 4H to 5H agroclimate; likely the most common of all OKY variants. Similar versions occur in strongly to very strongly calcareous or weakly calcareous tills. Dark Brown Ah horizons are common in some high elevattion with steep southerly aspects.

3) rOKY (rego) variant - classified as Rego Black but many similar features as OKY. In mapping, the rOKY symbol was also used to represent Calcareous Blacks and climatic variants in cooler areas. Some of these variants are also paraskeletal.

Competing Series: BZR (Beazer) differs because it is developed in much deeper till; likewise DVG (Dunvargan) is the deep till counterpart of OKYv. OKY vaguely resembles NFK (North Fork) which differs because it has a much thinner Ah and is classified as Orthic Eutric Brunisol.

Table A24. Selected features of a typical OKY pedon (PID No. AB-87-08).

	Ah	AB	Bm	BC	IIBC1	IIBC2	R
Depth, cm	0-11	11-23	23-40	40-52	52-67	67-80	@ 80
$CaCl_2$ pH	6.2	5.8	5.9	7.3	7.8	7.9	NS
Organic C, %	8.0	2.6	2.1	1.8	---	---	NS
Total N, %	0.56	0.22	---	---	---	---	NS
CEC, cmol/kg	39.9	26.9	28.6	---	---	---	NS
$CaCO_3$ eq., %	---	---	---	5.8	18.7	15.9	NS
Sand, %	49	44	32	27	24	24	NS
Clay, %	27	31	35	22	21	20	NS
Cf., %	<5 all	10 all	10 all	10 all	30 all	50 all	Rock

Notes: Calcareous residual material (IIBC horizons) is a weakly weathered "rind" on the underlying bedrock, here tilted shale and sandstone strata. Ah material tongues down to the BC horizon. Refer to Table A2 for explanation of abbreviations.

OSN (Olsen) Series and Variant

Subgroup: Calcareous Dark Brown (CA.DB).
Agroclimate: subclass 2AH (greater than about 1250 EGDD, roughly -400 to -425 P-PE) in the survey area, likely class 2A to the east; under cultivation and grasses.
Parent Material: very strongly calcareous, coarse textured (SL, <2% coarse fragments), glaciofluvial deposits (Table A25).
Family: coarse-loamy, strongly calcareous, cool semiarid.
Drainage: rapidly to well drained.
Physiography: in ice contact terrain along the Oldman R. on the eastern edge of the Cowley Basin and adjacent Three Rivers Plain.
Comments: often evident that wind erosion and deposition have affected soil development; also that profiles are slightly stratified (Table A25). A coarser variant has gravelly layers in the upper profile.
Major Variants: rOSN (rego) variant classified as Rego Dark Brown; occurs with OSN and dominates in areas that are cultivated.
Competing Series: rOAS (rego Oasis) variant differs because it has 30 cm or more of medium textured veneer overlying the coarse deposits. CIO (Chokio) and DIM (Diamond) differ because they occur in nongravelly medium textured sediments. CFT (Crowfoot) differs because it has gravel at 30-100 cm from the surface.

Table A25. Selected features of a typical OSN pedon (PID No. AB-87-03).

	Ahk1	Ahk2	Bmk	Ahkb	Ck1	Ck2	Ck3	Ck4
Depth, cm	0-5	5-14	14-25	25-27	27-55	55-76	76-105	105-120
$CaCl_2$ pH	7.6	7.6	7.6	7.6	7.7	7.8	7.9	8.1
Organic C, %	3.7	2.9	2.8	2.7	1.3	---	---	---
Total N, %	0.30	0.25	0.27	0.23	0.09	---	---	---
$CaCO_3$ eq., %	10.9	7.0	11.7	11.5	33.3	32.5	29.4	32.8
Sand, %	53	41	65	65	64	49	59	84
Clay, %	13	24	9	8	10	13	10	5
Cf., %	1-2% gravel in upper 60 cm, none below							

Notes: Ahk1 is calcareous drift, common on all soils in the vicinity. Ahkb likely a crotovina, also common in such soils. Coarser than modal layers such as the Ck4 are common, especially at depth. Refer to Table A2 for explanation of abbreviations.

OTP (Outpost) Series and Variant

Subgroup: Orthic Black (O.BL)
Agroclimate: class 4H (about 950 to 1050 EGDD, less than -260 P-PE except in drier area north of the Castle R.); under native grasses.
Parent Material: moderately calcareous, very cobbly to gravelly or stony (35-60% coarse fragments), coarse to medium textured (mainly SL-L), glaciofluvial (ice contact) deposits (Table A26).
Family: loamy-skeletal, strongly calcareous, cold subhumid.
Drainage: rapidly to well drained.
Physiography: found in moraine-like, ice contact landforms of the Southern Foothills and Front Ranges.

Table A26. Selected features of an OTP pedon (PID No. AB-86-04).

	Ah	Bm1	Bm2	BC1	BC2	Ck
Depth, cm	0-20	20-32	32-47	47-80	80-100	100-125
$CaCl_2$ pH	5.8	5.4	5.3	6.9	7.5	7.6
Organic C, %	9.2	1.7	1.1	0.7	---	---
Total N, %	0.73	---	---	---	---	---
CEC, cmol/kg	45.9	35.7	35.9	21.0	---	---
$CaCO_3$ eq., %	---	---	---	2.7	5.1	7.0
Sand, %	48	40	36	63	79	83
Clay, %	17	43	45	20	11	7
Cf., %	10 all[1]	20 all	30 all	50 all	50 all	40 all

Notes: This profile is a variant of OTP: located inside an area generalized as agroclimate 5H; displays textural extremes (fine textured Bm's, coarse textured Ck) associated with OTP-based map units rather than the series. Refer to Table A2 for explanation of abbreviations.
1. All = gravels, cobbles and stones; mainly stones in top horizons, cobbles through BC's, and gravels in Ck.

Comments: thick Ah horizon (>15 cm) and solum (carbonates below 50 cm) characteristic of OTP. A finer version with non-skeletal upper horizons occurs occasionally, mainly in

the Castle and Crowsnest R. areas. In some places, all or part of the Ah horizon may tend toward Dark Brown colors.
Major Variants: rOTP (rego) variant is classed Calcareous Black and occurs in very strongly calcareous glaciofluvial (ice contact) deposits, mainly in the Crowsnest R. valley. It is associated mainly with agroclimatic class 5H. A finer version with non-skeletal upper horizons occurs in the same area.
Competing Series: RFD (Rockford) differs because of a thinner Ah and solum that reflects a drier agroclimate. DVG (Dunvargan) differs because it is developed in medium textured till. LNB (Lundbreck) differs because it occurs in gravel deposits.

PGN (Peigan) Series

Subgroup: Black Solodized Solonetz (BL.SS)
Agroclimate: subclass 2HA (about 1180 to 1250 EGDD and -300 to -400 P-PE); under native grasses or cultivation.
Parent Material: fine textured (C-HC, 2-15% coarse fragments), moderately calcareous, moderately saline, glaciolacustrine material (sometimes called lacustro-till).
Family: clayey, strongly calcareous, cold subhumid.
Drainage: moderately well to imperfectly drained.
Physiography: found primarily in lower slope to depressional localities on the Cardston Plain, often at the fringes of the Southern Foothills, Porcupine Hills, and their outliers.
Comments: columnar, slowly pervious, Bnt horizon ("claypan" or "hardpan") begins at 10-25 cm below the surface; covered by thin topsoil (Ah) and a strongly leached Ae horizon. Weak gleying may occur above the Bnt or below 50 cm depth. PGN occurs with other Solonetzic and solonetzic-like soils in subtle discharge or former discharge areas. These include Solonetzic Black (eg. solonetzic CTN variant), Black Solonetz (Klemengurt, KGT), Gleyed Black Solonetz, Black Solod (Crowlodge, CGE), Gleyed Black Solodized Solonetz, and Solonetzic Gleysol or Humic Gleysol. Other variations in texture, calcareousness and salinity also occur.
Competing Series: Klemengurt (KGT), a Black Solonetz, and Crowlodge (CGE), a Black Solod, were recognized and mapped in adjacent areas (Kocaoglu 1977, Brierley *et al.* In press) but occur only in minor amounts in the Pincher-Crowsnest area. The zCTN (solonetzic Cardston) variant differs because it has a weaker "hardpan" horizon (called Bnjtj) and lacks the leached layer (Ae).

PNR (Pincher) Series

Subgroup: Orthic Black (O.BL)
Agroclimate: subclass 2HA (about 1180 to 1250 EGDD and -300 to -400 P-PE); under cultivation or native grasses.
Parent Material: fine textured (C-SiC-HC, <2% coarse fragments), moderately calcareous, varved, glaciolacustrine material.
Family: clayey, strongly calcareous, cold subhumid.
Drainage: moderately well drained.
Physiography: found primarily on the Cardston Plain.
Comments: thin Ah horizon (10-15 cm) and solum (carbonates within 50 cm) are characteristic. Virtually identical to CTN (Cardston) but contains no coarse fragments and is developed in varved sediments. Found with CTN. Calcareous and Rego versions also occur but are represented by CWY (Cowley) series and rego CWY (rCWY) variant in mapping.
Competing Series: CTN (Cardston) differs because it contains a few coarse fragments, coal flecks, reddish pebbles or sand grains, and other till indicators, and because it lacks, in the top meter or so, the varving commonly associated with glaciolacustrine deposits; in

most other respects it is similar (refer to Table A11). SOF (Standoff) differs because it occurs in medium textured sediments.

POT (Pothole Creek) Series

Subgroup: Orthic Humic Gleysol (O.HG)
Agroclimate: class 4H (about 950 to 1050 EGDD, moister than -260 P-PE except in drier area north of the Crowsnest R.); under prairie wetland vegetation including cottonwood and willows, occasionally cultivated.
Parent Material: moderately calcareous, fine textured (C-HC, <2% coarse fragments), glaciolacustrine or lacustrine sediments (Table A27).
Family: clayey, strongly calcareous, cold subhumid.
Drainage: poorly drained.
Physiography: occurs in depressional sites within morainal, ice contact and glaciolacustrine landforms of the Southern Foothills.
Comments: one of several, intimately associated, very poorly to imperfectly drained soils plus water that occupy potholes, slough bottoms and drains. Other wet soils lack Bg horizons (Rego Humic Gleysols), have little or no Ah (Orthic and Rego Gleysols), are only weakly gleyed (Gleyed subgroups, mainly of Black and Dark Gray soils), are saline, or have solonetzic tendencies. Any of these soils may be developed in lacustrine, glaciolacustrine, till, fluviolacustrine, or fluvial parent materials, and can exhibit different textural and chemical features.
Competing Series: JAT (Joanto) differs because it is a Rego Humic Gleysol and is associated with class 3H agroclimate.

Table A27. Selected features of a POT pedon (Calgary, MacMillan 1987).

	Ah	Ahg	Bg	Ckg
Depth, cm	0-10	10-30	30-80	80+
$CaCl_2$ pH	6.2	6.1	6.4	7.5
Organic C, %	7.3	5.6	1.2	---
Total N, %	---	0.39	0.07	---
CEC, cmol/kg	---	43.9	38.6	---
$CaCO_3$ eq., %	---	---	---	1.4
Sand, %	---	4	0	1
Clay, %	---	48	66	76

Notes: POT normally contains more carbonate in the C horizon than this pedon: also this profile is among the finest textured of POT soils. Refer to Table A2 for explanation of abbreviations.

PPE (Porcupine) Variant

Subgroup: Rego Black (R.BL).
Agroclimate: class 4H (about 950 to 1050 EGDD and moister than -260 P-PE); under native grasses and low shrubs or aspen forest.
Parent Material: moderately calcareous, medium to coarse textured (mainly SL-L, <2% coarse fragments), fluvioeolian material; wind blown detritus picked up from windward sides of ridges and deposited on the lee sides, then subjected to slopewash flow, slumping and soil creep.
Family: loamy, strongly calcareous, cold subhumid.
Drainage: well drained.

Physiography: located on steep lee slopes (northerly to easterly aspects) in the Southern Foothills and Porcupine Hills.
Comments: labelled rPPE (rego variant) and characterized by a very thick (50 to 150 cm) Ah horizon or a series of Ah layers. Often has transitional horizons (AC, AB or BC) or buried layers below the topsoil. Calcareous Blacks with Bmk horizons may sometimes be associated. Parent material may vary from weakly to strongly calcareous; most often weakly calcareous farther west under cooler climates and forest vegetation.
Competing Series: Unnamed soils classified as Orthic Eutric or Dystric Brunisols, which vaguely resemble WLB (Willoughby), occur with or instead of rPPE under coniferous or mixedwood forest in areas classed as agroclimate 5H. ODM (Oldman) differs because it has much thinner topsoil (roughly 10 to 20 cm of Ahk or Apk) and is associated with the 2HA agroclimatic subclass. PPE series, mapped in the Calgary (MacMillan 1987) and Cardston (Brierley *et al.* In press) areas, differs because it is classed Orthic Black.

PSO (Parsons) Series

Subgroup: Rego Black (R.BL).
Agroclimate: class 3H (about 1050 to 1180 EGDD, roughly -260 to -400 P-PE); mainly under cultivation.
Parent Material: medium textured (CL-L, 2-15% coarse fragments), moderately calcareous, continental or mixed till (Table A28).
Family: fine-loamy, strongly calcareous, cold subhumid.
Drainage: well drained.
Physiography: found mainly in the southern Porcupine Hills and on the Cow Creek Bench.
Comments: related versions may be developed in gravelly or strongly calcareous tills.
Competing Series: BZR (Beazer) series and rBZR variant differ because they are classified Orthic and Calcareous Black respectively. CWY (Cowley) and ODM (Oldman) differ because they are developed in fine and medium textured, water-laid deposits.

Table A28. Selected features of a typical PSO pedon (PID No. AB-87-01).

	Apk	BC	Ck1	Ck2
Depth, cm	0-15	15-21	21-40	40-100
$CaCl_2$ pH	7.7	7.7	7.7	7.8
Organic C, %	2.6	1.7	1.2	0.4
Total N, %	0.26	0.17	0.09	0.03
$CaCO_3$ eq., %	1.1	0.7	16.3	14.6
Sand, %	36	34	29	29
Clay, %	24	30	31	33
Cf., %	2-5 gr+cb	2-5 gr+cb	2-5 gr+cb	10 gr+cb

Notes: Apk is a mixture of Ah, Bm, and calcareous drift; its upper part was desiccated and loose. Refer to Table A2 for explanation of abbreviations.

RFD (Rockford) Series

Subgroup: Orthic Black (O.BL)
Agroclimate: class 3H (about 1050 to 1180 EGDD and -260 to -400 P-PE); mainly under native grasses, sometimes cultivated.

Parent Material: moderately calcareous, very cobbly to gravelly or stony (35-60% coarse fragments), coarse to medium textured (mainly SL-L), glaciofluvial (ice contact) deposits.
Family: loamy-skeletal, strongly calcareous, cold subhumid.
Drainage: well to rapidly drained.
Physiography: found in moraine-like, ice contact landforms of the Southern Foothills and Porcupine Hills.
Comments: thin Ah horizon (10-15 cm) and solum (carbonates within 50 cm) are characteristic. Similar soils classed as Rego and Calcareous Black also occur occasionally. All versions are not extensive; found as inclusions or subdominant soils in association with mainly BZR (Beazer).
Competing Series: OTP (Outpost) differs because of a thicker Ah and solum that reflects the moister class 4H agroclimate, otherwise many features are similar (refer to Table A25). BZR (Beazer) differs because it is developed in medium textured till. RND (Rinard) differs because it is developed in gravel deposits.

RND (Rinard) Series and Variant

Subgroup: Orthic Black (O.BL)
Agroclimate: class 3H (about 1050 to 1180 EGDD, roughly -260 to -400 P-PE); mainly under native grasses.
Parent Material: moderately calcareous, extremely gravelly to cobbly (>60% coarse fragments), coarse textured (LS-S), glaciofluvial or fluvial gravel.
Family: sandy-skeletal, strongly calcareous, cold subhumid.
Drainage: rapidly drained.
Physiography: found on upper to lower terraces associated with major streams that cut through the Cardston Plain.
Comments: thin Ah horizon (10-15 cm) and solum (carbonates within 50 cm) are characteristic (Table A29). Parent material of RND and closely related soils often varies from moderately to very strongly calcareous and sometimes has only 40-50% coarse fragments.
Major Variants: rRND (rego) variant has a Bmk horizon replacing the Bm and is classified as Calcareous Black.

Table A29. Selected features of a RND pedon (Cardston M.D., PID No. AB-82-24).

	Ah	Bm	Bmk	Ck
Depth, cm	0-13	13-22	22-33	33-100
$CaCl_2$ pH	6.3	6.2	7.3	7.6
Organic C, %	7.9	3.1	2.5	---
CEC, cmol/kg	25.7	28.0	---	---
$CaCO_3$ eq., %	---	---	4.3	7.2
Sand, %	39	45	59	63
Clay, %	13	26	14	12
Cf., %	30 gr	60 gr	80 gr+cb	80 gr+cb

Notes: This pedon is a variant: coarse fragment content is typical but the fine earth fraction is unusually fine textured. Refer to Table A2 for explanation of abbreviations.

Competing Series: BFT (Blackfoot) differs because it has 30 cm or more of medium textured veneer overlying gravel. LNB (Lundbreck) differs because of a thicker Ah and solum that reflects the moister class 4H agroclimate. BUR (Burmis) differs because it is

classed Rego Black, occurs in extremely calcareous gravel, and is associated with class 4H agroclimate.

SOF (Standoff) Series and Variant

Subgroup: Orthic Black (O.BL).
Agroclimate: subclass 2HA (about 1180 to 1250 EGDD, roughly -300 to -400 P-PE); under native grasses or cultivation.
Parent Material: strongly calcareous, medium textured (L-SiL-CL, <2% coarse fragments), fluviolacustrine, glaciolacustrine, or fluvial deposits.
Family: fine-loamy, strongly calcareous, cold subhumid.
Drainage: well drained.
Physiography: mainly on the Cardston Plain and in the Porcupine Hills; most common in and near major stream valleys.
Comments: thin Ah horizon (10-15 cm) and solum (carbonates within 50 cm) are characteristic; profiles may be slightly stratified, showing variable calcareousness and texture among layers. Related soils may contain a few fine gravels or occur in moderately to very strongly calcareous parent material.
Major Variants: rSOF (rego) variant - classified as Calcareous Black, otherwise similar to SOF. This variant is the subgroup intergrade between SOF and ODM (Oldman).
Competing Series: MFT (Maycroft) differs because of a thicker Ah and solum that reflects the moister class 4H agroclimate. BZR (Beazer) differs because it is developed in medium textured till. CTN (Cardston) and PNR (Pincher) differ because they occur in fine textured glaciolacustrine materials. BFT (Blackfoot) differs because it has gravel within 30-100 cm of the surface.

SPR (Spruce Ridge) Series, Taxadjunct and Variants

Subgroup: Orthic Gray Luvisol (O.GL)
Agroclimate: class 6H (less than approximately 700 EGDD, moister than -260 P-PE); under coniferous forests, mainly lodgepole pine.
Parent Material: moderately calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain till.
Family: fine-clayey (due to Bt) over loamy, strongly calcareous, cold subhumid.
Drainage: well to moderately well drained.
Physiography: found on benchlands and ridge or mountain slopes in the Southern Foothills and Front Ranges.
Comments: Bt horizon generally much greater than 15 cm thick and located between 20 and 75 cm (Table A30); free carbonates usually encountered between 50 and 100 cm; upper solum to 50 cm commonly acidic and contains a well developed AB horizon.
Major Variants: three major variants and taxadjuncts were identified.

1) SPRr (thin) taxadjunct - in the same family as SPR but with a much thinner solum, developed in strongly to very strongly calcareous, mountain till. Its Bt horizon is generally located between 10 and 50 cm. Free carbonates are usually encountered between 30 and 75 cm.
2) kSPR (loamy-skeletal) variant - developed in very gravelly to cobbly (35-60% coarse fragments), very strongly calcareous, glaciofluvial (ice contact) deposits. Similar to thin SPRr but coarser.
3) SPRv (thick) variant - fine-clayey, weakly calcareous soil developed in non- to weakly calcareous mountain till. It usually has a thick AB horizon, a thick Bt located between 40 and 100 cm, and free lime at well below 100 cm.

Competing Series: Tough Creek (TUC) and West Castle (WCT) are series used in Cardston (Brierley *et al.* In press) but found only in minor amounts in the Pincher-Crowsnest area.

TUC is as a paralithic variant of SPR. WCT differs because it is developed in pre-Wisconsin, skeletal, noncalcareous, mountain till.

Table A30. Selected features of a SPR pedon (Calgary area, MacMillan 1987).

	LH	Ae	Bt	Ck
Depth, cm	4-0	0-15	15-90	>90
$CaCl_2$ pH	6.0	4.2	4.8	7.0
Organic C, %	20.4	2.1	1.4	---
Total N, %	1.30	0.16	0.10	---
CEC, cmol/kg	75.6	14.4	24.7	---
$CaCO_3$ eq., %	---	---	---	5.3
Sand, %	---	22	21	23
Clay, %	---	18	38	31
Cf., %	---	15	20-30	20-30

Notes: In the Pincher-Crowsnest area, SPR commonly has a thick, brittle, porous, AB horizon between the Ae and Bt. Also the Ck usually contains more carbonates, ie. 5-15% $CaCO_3$ equivalent. Refer to Table A2 for explanation of abbreviations.

TDC (Todd Creek) Series and Variants

Subgroup: Gleyed Dark Gray (GL.DG)
Agroclimate: class 5H (about 700 to 950 EGDD, moister than -260 P-PE); mainly under aspen, cottonwood or mixedwood forest.
Parent Material: layered fluvial deposits; 30 to 100 cm of medium textured (CL-L, <2% coarse fragments) veneer overlying strongly calcareous, gravelly (15-35% coarse fragments), medium textured (mainly CL-L), mudflow material (Table A31).
Family: fine-loamy, strongly calcareous, cold subhumid.
Drainage: imperfectly drained, often with mottles in lower solum and C horizon.
Physiography: majority found in lower to toe slope segments (valley bench- to bottom-land) in the Southern Foothills at the fringes of the Clark and Front ranges.
Comments: parent materials vaguely stratified; generally found in apron and fan landforms along the base of steep mountain slopes. The overlying veneer may be of fluvial or slopewash origin; the underlying mudflow material is usually very till-like. Related associates may have a skeletal or clayey mudflow base, lower or higher carbonate content in the mudflow deposits, black rather than dark gray topsoil, less than 30 cm of veneer, weaker or stronger gleying, or more coarse fragments in the veneer.
Major Variants: two major variants were recognized.

1) TDCv (subgroup) variant - is drier than TDC, lacks mottles and other gley indicators, and is classified as Orthic Dark Gray.
2) kTDC (paraskeletal) variant - has a gravelly to cobbly veneer (15-35% coarse fragments), often over skeletal mudflow material. It is also drier than TDC and is classified as Orthic Dark Gray. A similar unlabelled version is skeletal throughout, another (cTDC) has a coarse textured (SL) veneer, still another is calcareous to the surface (Rego Dark Gray).

Competing Series: BVA (Beauvais) differs because it is an Orthic Dark Gray and occurs in medium textured till. TDC vaguely resembles grMFT (gleyed rego Maycroft) variant which differs because it is a Black soil and occurs in nongravelly or slightly gravelly water-laid deposits.

Table A31. Selected features of a TDC pedon (PID No. AB-87-09).

	LF	FH	Ahe	AB	Btjgj	IIBC	IICkgj
Depth, cm	10-5	5-0	0-15	15-35	35-62	62-72	72-100
$CaCl_2$ pH	6.3	6.0	6.5	6.9	7.2	7.4	7.6
Organic C, %	46.4	33.8	8.3	4.4	2.6	1.4	---
Total N, %	1.75	1.80	0.61	0.35	---	---	---
CEC, cmol/kg	136.4	133.1	57.7	43.0	---	---	---
$CaCO_3$ eq., %	---	---	---	---	---	5.6	28.4
Sand, %	---	---	38	36	35	42	34
Clay, %	---	---	26	23	24	26	22
Cf., %	---	---	2 gr	2 gr	2 gr	40 gr+cb	50 gr+cb

Notes: This profile is a taxadjunct: coarse fragment and carbonate contents of the mudflow material (IIBC and IICkgj) are slightly higher than modal but within the range commonly found in similar soils of the area. Refer to Table A2 for explanation of abbreviations.

VAC (Van Cleeve) Variant

Subgroup: Rego Dark Brown (R.DB)
Agroclimate: subclass 2AH (greater than about 1250 EGDD, roughly -400 to -425 P-PE); mainly under cultivation or grasses.
Parent Material: moderately calcareous, medium textured (CL-L-SiCL, 2-15% coarse fragments), continental till over moderately calcareous, very gravelly (35-60% coarse fragments), residual material weathered from sandstone and shale bedrock.
Family: fine-loamy, shallow lithic, strongly calcareous, cool semiarid.
Drainage: well drained; located on upper slopes and crests.
Physiography: on the Cowley Basin, but only on subtle, dome-shaped ridges and hills skirting the edge of the Porcupine Hills.
Comments: labelled rVAC (rego variant). In mapping this symbol was also used to represent a paralithic version, with solid bedrock occurring below 1 m, and Calcareous Dark Browns. Residuum is sometimes absent, often variable when present, and ranges from moderately to very strongly calcareous, and from nongravelly (paralithic version) to skeletal. The overlying till grades to deep, fine textured, glaciolacustrine deposits downslope.
Competing Series: cBKE (coarse Brocket) variant differs because it is developed in finer textured glaciolacustrine material. rVAC vaguely resembles NFK (North Fork) which differs because it is classified Orthic Eutric Brunisol, due to a thinner Ah horizon, and is associated with agroclimate 3H. VAC (Van Cleeve) series, defined and mapped in the Warner area (Kjearsgaard *et al.* 1986), differs because it is classified as Orthic Dark Brown.

WLB (Willoughby) Series and Variants

Subgroup: Eluviated Dystric Brunisol (E.DYB)
Agroclimate: class 6H-7H (less than approximately 700 EGDD, moister than -260 P-PE); under coniferous forest.
Parent Material: 30-100 cm of coarse to medium textured (mainly SL-L, 2-15% coarse fragments), fluvioeolian veneer overlying gravelly (15-35% coarse fragments), medium to coarse textured (mainly L-SL), mountain till; all noncalcareous. Bedrock may occur within 2 m of the surface. The veneer consists of wind blown detritus picked up from windward sides of ridges, and deposited on the lee slopes, then subjected to slopewash flow, slumping, wind throw of trees, and soil creep.

Family: loamy, neutral, noncalcareous, cold subhumid.
Drainage: moderately well to well drained.
Physiography: located on steep, northerly to easterly facing slopes of the Byron-Carbondale Hills and Grassy Mountain Ridges.
Comments: horizons often poorly differentiated and eluviation barely perceptible (Aej horizon), usually due to ongoing surface disturbances such as slumping and tree-throw (Table A32). Similar but more strongly eluviated soils have little or no veneer on the till and are more stable. Occasionally find a stony version with abundant quartzitic fragments. Finer textured versions of the featured pedon, with CL-L till beneath the veneer, are common.

Table A32. Selected features of a typical WLB pedon (PID No. AB-87-13).

	LFH	Aej	Bm1	Bm2	IIBC1	IIBC2	IIBC3
Depth, cm	3-0	0-3	3-26	26-50	50-62	62-82	82-110
$CaCl_2$ pH	5.4	5.7	4.9	4.9	5.4	5.0	5.8
Organic C, %	37.0	1.4	0.9	0.5	0.3	0.3	0.5
CEC, cmol/kg	75.1	22.0	22.7	20.6	18.9	18.0	20.1
Sand, %	---	67	59	57	65	56	49
Clay, %	---	9	12	11	9	15	17
Cf., %	---	2-5 gr[1]	1 gr	2-5 gr	20 all[2]	30 all	30 all

Notes: Weakly developed clay films present in the Bm1 and all BC horizons. Relatively high pH in the Aej may be due to humus additions and slope instability. Minor seepage in open pit near bottom of IIBC3. Refer to Table A2 for explanation of abbreviations.

1. Gr = fine gravels and channers in this profile.
2. All = gravel, cobble and stone sizes (and shapes) of coarse fragments.

Major Variants: two major variants were recognized.

1) WLBv (subgroup) variant - similar to WLB but no evidence of eluviation; classed as Orthic Dystric Brunisol.

2) lWLB (shallow lithic) variant - similar to WLB but bedrock occurs between 50 and 100 cm. Other versions include lithic Orthic Dystric Brunisols.

Competing Series: WLB vaguely resembles the thick, weakly calcareous SPRv (Spruce Ridge) variant which differs because it is classified Orthic Gray Luvisol due to much stronger eluviation (Ae horizon) and illuviation (Bt).

APPENDIX B

SOIL, MAP AND MISCELLANEOUS UNIT DESCRIPTIONS

INTRODUCTION

The one hundred thirty-nine map units mapped in the Pincher Creek-Crowsnest Pass area are briefly described below. Emphasis is placed on the 78 soil units (groups of map units without topographic subdivisions) and 12 miscellaneous units. The closed legend format and soil unit numbering system follow the pattern used in the Warner (Kjearsgaard *et al.* 1986) and Cardston (Brierley *et al.* In press) surveys.

The map legend provides minimal information on the major soils of each map unit. Expanded information on the major soils and soil inclusions is provided only in this section. First however, soil, map and miscellaneous units and some separation criteria are explained. Most of the terms used below are defined in Appendix D, the Glossary of Terms.

THE SOIL AND MAP UNITS

The Soil Unit

A soil unit is a geographic grouping of taxonomic soil classes - a mapping tool that describes spatial relationships of soil bodies classified at the series level (series, taxadjuncts and variants) in the Canadian system of taxonomy (E.C.S.S. 1987b).

Each soil unit is identified using the name of its first and, if necessary, second major soil. A number completes the soil unit identification. For example, BZR1 and BZR4 are named after their dominant soil series, BZR (Beazer); BZCT1 and BZCT4 are named after two codominant series, BZR and CTN (Cardston). The number is used to signify additional information about major and significant soils. The number "1" signifies that the taxonomic soil entities encoded within the name (BZR and BZCT in this example) are in fact the major or representative soils of the soil unit. The number "4" signifies that the soil units in this example also contain significant Rego and Calcareous Black soils, some of which may also have names.

Numbers 1 through 9 are used in the Pincher-Crowsnest survey and apply to all but the miscellaneous map units, ZAV1 through ZSA, which are numbered independently. Soil unit numbers and their corresponding features are listed below.

1 The major or representative soils are identified by the soil unit name.
2 In addition to the soils identified by its name, the soil unit contains significant proportions of Gleyed subgroups (related to the named soils), Gleysolic soils and water (eg. sloughs).
3 In addition to the soils identified by its name, the soil unit contains significant proportions of saline variants, usually related to the named soils.
4 The soil unit contains major amounts of soils classed as Rego and Calcareous subgroups within the Chernozemic Order, or Regosolic soils in a few cases.
5 The soil unit contains major amounts of soils that are related to but finer textured than the named soils.
6 The soil unit contains major amounts of soils that are related to but coarser textured than the named soils.
7 In addition to the soils identified by its name, the soil unit contains significant amounts of Solonetzic subgroup and Solonetzic Order soils.

8 The soil unit contains major amounts of Rego and Calcareous subgroups (of the Chernozemic Order) plus significant Gleyed subgroups, Gleysolic soils and water. Number "8" combines features of "2" and "4".

9 In addition to the soils identified by its name, the soil unit contains significant amounts of soils that are coarser textured than the named soils, plus significant proportions of Gleyed subgroups, Gleysolic soils and water. Number "9" combines features of "2" and "6".

The Map Unit

Each soil unit is subdivided into map units according to standardized repeating topographic classes. Thus, a map unit describes the actual landscape setting by linking the spatial distribution of soils, identified by the soil unit, to a topographic framework, imposed by the slope class and modifier. These are the real mapping units - the landscape entities that can be viewed on the ground and delineated on a map.

Topographic (slope) classes used to describe map units were adapted from the standard system (E.C.S.S. 1983, 1987b), and are listed on the maps. Associated landform surface expressions are also listed in the legend for each map unit. In agriculturally productive areas, map units were created for each slope class below 15%, if of sufficient acreage. Broader groupings were allowed in the more complex mountain and foothill areas.

Three slope modifiers, based on landform surface expression, were also used to describe some map units, provided the feature was not already identified by a major soil (eg. shallow lithic series or variants).

D Dissected - denotes long (ie. about 300 m or more), unidirectional, usually inclined, often gullied slopes; longer than found in ridged and hummocky terrain; important to determining potential for water erosion. Also used to denote severely dissected (gullied and channelled) terrain.

R Bedrock controlled - overall landform surface expression is controlled by an underlying bedrock surface which is estimated at about 1 to 5 m below the ground surface; terrain may be slightly higher than that of surrounding deeper deposits and slopes are generally moderately long; important for evaluating irrigability.

T Terraced - tracts may consist of single or multiple terrace treads bounded or separated by steep risers; mobility of machinery and irrigation systems is frequently affected by the risers.

Proportions of Major Soils

We rely heavily on proportions or percentages of soil entities or other landscape features to describe mapping units. In the Pincher-Crowsnest survey, soil series and equivalents (refer to Appendix A) are used to name and describe soil and map units which represent mappable repeating landscapes. The generalizing process from detailed taxonomy to soil landscape, was accomplished by:

* defining several taxadjuncts and variants at the series level (E.C.S.S. 1987a) but allowing them to have broader connotations in some cases.
* listing groups of closely related soils that illustrate landscape dynamics relative to the naming series; for example, "Rego and Calcareous Black variants" are related to BZR (Beazer) and CTN (Cardston) in the BZCT4 soil unit, "coarser textured variants" are related to CRW (Carway) in the CRW6 soil unit.
* allowing some soil and map units to have very wide percentages of major soils (or groups of soils).

The DRLN4/3T map unit effectively illustrates the last feature. Its major soils are DRW (Drywood) series and gravelly taxadjunct (20-60%), LNB (Lundbreck) series (15-50%), and rego variants of DRW and LNB (5-60%). Either DRW, LNB or the rego variants can dominate, or all three may codominate in some cases. In some tracts, rego variants are only inclusions (as little as 5% of the landscape). Further, a shift in percentage of one soil entity from tract to tract usually occurs at the expense of one or both of the others. The crucial point is that the complex soil patterns comprising DRLN4 soil and map units were, for pragmatic reasons, not subdivided according to different percentages of the three major soils. This approach helped prevent unnecessary proliferation of mapping concepts across an already complex area of the province.

One or several map units may be characterized by the same soil unit. If more than one, the proportions of major soils in each (listed in the legend) may vary slightly from that provided in the soil unit description. Nevertheless, the overall essence of each map unit is captured in the soil unit descriptions that follow. Terms such as "dominant", "significant", "major", "recurrent inclusions", and others that deal with concepts of proportionality are defined in Appendix D, Glossary of Terms.

Estimates of Areal Extent

The descriptions that follow include estimates of the total area of land covered by each mapping unit. The area values, rounded to the nearest 50 hectares (100 acres), were estimated visually, and indicate the rough proportions of each mapping unit.

BDLT1 (Birdseye-Leighton Centre) Soil Unit

BDLT1 is a compound soil unit (E.C.S.S. 1981, 1987a) that features shallow to deep till overlying ridges and hills of the Porcupine Hills and the Byron-Carbondale Hills near Maycroft. It occurs in areas classed as agroclimate 5H. Vegetation is primarily Douglas fir forest including intermixed spruce on the moistest sites. Aspen stands and southerly to westerly facing grassland patches are included.

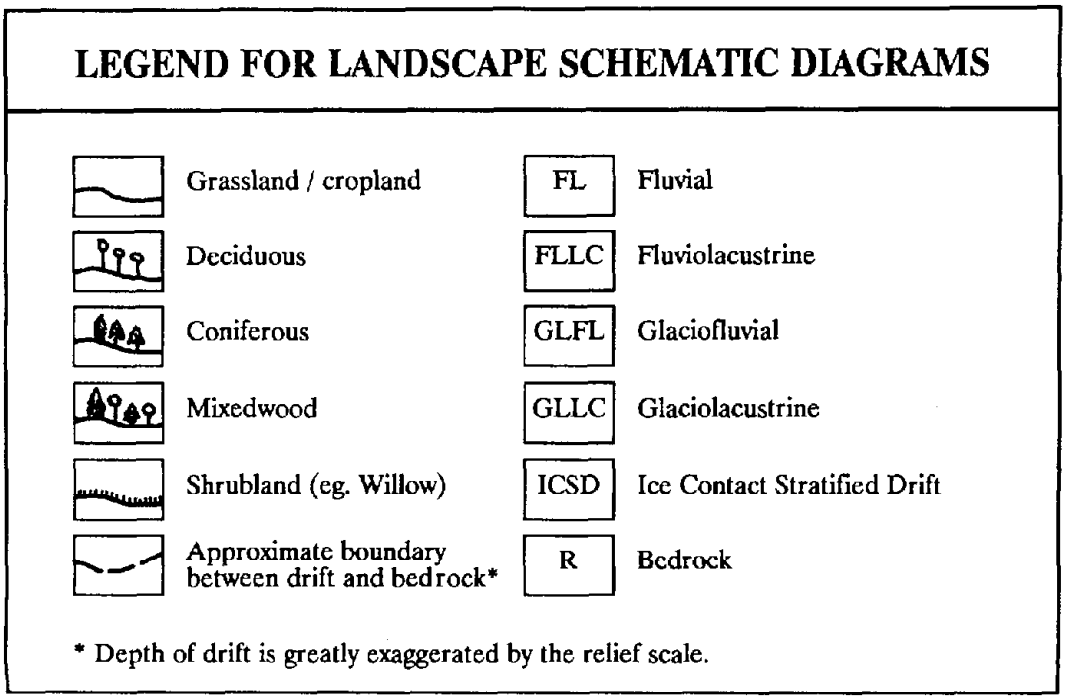
The unit's complex soil patterns are represented by the most consistently occurring members - kBDY (paraskeletal Birdseye) variant, kLTC (paraskeletal Leighton Centre) variant, and LTC (Leighton Centre) series. These are weakly leached soils that reflect a moist cool mesoclimate associated with northerly to easterly aspects. The kBDY variant, a shallow lithic Orthic Dark Gray comprises about 20-40% of the unit; the LTC group, classified as Dark Gray Luvisol, accounts for 15-30%.

These soils are usually developed in strongly to moderately calcareous, gravelly to non-gravelly (2-35% coarse fragments), medium textured (mainly CL-SiCL-SCL), mixed origin tills. Non- to weakly calcareous till occurs in some of the foothills tracts. Till variability reflects the underlying sandstone and shale bedrock encountered at shallow depths (outcrop to roughly 5 m).

The major soils often occupy less than 40% of the areal extent because of complex soil patterns involving depth to bedrock, A horizon variability (Ah, Ahe and Ae), and kind of B horizon development (Bm, Btj or Bt). This complexity is also responsible for the variety of soil inclusions. Recurrent inclusions are Eluviated and Orthic Eutric Brunisols (in the foothills and Porcupine Hills) or Eluviated and Orthic Dystric Brunisols (foothills only); shallow lithic Dark Gray Luvisols; deep Orthic Dark Grays (kBVA and BVA); and deep Orthic Blacks (kDVG and DVG). Occasional inclusions are shallow lithic Orthic Blacks (kOKY) and Dark Browns (BEVv), Orthic Gray Luvisols, bedrock outcrop, and seeps.

Only one BDLT1 map unit was recognized.

BDLT1/6-7: 1050 ha (2600 ac); veneer to blanket over inclined to ridged bedrock (Fig. B1). Slopes mainly 15-45%; topography classes 5 and 8 occur as inclusions.



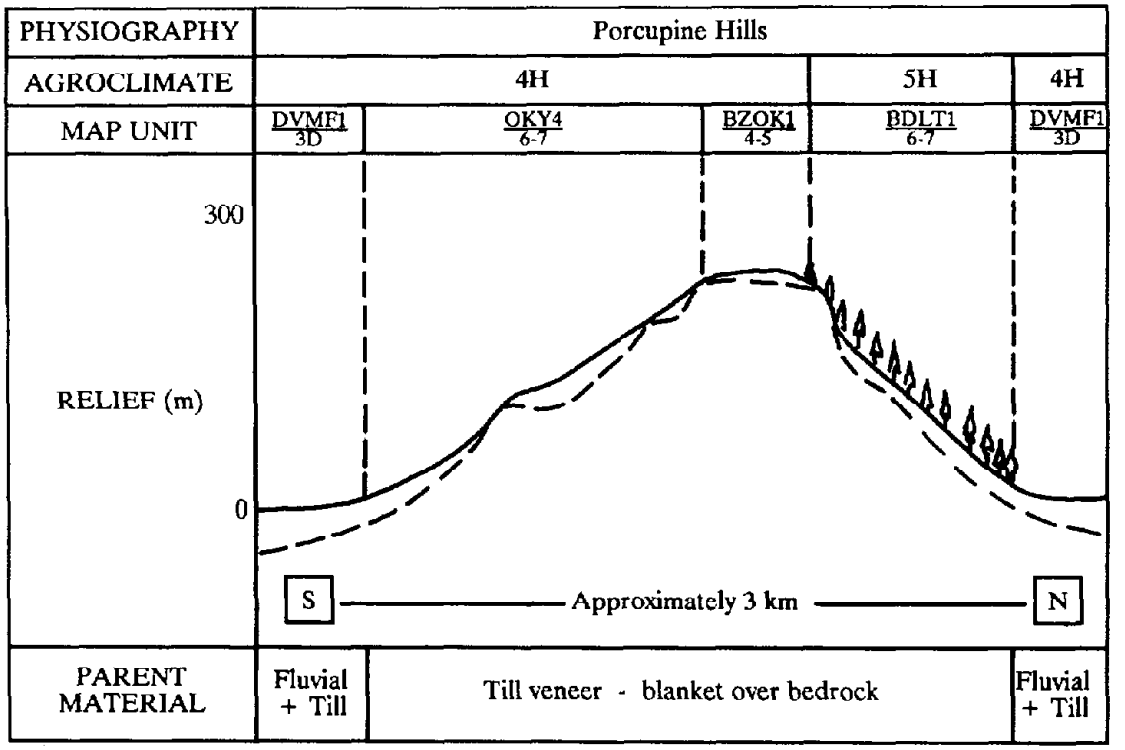


Figure B1. Landscape schematic showing topographic relationships among several map units occurring between Olin and Heath creeks. Legend for landscape schematics included above.

BFRN4 (Blackfoot-Rinard) Soil Unit

BFRN4 is a compound soil unit representing many stream terrace landscapes on the Cardston Plain. It occurs in areas classed as agroclimates 2HA and 3H; both are equated with the distribution of thin Black soils. Where uncultivated, vegetation is native grassland. Several tracts are under cultivation, some with irrigation.

The unit is characterized by three major soils with wide percentages of occurrence. BFT (Blackfoot) series (20-60%) and RND (Rinard) series (20-50%) are both Orthic Black. The third group - Rego and Calcareous Black variants of BFT and RND including rBFT, rRND and BUR (Burmis) - range from inclusion status (minimum about 5%) in some tracts to dominant (maximum about 50%) in others.

The major soils are developed in a discontinuous, medium textured veneer overlying glaciofluvial or fluvial gravel. Veneer textures are mainly L-CL-SiL but sometimes range into the coarse (SL) and fine (C-SiC) groups and may include a few gravels. BFT and rBFT have 30-100 cm of veneer over gravel. The gravel base is mainly moderately to very strongly calcareous, extremely gravelly to cobbly (>60% coarse fragments), and coarse textured (LS-S). Fewer coarse fragments (40-50%), finer textures (SL), and sandy to silty lenses and bands may also occur. RND, rRND and BUR are gravel soils with less than 30 cm of veneer.

Any of the three major soils may dominate but at the expense of the other two. Critically, BFRN4 has more than 30% of soils with the medium textured veneer (BFT and rBFT) to differentiate it from the RND4 soil unit. Further, it has more than 15% of gravel soils (RND and its rego variants) to differentiate it from the BFT4 soil unit.

Recurrent inclusions - SOF (Orthic Black) and ODM (Rego Black) - occur where the "veneer" exceeds 1 m depth. Occasional inclusions are thick Black soils like DRW, Regosolic soils, finer textured variants such as CWY or PNR, nongravelly coarse textured soils such as KNT and cKNT, wetter soils associated with high water tables, and shallow lithic variants.

Only one BFRN4 map unit was recognized.

BFRN4/3T: 3600 ha (8800 ac); terraced glaciofluvial and fluvial terrain near major streams (Fig. B2, B17). Most tracts consist of multiple terrace treads (slopes 0-5%) separated by short steep risers (slopes 5-45%). A few tracts consist of a single large tread bounded by risers. The risers can severely hinder some cultivation and irrigation operations even though rarely occupying more than 20% of a tract.

BFT4 (Blackfoot) Soil Unit

BFT4 is a compound soil unit representing some stream terrace landscapes on the Cardston Plain (Fig. B20). It occurs in areas classed as agroclimates 2HA and 3H, both equated with the distribution of thin Black soils. Cultivation is widespread and some tracts are also irrigated.

The unit is characterized by three major soil groups. The Orthic Black BFT (Blackfoot) series often dominates (30-50%). Rego and Calcareous Black variants (rBFT) may be significant or dominant (20-40%). Soils of both BFT groups have gravel at 30-100 cm depth. The third group, consisting of deeper soil materials overlying gravel, is usually significant (15-30%). It includes the Orthic Black SOF (Standoff) series, the Rego Black ODM (Oldman) series, and a Calcareous Black intergrade (rSOF).

BFT and rBFT soils are developed in 30-100 cm of medium textured veneer overlying glaciofluvial or fluvial gravel. SOF, ODM and rSOF soils are developed in moderately to strongly calcareous, medium textured material like the veneer; gravel if present occurs below 1 m. Veneer textures are mainly L-CL-SiL but sometimes range into the coarse (SL) and fine (C-SiC) groups and may include a few gravels. The gravel base is mainly moderately to very strongly calcareous, extremely gravelly to cobbly (>60% coarse fragments), and coarse textured (LS-S). Fewer coarse fragments (40-50%), finer textures (SL), and sandy to silty lenses and bands may also occur.

BFT4 is differentiated from BFRN4 by having 15% or less of gravel soils (RND, rRND and BUR). The gravel soils are recurrent inclusions, and are commonly associated with terrace risers. Occasional inclusions are nongravelly coarse textured soils such as KNT and cKNT, thick Black soils like MFT, finer textured variants such as CWY or PNR, and wetter soils associated with high water tables.

Only one BFT4 map unit was recognized.

BFT4/3T: 800 ha (2000 ac); terraced glaciofluvial and fluvial terrain near major streams. Most tracts consist of multiple terrace treads (slopes 0-5%) separated by short steep risers (slopes 5-45%). A few tracts consist of a single large tread bounded by risers. The risers can severely hinder some cultivation and irrigation operations even though rarely occupying more than 20% of a tract.

BKE1 (Brocket) Soil Unit

BKE1 is a simple soil unit (E.C.S.S. 1981, 1987a) dominated by eroded Dark Brown soils developed in glaciolacustrine sediments. It occurs at the eastern end of the Cowley Basin, an area classed as agroclimate 2AH. Most BKE1 is cultivated, some irrigated.

The Rego Dark Brown BKE (Brocket) series is the dominant soil (40-60%). It and associated soils are developed mainly in moderately to strongly calcareous, nongravelly (<2% coarse fragments), fine textured (C-SiC-HC), glaciolacustrine deposits. Textures commonly grade from SiCL at or near the surface to HC at depth.

Recurrent inclusions are Calcareous Dark Brown soils (BKEv), medium textured Rego and Calcareous Dark Browns (DIM and CIO), and saline (sBKE) to solonetzic (zBKE) variants. Occasional inclusions are the till-like (lacustro-till) coarse cBKE taxadjunct, Black soils, wetter soils of small potholes, and coarse textured (SL) ice contact soils.

Only one BKE1 map unit was recognized.

BKE1/2: 3600 ha (8900 ac); level to undulating plain (Fig. B3). Slopes mainly 0-2%; class 3 topography usually included, sometimes significant.

BKE3 (Brocket) Soil Unit

BKE3 is a compound soil unit consisting of eroded Dark Brown soils plus saline variants. It is found on the Cowley Basin, mainly in apron-like landforms that flank the Porcupine Hills (Fig. B3). These areas are classed as agroclimate 2AH. Most BKE3 is cultivated.

Rego Dark Brown BKE (Brocket) series and Calcareous Dark Brown BKE variant (BKEv) form the dominant soil group (40-60%). Similar weakly to moderately saline (Eilers 1985), Rego and Calcareous Dark Brown soils (sBKE) are significant (15-25%). The saline soils limit certain uses.

The BKE group of soils are developed in moderately to strongly calcareous, nongravelly (<2% coarse fragments), fine textured (C-SiC-HC), glaciolacustrine deposits. One small tract at the edge of the Oldman R. valley contains appreciable ice contact deposits. It has a glaciolacustrine base with a discontinuous coarse textured (SL-LS, some coarse fragments) veneer that dominates knoll tops.

The till-like coarse cBKE taxadjunct is a recurrent inclusion. Occasional inclusions are coarse textured (SL) ice contact soils (rOSN and rOAS), medium textured Rego and Calcareous Dark Browns (DIM and CIO), Black soils, solonetzic variants (zBKE), and wetter soils of small potholes.

Only one BKE3 map unit was recognized.

BKE3/3: 950 ha (2400 ac); inclined to undulating, often with small channels on relatively long slopes. Slopes mainly 2-5%; inclusions of class 2 and 4 topography.

BKE6 (Brocket) Soil Unit

BKE6 is a compound soil unit that features eroded Dark Brown soils in fine textured till-like deposits. It occurs near the Cowley Basin-Three Rivers Plain boundary (Fig. B3), and in apron-like slopes that skirt the Porcupine Hills. These areas are classified as agroclimate 2AH. Most BKE6 is cultivated.

The major soils include the till-like (lacustro-till) coarse cBKE taxadjunct (20-40%) and BKE (Brocket) series (20-30%). Both are classified as Rego Dark Brown. Calcareous Dark Brown variants (BKEv) are also important (15-30%).

The parent materials of these soils are moderately to strongly calcareous glaciolacustrine deposits. BKE is developed in nongravelly (<2% coarse fragments), fine textured (C-SiC-HC), usually varved sediments that dominate depressional to mid slope positions. The coarse BKE taxadjunct occurs in upper slope to crest sites where the glaciolacustrine sediment is slightly coarser (SiC-C) and more till-like (about 2-15% coarse fragments). Overall, BKE6 landforms may mark the margin or shallow parts of a former glacial lake.

Recurrent inclusions are medium textured Rego and Calcareous Dark Browns (DIM and CIO), and wet (gleyed) soils plus associated saline variants (sBKE) of seeps and potholes. Occasional inclusions are Orthic Dark Brown soils and various Black soils.

Only one BKE6 map unit was recognized.

BKE6/3: 1900 ha (4700 ac); undulating to inclined. Slopes mainly 2-5%; class 2 topography usually included, often significant.

BKVA6 (Brocket-Van Cleeve) Soil Unit

BKVA6 is a compound soil unit that features eroded Dark Brown soils in deep to shallow glaciolacustrine and till deposits overlying bedrock. It occurs as terrace- or dome-shaped terrain that skirts the Porcupine Hills at their contact with the Cowley Basin (Fig. B3). These areas are classed as agroclimate 2AH. Most BKVA6 has been cultivated. Some areas of "native" grassland have been affected by deposition of calcareous drift.

The Rego Dark Brown cBKE (coarse Brocket) taxadjunct plus a Calcareous Dark Brown counterpart is the dominant soil group (30-60%). The shallow lithic rVAC (Rego Dark Brown Van Cleeve) variant plus Calcareous Dark Brown counterpart form the significant soil group (15-25%).

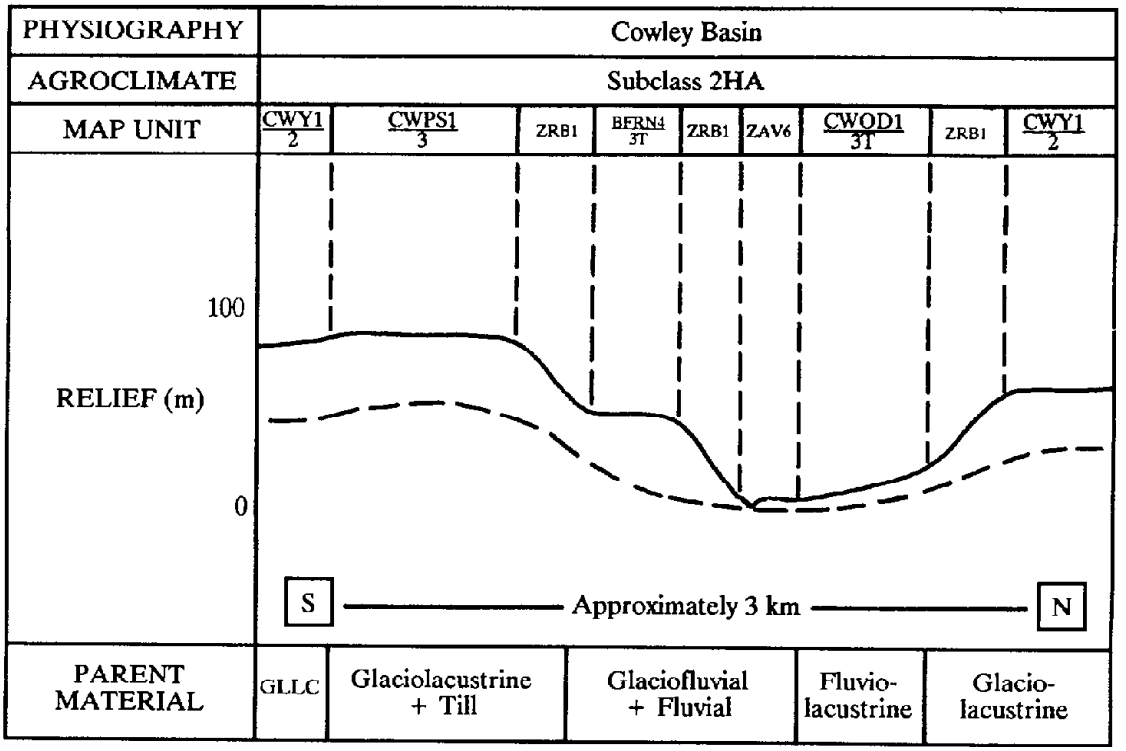


Figure B2. Landscape schematic showing topographic relationships among several map units occurring across the Crowsnest River valley near Cowley.

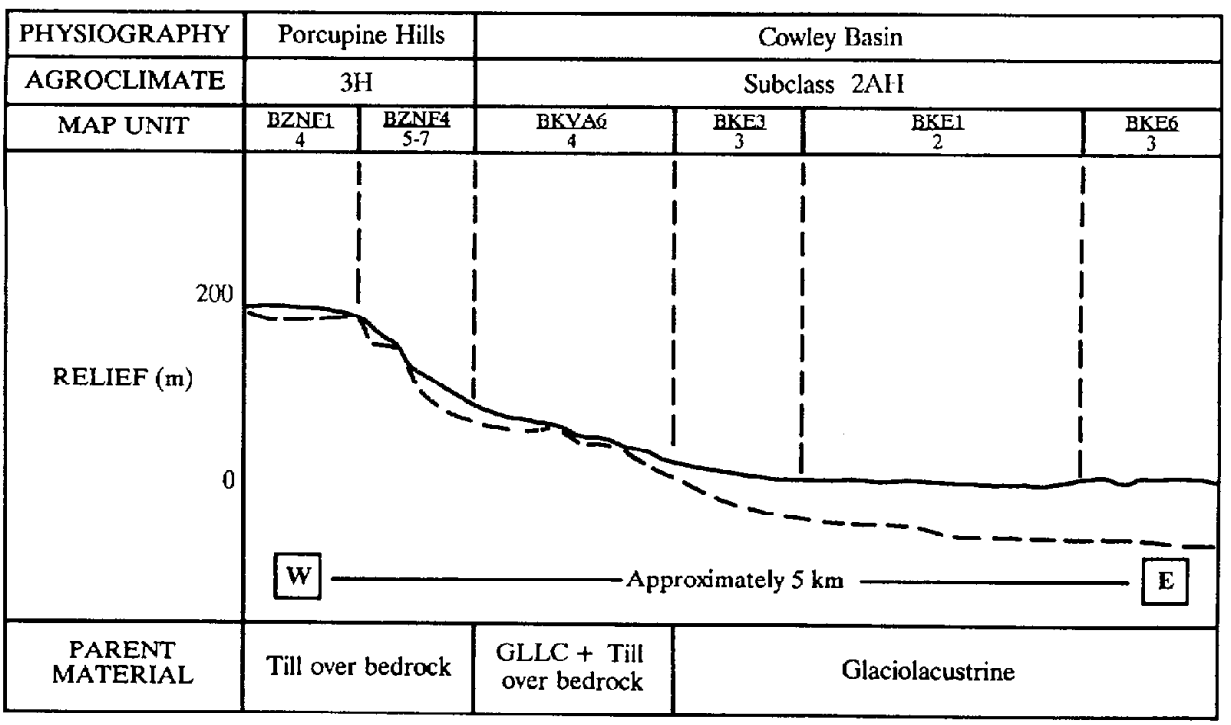


Figure B3. Landscape schematic showing topographic relationships among several map units of the Summerview area

The cBKE taxadjunct and closely related soils are developed in moderately to strongly calcareous, fine textured (SiC-C), till-like (2-15% coarse fragments), glaciolacustrine (lacustro-till) deposits. These occur on lower to mid slopes and grade to the shallow till of rVAC soils in upper slope to crest positions. Rego VAC (rVAC) and closely related soils occur in moderately to strongly calcareous, medium textured (CL-L-SiCL, 2-15% coarse fragments) till overlying residual material and bedrock usually at 50-100 cm depth. The residuum, when present, ranges from moderately to very strongly calcareous, nongravelly to very gravelly, and is weathered from the underlying shale or sandstone.

Recurrent inclusions are various Black soils, fine textured Rego Dark Brown soils (BKE), and bedrock outcrops. Occasional inclusions are medium textured Rego and Calcareous Dark Browns (DIM and CIO), Orthic Dark Brown, and saline variants in seeps and drains.

Only one BKVA6 map unit was recognized.

BKVA6/4: 750 ha (1900 ac); blanket to veneer over inclined to hummocky or, occasionally, rolling bedrock. Slopes mainly 5-9%; significant class 3 topography and inclusions of class 5.

BRG6 (Bragg Creek) Soil Unit

BRG6 is a simple soil unit encompassing forested glaciofluvial and ice contact terrain on the floor of the Crowsnest R. valley and its tributaries in the Front Ranges (Fig. B4, B5). It occurs in areas classed as agroclimate 6H and 5H. Vegetation is mainly lodgepole pine or mixed coniferous forest.

The Orthic Eutric Brunisol kBRGv (Bragg Creek) variant is the dominant soil (30-60%). It is based on the BRG series defined and mapped in the Calgary area (MacMillan 1987).

Layered glaciofluvial or fluvial deposits characterize the BRG6 unit. These are usually extremely calcareous, sometimes very strongly or strongly calcareous. A very gravelly to cobbly (35-60% coarse fragments), medium textured (mainly L) veneer is usually present. Sometimes the veneer is very thin to absent, or grades to nongravelly. The ubiquitous base material is mainly extremely gravelly to cobbly (>60% coarse fragments), coarse textured (S-LS) gravel. Sometimes the gravel contains only 40-50% coarse fragments and has some sandy lenses or bands.

Two BRG6 map units were recognized.

BRG6/3-4: 550 ha (1400 ac); terraced glaciofluvial and fluvial terrain near streams, often including fans superimposed on the terraces; occasionally channelled. Slopes mainly 2-9% (gentlest on terrace treads, steepest on fans); inclusions of class 5 and 2 topography.

BRG6/5-7: 350 ha (800 ac); ridged to hummocky terrain comprised of eskers, kames and kettles; usually channelled. Slopes extremely variable and usually short, mainly 9-45%, with inclusions of small terraces (class 2 or 3 topography). Low elevation tracts along the Crowsnest R. have substantial Black grassland soils, mainly BUR and BURv.

Recurrent inclusions are:

* Eluviated Eutric Brunisols including BRG series, (sometimes significant in BRG6/3);
* Orthic Eutric Brunisols with a nongravelly veneer (BRGv), mainly in BRG6/3-4 (codominant in one tract);

* loamy-skeletal Brunisols (MGV and MGVv); and
* various Black soils (BUR, BURv, kDRW, LNB) of small grassland patches.

Occasional inclusions are Orthic Gray Luvisols (kSPR and SPRr), Dark Gray Luvisols and Orthic Dark Grays under aspen forest or mixedwood, and wet soils associated with high water tables.

BUR1 (Burmis) Soil Unit

BUR1 is a compound soil unit representing many stream terrace and fan landscapes, mostly in major valleys that cut through the Southern Foothills and Front Ranges. These areas are classed as agroclimate 4H and 5H. Vegetation is mainly Montane grassland.

The unit is characterized by two closely related soils that vary widely in areal extent from tract to tract. The Rego Black BUR (Burmis) series often dominates (20-70%). Its Calcareous Black counterpart (BURv), at 5-40% overall, dominates a few tracts. BURv is most abundant in tracts at the south end of Pincher M.D. near Waterton Lakes National Park and on the highest, oldest terraces elsewhere. In a few low elevation tracts along the Crowsnest River, BURv is merely an inclusion (minimum about 5%).

The parent material of both BUR soils is extremely calcareous, extremely gravelly to cobbly (>60% coarse fragments), coarse textured (S-LS), glaciofluvial or fluvial gravel. Fewer coarse fragments (40-50%), lower carbonate content, finer textures (SL), and sandy to silty lenses and bands may also occur. Parent materials in tracts near Waterton are moderately to very strongly calcareous.

Recurrent (sometimes significant) inclusions are Regosolic soils on the youngest terrace treads near major streams, and Orthic Blacks, mainly LNB, in association with BURv where lime content is lower than normal. Occasional inclusions are Rego and Calcareous Dark Brown "Mountain Chernozems"; and several Orthic, Rego and Calcareous Black soils with >30 cm of medium textured veneer over gravel (DRW, rDRW, BFT, MFT, rMFT, and SOF).

Only one BUR1 map unit was recognized.

BUR1/3T: 1650 ha (4000 ac); terraced glaciofluvial or fluvial terrain near major streams like the Crowsnest R. (Fig. B5); occasionally fluvial fan with abandoned and active channels, eg. Galwey Cr. fan. Most tracts consist of multiple terrace treads (slopes 0-5%) separated by short steep risers (slopes 5-45%).

BUR5 (Burmis) Soil Unit

BUR5 is a compound soil unit featuring deep to shallow ice contact deposits on the floor of the Crowsnest valley in the Southern Foothills and Front Ranges (Fig. B5). It occurs in areas classed as agroclimate 4H and 5H. Vegetation is mainly Montane grassland with a few patches of Douglas fir and aspen forest.

The unit is characterized by two major soil groups that vary widely in areal extent from tract to tract. The Rego Black BUR (Burmis) series and its Calcareous Black counterpart (BURv) often form the dominant group (20-60%). Several finer textured soils such as rOTP (rego Outpost) variant and others, also at 20-60% overall, replace BUR and BURv as dominant soils in some tracts.

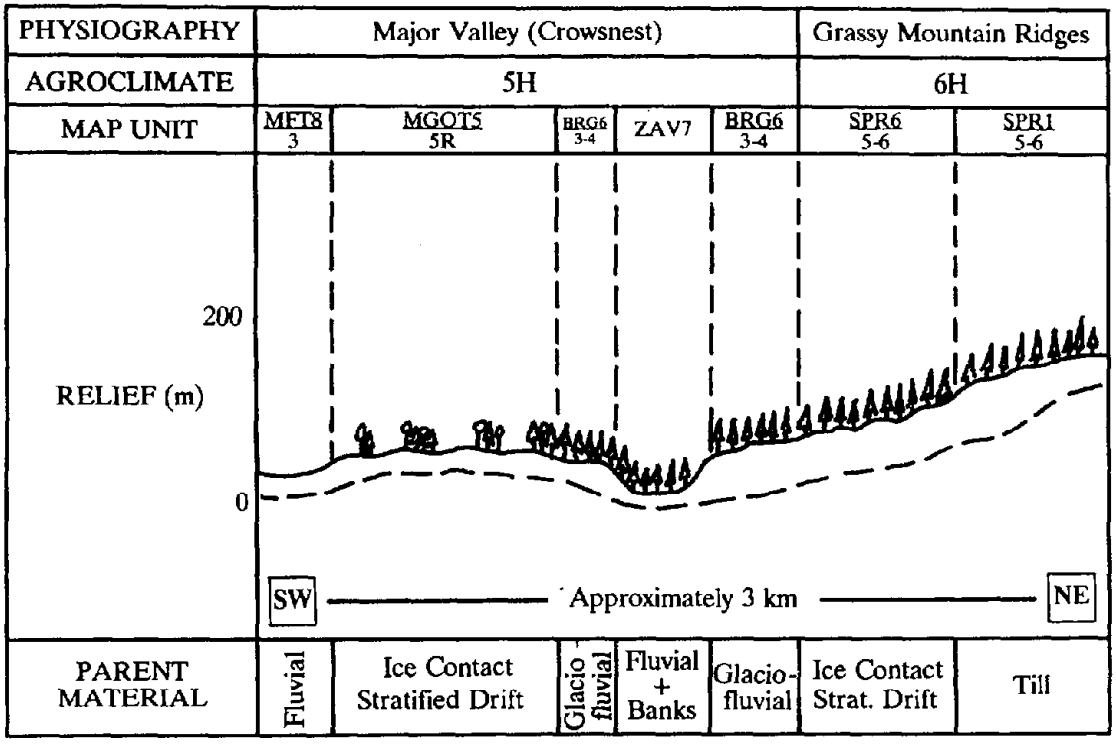


Figure B4. Landscape schematic showing topographic relationships among several map units occurring across Allison Cr. north of Sentinel.

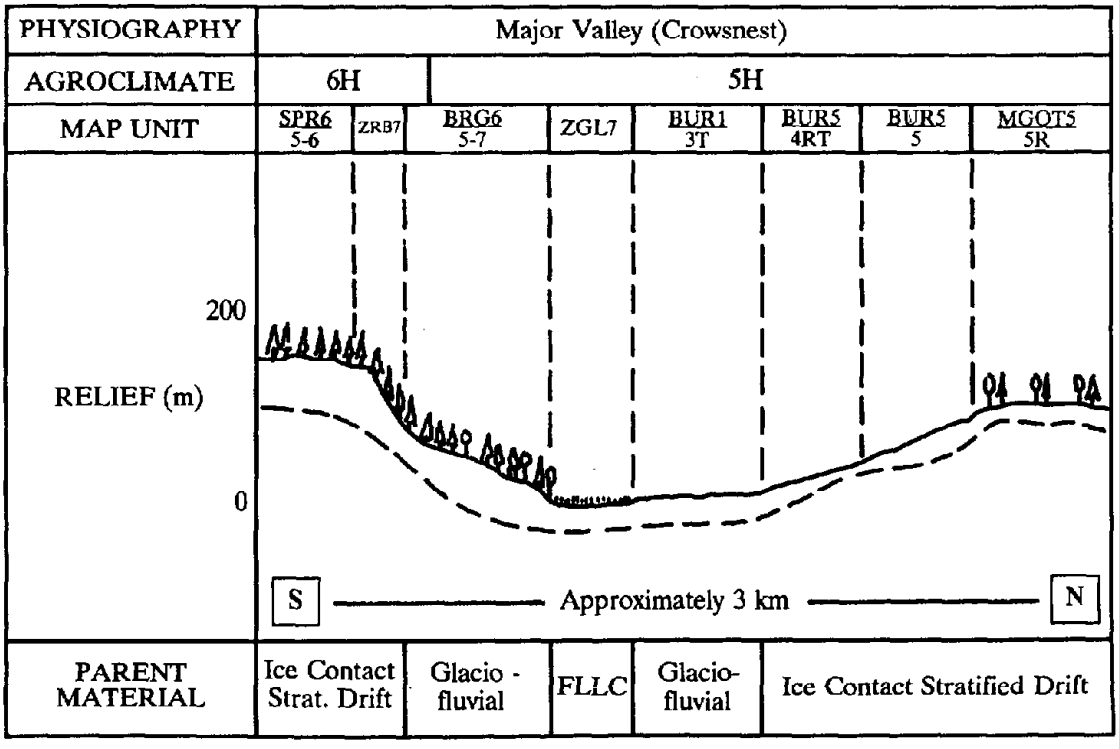


Figure B5. Landscape schematic showing topographic relationships among several map units occurring across the Crowsnest River valley near Sentinel.

Complex, often stratified, strongly to extremely calcareous, ice contact and fluvial fan deposits characterize the BUR5 soil unit. BUR and BURv soils occur in extremely gravelly to cobbly (>60% coarse fragments), coarse textured (S-LS) gravel. Sometimes the gravel contains only 40-50% coarse fragments and has some sandy lenses or bands. The finer soils occur in a variety of parent materials; most would be considered coarse textured soils in other units. The most common is very gravelly to cobbly (35-60% coarse fragments), medium to coarse textured (mainly L-SL), till-like, glaciofluvial (ice contact) and fluvial deposits. Others include gravelly, medium textured till; nongravelly, coarse textured, glaciofluvial deposits; gravel veneer overlying nongravelly, coarse to medium textured (sands to silts), glaciofluvial deposits; and even gravel overlying fine textured glaciolacustrine (lacustro-till) deposits in one tract.

Two BUR5 map units were recognized.

BUR5/4RT: 1550 ha (3800 ac); complex mix of terraced, ridged, hummocky, and fan shaped landforms, usually overlying bedrock (estimated at 1-5 m depth) and sometimes channelled. Slopes mainly 5-9%; topography classes 3 and 5 often significant.

BUR5/5: 400 ha (1000 ac); hummocky, ridged or inclined landforms, sometimes overlying bedrock (estimated at 1-5 m depth); sometimes gullied. Slopes mainly 9-15%; topography classes 4 and 6 usually included, sometimes significant.

Shallow lithic variants of the major soils are recurrent inclusions (sometimes significant) in most BUR5/4RT tracts, two BUR5/5 tracts. Orthic Black soils, mainly LNB and OTP, are recurrent inclusions and are most extensive where lime content is lower than normal. Occasional inclusions are medium textured slopewash soils (eg. MFT and rMFT), wet soils associated with high water tables and depressions, and bedrock outcrops (BUR5/4RT).

BVLT1 (Beauvais-Leighton Centre) Soil Unit

BVLT1 is a compound soil unit that encompasses forested morainal landscapes of the Southern Foothills (Fig. B23). A few tracts abut the Clark and Front ranges on long mountain slopes. These areas are classed as agroclimate 5H, but often extend upwards into 6H on longer slopes. Vegetation is aspen, mixedwood or mixed coniferous forest, usually with a lush understory.

The unit is characterized by two or three major soil groups. Orthic Dark Gray BVA (Beauvais) series and paraskeletal kBVA variant commonly form the dominant group at 30-50%. Dark Gray Luvisol LTC (Leighton Centre) series and paraskeletal kLTC variant, at 15-40% overall, dominate some tracts. Finer textured variants of both groups, at 5-40% overall, may be dominant or co-dominant in a few tracts.

The paraskeletal variants are usually far more abundant than their series counterparts. Both kBVA and kLTC are developed in weakly calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain till. These soils tend to have thick (often >1 m), acidic to neutral sola. Similar but thinner, less acidic versions occur occasionally in moderately to strongly calcareous mountain till. The BVA and LTC series are developed in moderately calcareous, medium textured (CL-L, 2-15% coarse fragments), continental and mixed origin tills. The finer textured variants occur in weakly to moderately calcareous, fine textured (mainly C), slightly gravelly to gravelly (2-35% coarse fragments) till or shallow glaciolacustrine (lacustro-till) deposits.

Two BVLT1 map units were recognized.

BVLT1/5: 900 ha (2200 ac); hummocky to inclined terrain (often one superimposed on the other), occasionally bedrock controlled. Slopes mainly 9-15%; topography

classes 4 and 6 usually included, sometimes significant. Two tracts contain mappable areas dominated by class 4 topography.

BVLT1/6: 3000 ha (7400 ac); mainly long inclined slopes with a superimposed hummocky element, at least partially controlled by bedrock in several tracts. Slopes mainly 15-30%; topography classes 5 and 7 usually included, sometimes significant.

Recurrent inclusions, in a least one of the map units, are coarser textured variants, mainly skeletal soils, and wet soils (Gleyed subgroups and Gleysolics) of seeps, potholes and drains. Occasional inclusions are Gleyed and Orthic Dark Gray stratified fan and mudflow soils (TDC and kTDC); Orthic Gray Luvisols (SPR and SPRv), Dystric and Eutric Brunisols, shallow lithic variants, and Orthic Black soils (eg. kDVG and DVG).

BVLT6 (Beauvais-Leighton Centre) Soil Unit

BVLT6 is a compound soil unit of the Beauvais Lake Upland that encompasses forested ice contact terrain (Fig B6, B18). A few tracts abut the Clark Range on long mountain slopes. These areas are classed as agroclimate 5H, but often extend upwards into 6H on longer slopes. Vegetation is aspen or mixedwood forest, usually with a lush understory.

The unit is characterized by three major soil groups. Orthic Dark Gray soils, mainly kBVA (paraskeletal Beauvais) variant and sometimes BVA (Beauvais) series, are usually the dominant or codominant group (20-50%). Dark Gray Luvisols, mainly kLTC (paraskeletal Leighton Centre) variant and sometimes LTC (Leighton Centre) series may be significant or dominant (15-30%). Coarser textured variants of both groups, namely skeletal soils, are significant to codominant (20-30%).

Both kBVA and kLTC are developed in weakly calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain till. These soils tend to have thick (often >1 m), acidic to neutral sola. Similar but thinner less acidic versions occur near Maycroft in moderately to strongly calcareous mountain till. The BVA and LTC series are developed in moderately calcareous, medium textured (CL-L, 2-15% coarse fragments), continental and mixed origin tills. The coarser textured variants occur mainly in weakly to moderately calcareous, very gravelly to cobbly (35-60% coarse fragments), coarse to medium textured (mainly SL-L), glaciofluvial (ice contact) and fluvial mudflow deposits.

Two BVLT6 map units were recognized.

BVLT6/5: 550 ha (1300 ac); hummocky to inclined terrain; sometimes includes small fluvial (mudflow) aprons and fans; often gullied or channelled. Slopes mainly 9-15%; topography classes 4 and 6 usually included, sometimes significant.

BVLT6/6-7: 1200 ha (3000 ac); mainly inclined slopes with superimposed hummocky or ridged elements; occasionally controlled by underlying bedrock; often gullied. Slopes mainly 15-45%; occasionally class 7 topography is only an inclusion.

Recurrent inclusions are wet soils (Gleyed subgroups and Gleysolics) of seeps, potholes and drains. Occasional inclusions are Orthic Gray Luvisols (SPR and SPRv), Dystric and Eutric Brunisols, Gleyed and Orthic Dark Gray stratified fan and mudflow soils (TDC and kTDC), shallow lithic variants, Orthic Black soils (eg. kDVG and OTP) or their Dark Brown "Mountain Chernozem" counterparts, and finer textured variants.

BVLT9 (Beauvais-Leighton Centre) Soil Unit

BVLT9 is a compound soil unit of the Beauvais Lake Upland that encompasses forested ice contact terrain dotted with potholes, sloughs and drains (Fig. B6). It occurs in areas

classed as agroclimate 5H bordering on 6H. Vegetation is mainly aspen or mixedwood forest, usually with a lush understory.

The unit is characterized by four major soil groups. Orthic Dark Grays, namely kBVA (paraskeletal Beauvais) variant and BVA series, commonly form one codominant group (20-30%). Dark Gray Luvisols, namely kLTC (paraskeletal Leighton Centre) variant and LTC series, are the second codominant group (20-30%). Coarser textured variants of both groups, namely skeletal soils, are also significant to codominant (20-30%). Wet soils of the potholes, drains and sloughs are significant (15-20%). The last group ranges from imperfectly drained soils related to BVA and LTC through Gleysolic soils like POT (Pothole Creek), to small water bodies such as sloughs.

Both kBVA and kLTC are developed in weakly calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain till. These soils tend to have thick (often >1 m), acidic to neutral sola. Moderately calcareous versions with thinner sola also occur. The BVA and LTC series are developed in moderately calcareous, medium textured (CL-L, 2-15% coarse fragments), continental and mixed origin tills. The coarser textured variants occur mainly in weakly to moderately calcareous, very gravelly to cobbly (35-60% coarse fragments), coarse to medium textured (SL-L), glaciofluvial (ice contact) deposits.

Occasional inclusions are Orthic Black soils (eg. kDVG and OTP), Orthic Gray Luvisols (SPR and SPRv), and slopewash soils such as MFT and TDC.

Only one BVLT9 map unit was recognized.

BVLT9/5: 500 ha (1200 ac); hummocky and ridged ice contact terrain. Slopes highly variable and usually short, mainly 9-15% with significant class 6 and inclusions of class 4 topography. The coarse textured (skeletal) soils are commonly found on hummock and ridge crests.

BVOK1 (Beauvais-Ockey) Soil Unit

BVOK1 is a compound soil unit, primarily of the Southern Foothills, featuring till thinly covering bedrock ridges and hills (Fig. B6). It occurs in areas classed mainly as agroclimate 5H. Vegetation is dominantly aspen and mixedwood forest with significant grassland patches on southerly aspects in association with shallow soils.

The dominant soil group, Orthic Dark Gray kBVA (paraskeletal Beauvais) variant and BVA series at 30-50%, occur under the forested segment. Combined microclimatic and edaphic conditions associated with the grasslands result in significant Orthic Black soils, namely the kOKY (paraskeletal Ockey) and OKYv climatic variants, at 15-25%.

The till is mainly weakly to moderately calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain till in the western foothills. The mixed origin to continental tills of the eastern foothills have less coarse fragments (mainly 2-15%) and are usually moderately calcareous. Across upper slopes and crests, the till is shallow, overlying residual material and bedrock. The residuum, when present, ranges from non- to strongly calcareous, nongravelly to very gravelly, and is weathered from underlying sandstone or shale.

Recurrent inclusions are shallow lithic Orthic Eutric Brunisols (NFK) and deep Orthic Blacks (kDVG and DVG). Occasional inclusions are Orthic Dark Brown (BEVv), shallow lithic Orthic Dark Grays (kBDY and BDY), Luvisolic soils like kLTC, coarser textured (mainly skeletal) variants, and bedrock outcrops.

Only one BVOK1 map unit was recognized.

BVOK1/6: 2000 ha (4900 ac); blanket to veneer over ridged, inclined or, occasionally, hummocky bedrock. Slopes mainly 15-30%; topography classes 5 and 7 usually included, sometimes significant to codominant. Gentler sloping segments in some tracts have been cultivated for forage production.

BZCT1 (Beazer-Cardston) Soil Unit

BZCT1 is a compound soil unit characterized by landforms of mixed till and glaciolacustrine materials. It occurs mainly on the Cow Creek Bench (Fig. B7, B21), the Goose Lake Bench, and the edge of the Porcupine Hills. The vast majority occurs in areas classed as agroclimate 3H, the coolest part of an area equated with thin Black soils. Most BZCT1 has been cultivated.

BZR (Beazer) series, ranging from 20-50% overall, and CTN (Cardston) series, at 20-40% overall, are the major soils. Both are classified as Orthic Black. Frequently both are codominant; at other times BZR dominates, especially in the rougher landscapes. CTN sometimes dominates but only on the very gently sloping terrain (BZCT1/3).

The BZCT1 soil unit is characterized by a mixture of continental till and glaciolacustrine deposits with few clear sequences or boundaries. Normally, till occupies elevated portions of a landscape, glaciolacustrine the lower localities. The till is mainly moderately calcareous and medium textured (CL-SiCL, 2-15% coarse fragments). The glaciolacustrine (lacustro-till) deposits are moderately to strongly calcareous and fine textured (mainly C-SiC, 2-15% coarse fragments). BZR series is developed in the till, CTN in the glaciolacustrine sediments.

Three BZCT1 map units were recognized.

BZCT1/3: 4500 ha (11 200 ac); undulating to inclined terrain, perhaps bedrock controlled in one or two tracts. Slopes mainly 2-5%; topography classes 2 and 4 usually included, sometimes significant.

BZCT1/4D: 1000 ha (2500 ac); mainly long inclined slopes with superimposed hummocky or undulating segments; occasionally gullied. Slopes mainly 5-9%; topography classes 3 and 5 usually included, sometimes significant.

BZCT1/4R: 500 ha (1300 ac); blanket or deeper (estimated at 1-5 m) over ridged, inclined or hummocky bedrock. Slopes mainly 5-9%; topography classes 3 and 5 usually included, sometimes significant. A tract near Fishburn may be drumlinoid rather than bedrock controlled.

Most BZCT1 tracts are cultivated and therefore include (5-20%) Rego and Calcareous Black variants like PSO and CWY due to erosion. Other recurrent inclusions are the thick Black counterparts, DVG and kFSH. Occasional inclusions are wet soils of seeps, potholes and sloughs; nongravelly, varved, glaciolacustrine soils (SOF and PNR) in low lying level sites (BZCT1/3 only); slopewash soils (SOF and MFT) along the bases of long slopes (mainly in BZCT1/4D); shallow lithic variants (BZCT4/4R only); and saline plus solonetzic variants bordering seeps, potholes and sloughs.

BZCT4 (Beazer-Cardston) Soil Unit

BZCT4 is a compound soil unit characterized by mixed till and glaciolacustrine materials with significant eroded Black soils. It occurs mainly on the Cardston Plain and adjacent edge of the Porcupine Hills (Fig. B7, B8). The majority occurs in areas classed as

agroclimate 3H, with a significant proportion in areas classed as agroclimate subclass 2HA Both are equated with the distribution of thin Black soils. Cultivation is widespread.

Orthic Black soils dominate. These are BZR (Beazer) series (20-40%) and CTN (Cardston) series (20-30%). Usually both are codominant; in some tracts BZR dominates, especially in the rougher landscapes. CTN sometimes dominates but only on the very gently sloping terrain (BZCT4/3). Rego and Calcareous Black variants such as PSO (Parsons) and CWY (Cowley) series are subdominant (20-30%). They may as a group be equivalent to either BZR or CTN in some tracts.

The BZCT4 soil unit is characterized by a mixture of continental till and glaciolacustrine deposits with few clear sequences or boundaries. Normally, till occupies elevated portions of a landscape, glaciolacustrine the lower localities. The till is mainly moderately calcareous and medium textured (CL-SiCL, 2-15% coarse fragments). The glaciolacustrine (lacustro-till) deposits are moderately to strongly calcareous and fine textured (mainly C-SiC, 2-15% coarse fragments). BZR series is developed in the till, CTN in the glaciolacustrine sediments.

Three BZCT4 map units were recognized.

BZCT4/3: 1650 ha (4100 ac); undulating to inclined terrain, occasionally with hummocky localities. Slopes mainly 2-5%; topography class 4 usually included, sometimes significant. Possible bedrock control in one or two tracts.

BZCT4/4D: 1450 ha (3600 ac); mainly long inclined slopes with superimposed hummocky or undulating segments; usually gullied. Slopes mainly 5-9%; topography classes 3 and 5 often included, sometimes significant. A large tract near Rouleau Lake is hummocky.

BZCT4/4R: 700 ha (1800 ac); blanket or deeper (estimated at 1-5 m) over inclined, ridged or hummocky bedrock (Fig. B7). Slopes mainly 5-9%; topography class 3 usually included, sometimes significant.

The only group of recurrent inclusions is wet soils of seeps, potholes and sloughs. Occasional inclusions are nongravelly glaciolacustrine soils (PNR) in BZCT4/3; medium textured slopewash or glaciolacustrine soils (SOF) in BZCT4/3 and BZCT4/4D; Dark Brown soils in BZCT4/3 and BZCT4/4D; thick Black soils (DVG and kFSH); shallow lithic variants in BZCT4/4R; and saline plus solonetzic variants bordering seeps, potholes and sloughs.

BZNF1 (Beazer-North Fork) Soil Unit

BZNF1 is a compound soil unit that features till overlying rolling to gently inclined bedrock "plateaus" of the southern Porcupine Hills and outliers (Fig. B3). These areas are classed as agroclimate 3H. Vegetation is mainly grassland. Some cultivation has been tried in the past but subsequently abandoned.

The dominant (40-50%) soil group, BZRv (thin Beazer) variant plus BZR series, occurs where the till is deeper than 1 m. For convenience, both are considered Orthic Black; technically, BZRv is an Orthic Eutric Brunisol with 4-9 cm of black to dark brown Ah. An Orthic Eutric Brunisol, NFK (North Fork) series which is developed in shallow till over bedrock, is significant (20-30%). It too has a thin Ah - a feature that reflects the windswept position of the unit in the general landscape.

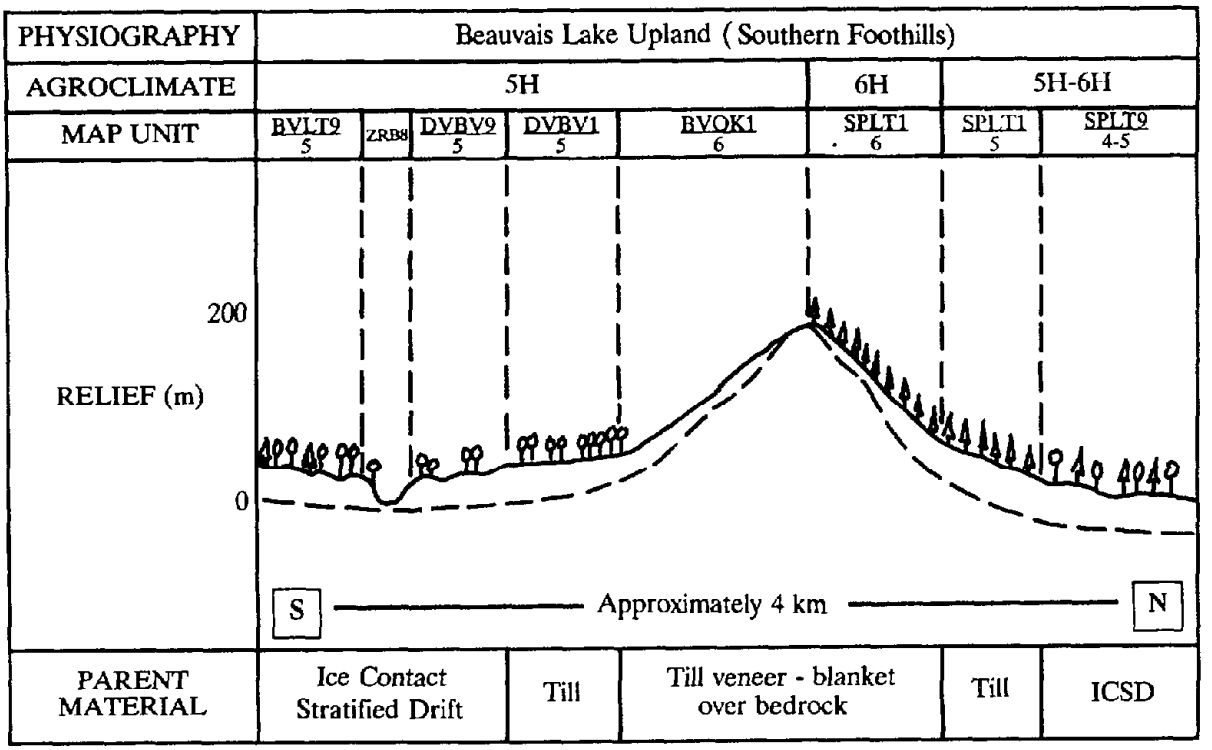


Figure B6. Landscape schematic showing topographic relationships among several map units of the Gladstone Valley area.

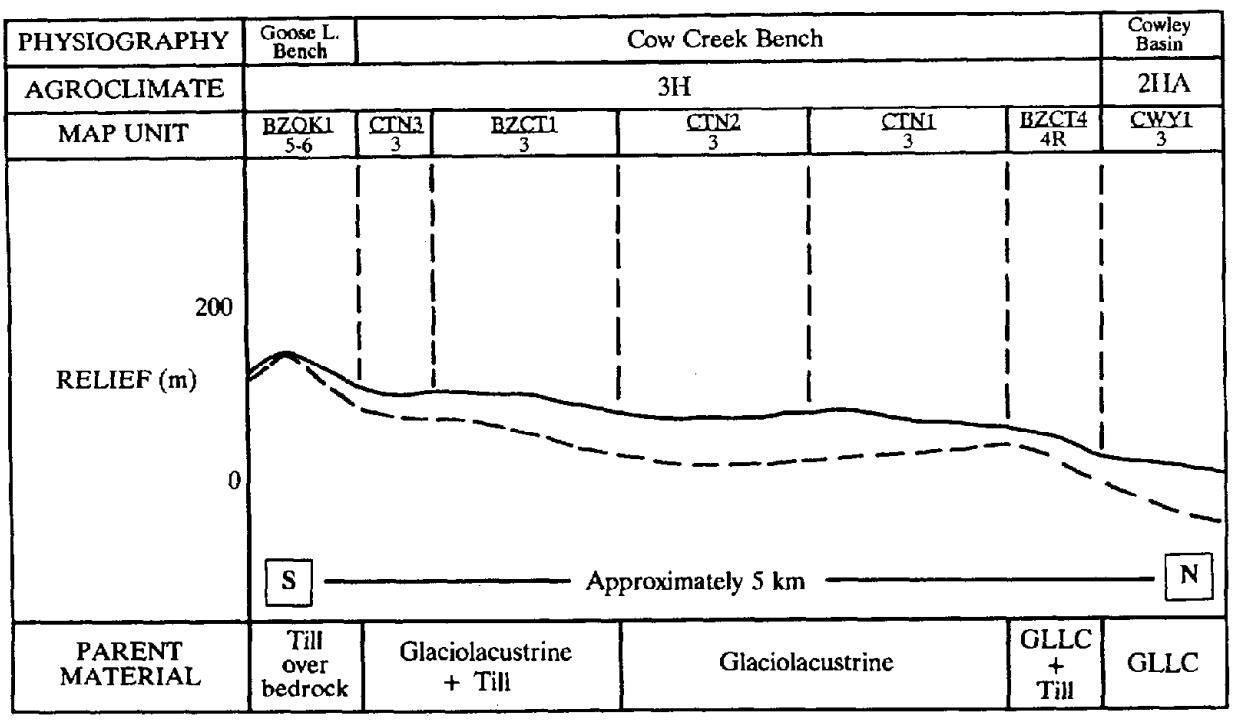


Figure B7. Landscape schematic showing topographic relationships among several map units mapped south of Pincher Creek airport.

The till varies from moderately to strongly calcareous and from slightly gravelly to gravelly (2-35% coarse fragments). Medium textures (CL-L) are prevalent but coarser textured (SCL-CL) layers can be found where the underlying bedrock is sandstone. The till is often shallowest near tract margins and overlies residual material and bedrock. Residuum, when present, ranges from moderately to very strongly calcareous and nongravelly to very gravelly. It is weathered from shale or sandstone.

All inclusions are recurrent. Rego variants, including Rego and Calcareous Blacks (eg. PSO) and Orthic Regosols, reflect erosion. Others are Dark Brown soils, shallow lithic Orthic Black soils (OKY and kOKY), and bedrock outcrops.

Only one BZNF1 soil unit was recognized.

BZNF1/4: 600 ha (1500 ac); morainal blanket to veneer overlying rolling (truncated) to hummocky or, occasionally, ridged bedrock. Slopes mainly 5-9%; class 3 topography usually significant, class 5 included. Most tracts are bounded, at least on three sides, by much steeper terrain, usually BZNF4/5-7.

BZNF4 (Beazer-North Fork) Soil Unit

BZNF4 is a compound soil unit that features steep, eroded, scarp terrain of the southern Porcupine Hills (Fig. B3). It occurs in areas classed as agroclimate 3H, occasionally bordering on 4H. Vegetation is mainly native grassland with some patches of subxeric Douglas fir-limber pine open forest.

The dominant (30-50%) soil group, BZR (Beazer) series and BZRv (thin Beazer) variant, occur where the till is deeper than 1 m. For convenience, both are considered Orthic Black; technically, BZRv is an Orthic Eutric Brunisol with 4-9 cm of black to dark brown Ah. An Orthic Eutric Brunisol, NFK (North Fork) series developed in shallow till over bedrock, is one significant soil (20-30%). It too has a thin Ah - a feature that reflects the windswept position of the unit in the general landscape. Rego variants, including Rego and Calcareous Blacks (eg. PSO and rBZR) plus Orthic Regosols, form the other significant group (20-30%). These too reflect microclimatic and edaphic conditions that promote drought, erosion and lack of development.

The till varies from moderately to strongly calcareous and slightly gravelly to gravelly (2-35% coarse fragments). Medium textures (CL-L) are prevalent but coarser textured (SCL-SL) layers can be found where the underlying bedrock is sandstone. Where shallow, the till overlies residual material and bedrock. Residuum, when present, ranges from moderately to very strongly calcareous and nongravelly to very gravelly. It is weathered from shale or sandstone.

Recurrent inclusions are shallow lithic Orthic Black soils (OKY and kOKY), mainly on moister northerly aspects, and bedrock outcrops. Occasional inclusions are Dark Brown soils and Rego Blacks developed in deep fluvioeolian deposits (rPPE) accumulated on lee slopes.

Only one BZNF4 soil unit was recognized.

BZNF4/5-7: 2400 ha (5900 ac); blanket to veneer over inclined to ridged or, occasionally, hummocky segments of large bedrock hills; usually gullied. Slopes mainly 9-45% and variable, sometimes including small benches with class 4 topography.

BZOK1 (Beazer-Ockey) Soil Unit

BZOK1 is a compound soil unit that features till overlying bedrock ridges and hills of the Southern Foothills, the Porcupine Hills, and their outliers on the Cardston Plain. It occurs in areas classed as agroclimate 3H (BZOK1/5-6) and 4H (BZOK1/4-5). Vegetation is mainly native grassland.

Orthic Black BZR (Beazer) series, or climatic variant thereof, is the dominant soil (30-60%). Orthic Blacks, including OKY (Ockey) series and its climatic (OKYv) and paraskeletal variants (kOKY), form the significant group (15-30%). The OKY group of soils are developed in shallow till overlying bedrock.

The till varies from moderately to strongly calcareous and from slightly gravelly to gravelly (2-35% coarse fragments). Medium textures (CL-L-SCL-SiCL) reflect local bedrock influence on the dominantly continental till. Across upper slopes and crests the till is shallow, overlying residual material and bedrock. The residuum, when present, ranges from moderately to very strongly calcareous and nongravelly to very gravelly. It is weathered from shale or sandstone.

Two BZOK1 map units were recognized.

BZOK1/4-5: 650 ha (1600 ac); blanket to veneer over ridged to hummocky or, occasionally, rolling (truncated) bedrock "plateaus" (Fig. B1). Slopes mainly 5-15%; topography classes 6 and 3 usually included. Most tracts bounded, at least on three sides, by much steeper terrain, often OKY4/6-7. Located in areas classed as agroclimate 4H, but soil morphology (thin Ah and sola) is similar to soils of agroclimatic class 3H and drier, likely due to windswept exposures.

BZOK1/5-6: 7650 ha (18 900 ac); blanket to veneer overlying ridged, inclined or hummocky bedrock (Fig. B7, B9, B10, B11); sometimes gullied. Slopes mainly 9-30%; sometimes topography class 6 is an inclusion rather than significant to dominant.

Recurrent inclusions are:

* Rego variants, mainly Rego and Calcareous Blacks (PSO) and Orthic Regosols;
* Orthic Eutric Brunisols like NFK and BZRv; and
* thick Black soils like DVG that reflect moister conditions.

Occasional inclusions are coarser textured variants in BZOK1/5-6, finer textured variants in BZOK1/5-6, Rego Black soils developed in deep fluvioeolian deposits (rPPE) in BZOK1/5-6, and bedrock outcrops in both map units.

BZOK4 (Beazer-Ockey) Soil Unit

BZOK4 is a compound soil unit that features till overlying bedrock hills and ridges of the southern Porcupine Hills and outliers on the Cardston Plain (Fig. B8). These areas are classed as agroclimate 3H. The steepest and rockiest sections have been left in native grassland. In contrast, gently sloping segments such as hill tops and benches have been cultivated in many cases.

The Orthic Black BZR (Beazer) series is the dominant soil (30-50%). Orthic Blacks, mainly OKY (Ockey) series and paraskeletal variant (kOKY), developed in shallow till over bedrock, form one significant group (15-30%). Rego variants, including Rego and Calcareous Blacks (eg. PSO and rBZR) plus Orthic Regosols, form the other significant group (20-30%).

The till varies from moderately to strongly calcareous and slightly gravelly to gravelly (2-35% coarse fragments). Medium textures (CL-SiCL) reflect local bedrock influence on the dominantly continental till. The till is shallow across upper slopes and crests, overlying residual material and bedrock. Residuum, when present, ranges from moderately to very strongly calcareous and nongravelly to very gravelly. It is weathered from shale or sandstone.

The recurrent inclusions have thin (4-9 cm) Ah horizons and are classified as Orthic Eutric Brunisol (NFK and BZRv). Occasional inclusions are finer textured variants, Rego Black soils developed in deep fluvioeolian deposits (rPPE), and bedrock outcrops.

Only one BZOK4 map unit was recognized.

BZOK4/4-6: 3300 ha (8100 ac); blanket to veneer over ridged or hummocky bedrock. Slopes mainly 5-30% and variable, often including small gently sloping benches or "terraces" in the overall dome-shaped mass.

BZR1 (Beazer) Soil Unit

BZR1 is a simple soil unit encompassing morainal terrain, mainly on the Cow Creek Bench, the Goose Lake Bench (Fig. B9), and the edge of the Porcupine Hills. The majority occurs in areas classed as agroclimate 3H, the coolest part of an area equated with thin Black soils. Some polygons extend into areas classed as 2HA and 4H. Cultivation is widespread although much of the steeper terrain has been left in native grassland.

The Orthic Black BZR (Beazer) series is the dominant soil (40-80%). All landscapes are morainal and composed of moderately calcareous, medium textured (CL-SiCL-L, 2-15% coarse fragments), continental till.

Five BZR1 map units were recognized.

BZR1/3: 1100 ha (2800 ac); undulating to inclined terrain. Slopes mainly 2-5%; class 4 topography usually included, sometimes significant. Bedrock, estimated at 1-5 m depth, controls landform in two tracts near the Waterton Reservoir.

BZR1/4: 500 ha (1200 ac); hummocky and ridged terrain, sometimes superimposed on a subtle dome-shaped (rolling) landform. Slopes mainly short and 5-9%; topography classes 3 and 5 often included, sometimes significant.

BZR1/4D: 3400 ha (8400 ac); long inclined slopes, often with a superimposed hummocky element; often gullied. Slopes mainly 5-9%; topography classes 3 and 5 often included, sometimes significant. In one tract near North Fork and another near the Waterton Reservoir, the incline is controlled in part by bedrock.

BZR1/4R: 1650 ha (4100 ac); blanket or deeper (estimated at 1-5 m) over ridged, hummocky or, occasionally, rolling bedrock. Slopes moderately long and mainly 5-9%; topography classes 3 and 5 often included, sometimes significant.

BZR1/5D: 900 ha (2200 ac); mainly long inclined slopes, often with a superimposed hummocky element; usually gullied. Slopes mainly 9-15%; topography classes 4 and 6 often included, sometimes significant. In three tracts the incline is controlled by bedrock (estimated at 1-5 m depth).

Recurrent inclusions in most but not all of the map units are:

* thick Black soils like DVG that reflect moister conditions;
* Rego and Calcareous Black variants like PSO and rBZR, usually found in upper slope to crest positions;
* fine textured variants (CTN) most common in gently sloping units (BZR1/3 and BZR1/4), absent in the steepest terrain (BZR1/5D); and

* wet soils (Gleyed subgroups, Gleysolics and water) of potholes, sloughs and seeps.

Occasional inclusions are coarser textured variants (kBZR and RFD) in BZR1/4, BZR1/4D and BZR1/4R; medium textured soils of water-laid deposits (SOF and MFT) in BZR1/3, BZR1/4D and BZR1/5D; saline variants (sBZR) associated with seeps and potholes in BZR1/4D, BZR1/4R and BZR1/5D; shallow lithic soils (OKY) in BZR1/4R and BZR1/5D; and Orthic Eutric Brunisols (BZRv) in BZR1/5D.

BZR2 (Beazer) Soil Unit

BZR2 is a compound soil unit that encompasses morainal landforms dotted with potholes and sloughs. It occurs mainly on the Goose Lake Bench (Fig. B9), occasionally on the Cow Creek Bench and in the Porcupine Hills. All areas are classed as agroclimate 3H, the coolest part of an area equated with thin Black soils. Cultivation is common although much has been left in grassland.

The Orthic Black BZR (Beazer) series is the dominant soil (30-60%). Its parent material is moderately calcareous, medium textured (CL-SiCL-L, 2-15% coarse fragments), continental till. Wet soils of potholes and sloughs are significant (15-25%). These range from imperfectly drained Gleyed Black variants (of BZR and CTN) through Gleysolic soils like JAT (Joanto) to small water bodies such as sloughs. Parent materials in the depressions tend to be finer textured than the surrounding till.

Two BZR2 map units were recognized.

BZR2/3: 950 ha (2400 ac); undulating terrain. Slopes mainly 2-5%; class 4 topography usually included, sometimes significant.

BZR2/4: 1500 ha (3700 ac); hummocky terrain. Slopes generally short and 5-9%; topography classes 3 and 5 often included, sometimes significant (especially class 5). One tract near Ashvale in the Porcupine Hills has substantial coarse textured (skeletal) ice contact soils and class 5 topography.

The Orthic Black DVG (Dunvargan) series is significant in BZR2/3 (20-30%), and a recurrent inclusion in BZR2/4. It occurs in the same parent material as BZR but has thicker Ah and solum that reflects moister conditions. Its abundance coincides with the occurrence of BZR2 in areas that are moist compared to most agroclimatic class 3H equivalents.

Other recurrent inclusions are Rego and Calcareous Black variants (PSO and rBZR), mainly across knoll tops, and fine textured variants (CTN), mainly in lower lying, more level sites. Occasional inclusions are coarser textured variants (kBZR and RFD), situated in some knoll tops. One BZR2/4 tract, located near Ashvale in township 8-29-W4, encompasses an ice contact landform with 20-30% loamy-skeletal and sandy-skeletal soils.

BZR3 (Beazer) Soil Unit

BZR3 is a compound soil unit featuring morainal terrain with significant saline soils. The unit occurs on the Cow Creek Bench, mainly on apron-like slopes that skirt the Beauvais Lake Upland (Fig. B10). These areas are classed as agroclimate 3H, the coolest part of an area equated with thin Black soils. A major portion has been left in native grassland, the remainder has been cultivated.

The Orthic Black BZR (Beazer) series is the dominant soil (30-60%). Saline variants like sBZR plus solonetzic variants similar to zCTN (Cardston) and PGN (Peigan) form the significant group (15-30%). The latter group occurs around seepage sites. Each seep usually

features a core of wet soils surrounded by an inner ring of saline soils and an outer ring of solonetzic variants.

The morainal terrain is composed of moderately calcareous, medium textured (CL-SiCL-L, 2-15% coarse fragments), continental or mixed origin till. The seep materials may be slightly finer textured, perhaps mudflow material. The patchy salinity is classed as weak to moderate with salts usually found below 50 or 60 cm.

Recurrent inclusions are thick Black soils (DVG), which reflect moister conditions, and finer textured soils (CTN). Occasional inclusions are Rego and Calcareous Black variants (PSO and rBZR), medium textured slopewash soils (SOF and MFT), and wet soils (Gleyed subgroups and Gleysolics) at the centers of seeps.

Only one BZR3 map unit was recognized.

BZR3/4D: 1550 ha (3900 ac); gullied inclined slopes, usually at the base of steeper bedrock controlled terrain. Slopes long, mainly 5-9%; topography classes 3 and 5 usually included, sometimes significant. One tract near the junction of Todd and Wildcat Creeks is dominantly undulating with codominant class 3 topography.

BZR4 (Beazer) Soil Unit

BZR4 is a compound soil unit that features subdominant eroded soils in morainal terrain. It occurs in the southern Porcupine Hills and on or near its outliers on the Cardston Plain (Fig. B8). The majority occurs in areas classed as agroclimate 3H, a significant proportion in areas classed as 2HA. Both classes are equated with the distribution of thin Black soils. Cultivation is widespread although some of the steeper terrain has been left in native grassland.

The Orthic Black BZR (Beazer) series is the dominant soil (30-60%). Rego and Calcareous Black variants, mainly PSO (Parsons) series and rBZR (rego Beazer) variant, form the significant group (20-40%). In a few cases the two major soil groups are codominant. All landscapes are morainal and composed of moderately calcareous, medium textured (CL-SiCL-L, 2-15% coarse fragments), continental or mixed origin till.

Four BZR4 map units were recognized.

BZR4/3R: 300 ha (700 ac); blanket or deeper (estimated at 1-5 m) over ridged to rolling or, occasionally, inclined bedrock; often in elevated "plateau-like" locations. Slopes mainly 2-5%; class 4 topography usually significant. One tract near Springridge has little or no bedrock control.

BZR4/4D: 1550 ha (3900 ac); mainly long inclined slopes, often with a superimposed hummocky element; usually gullied. Slopes mainly 5-9%; topography classes 3 and 5 often included, sometimes significant. In one tract near Tanner the incline is controlled in part by bedrock.

BZR4/4R: 1350 ha (3400 ac); blanket or deeper (estimated at 1-5 m) over ridged to hummocky or, occasionally, inclined to rolling bedrock. Slopes moderately long and mainly 5-9%; topography classes 3 and 5 often included, sometimes significant (slope class 5 prominent in some tracts).

BZR4/5D: 600 ha (1500 ac); mainly long inclined slopes, sometimes with a superimposed hummocky element; usually gullied. Slopes mainly 9-15%; topography classes 4 and 6 often included, sometimes significant.

Fine textured soils (ie. CTN) are recurrent inclusions in BZR4/4R, occasional inclusions in the other BZR4 map units. Coarse textured variants (mainly kBZR and RFD) are recur-

rent inclusions in BZR4/5D, occasional inclusions in the other BZR4 map units. Other occasional inclusions are thick Black soils (DVG) in all but BZR4/3R; medium textured soils (SOF and MFT) of water-laid deposits, including slopewash in all but BZR4/3R; Orthic Eutric Brunisols (BZRv) in BZR4/4D and BZR4/5D; wet soils and associated saline variants in all but BZR4/5D; and shallow lithic variants (OKY) in BZR4/3R and BZR4/4R.

BZR6 (Beazer) Soil Unit

BZR6 is a compound soil unit that features moraine-like ice contact terrain with subdominant coarse textured soils. It occurs in the Porcupine Hills and Southern Foothills, in areas classed mainly as agroclimate 3H. Most has been left in native grassland, some has been cultivated.

The Orthic Black BZR (Beazer) series is the dominant soil (30-50%). Coarser textured variants form the subdominant group (20-40%). This group consists mainly of RFD (Rockford) series but includes others like RND (Rinard) and KNT (Knight) series plus intergrades.

BZR is developed in moderately calcareous, medium textured (CL-SiCL-L, 2-15% coarse fragments), continental or mixed origin till. One tract near Chapel Rock is dominated by kBZR (paraskeletal) variant, occurring in gravelly (15-35% coarse fragments) mountain till. The coarse soils occur in various moderately to very strongly calcareous glaciofluvial deposits, most often very gravelly to cobbly (35-60% coarse fragments) and medium to coarse textured (L-SL). Nongravelly to extremely gravelly coarse textured materials are also included.

Recurrent inclusions are Rego and Calcareous Black variants (PSO and rBZR or coarser textured versions) and wet soils (Gleyed subgroups, Gleysolics and water) of potholes and sloughs. Occasional inclusions are thick Black soils (DVG).

Only one BZR6 map unit was recognized.

BZR6/5: 350 ha (900 ac); mainly hummocky, in a few localities ridged; in some areas the hummocky surface is superimposed on an overall incline. Slopes generally short, mainly 9-15%; topography classes 4 and 6 usually included, class 6 sometimes significant.

COCR6 (Connop-Carway) Soil Unit

COCR6 is a compound soil unit that features ice contact terrain with stratified glaciofluvial soils in the Lees Lake area of the Southern Foothills. The area is classed as agroclimate 5H but borders on and has elements of 4H. Vegetation is mainly Douglas fir and related mixedwood forest with subdominant grassland patches, mainly on southerly aspects.

The Orthic Eutric Brunisol CONv (Connop) variant is the dominant (30-50%) soil and occurs under forest. It is based on the CON series established in the Calgary area (MacMillan 1987). An Orthic Black CRW (Carway) taxadjunct, one of the significant soils (20-30%), is associated with the grassland patches. Coarser textured variants, mostly Orthic Blacks, form the other significant group, also at 20-30%. Identified series or variants include cCRW and kCRW (coarse and gravelly CRW), cCON (coarse CONv), LNB (Lundbreck), BUR (Burmis), and DRW (Drywood). Similar unnamed soils plus intergrades may also occur.

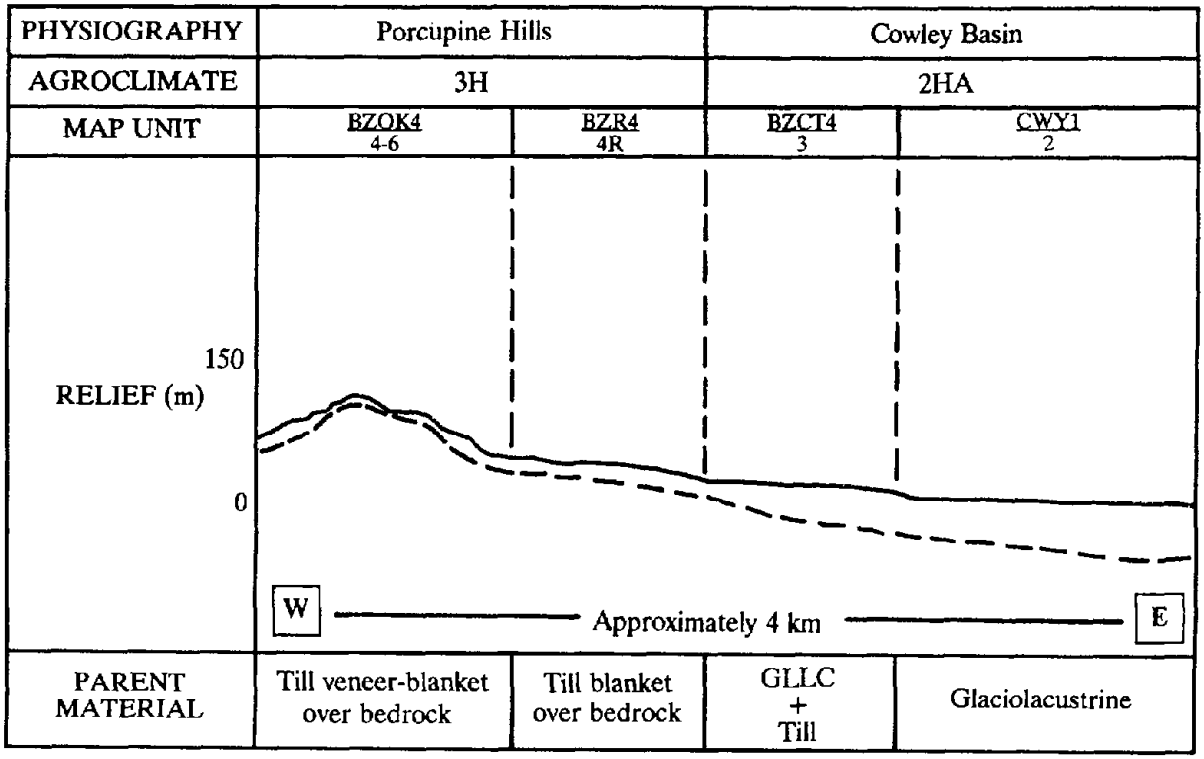


Figure B8. Landscape schematic showing topographic relationships among several map units occurring in the Pincher Station area.

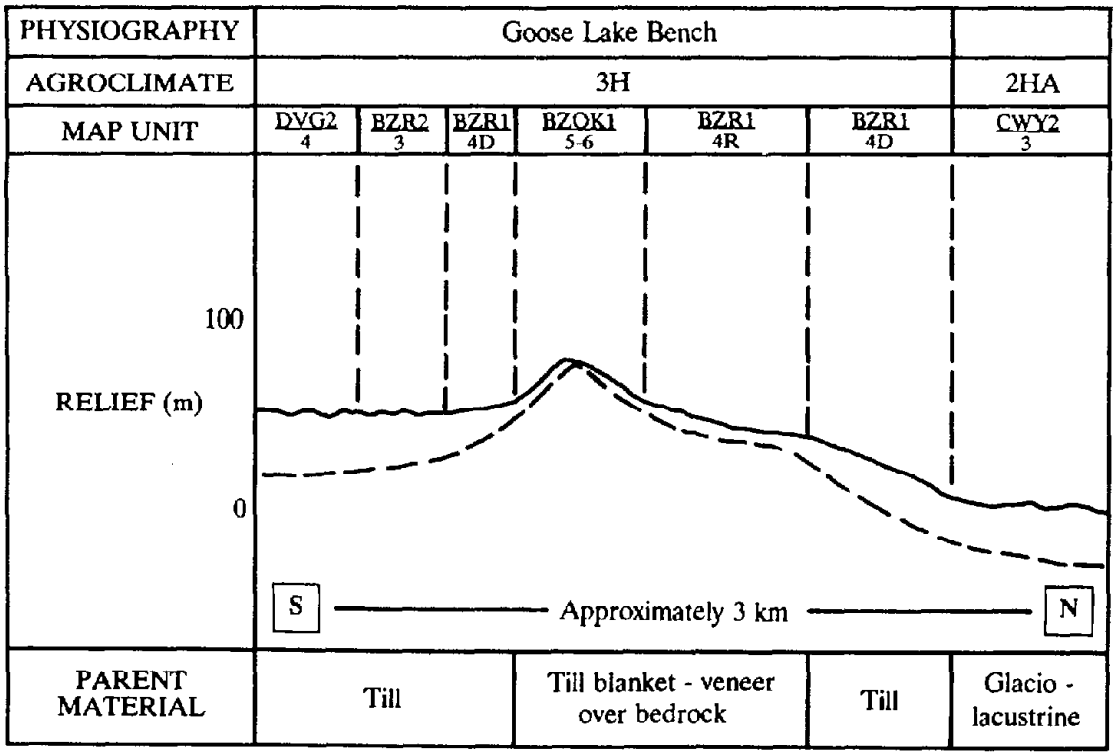


Figure B9. Landscape schematic showing topographic relationships among several map units in the Fishburn area.

Both CONv variant and CRW taxadjunct are developed in very strongly to strongly calcareous, coarse textured (SL, <2% coarse fragments), glaciofluvial deposits. The coarser textured soils are often distinctly stratified. Some have gravel veneers, others have sandy (LS-S) layers at depth, still others have gravel layers at depth or some gravels throughout.

Recurrent inclusions are wet soils (Gleyed subgroups, Gleysolics and water) in depressions, thin black soils like KNT and RND, and "slopewash" soils like MFT.

Only one COCR6 map unit was recognized.

COCR6/5-6: one tract of 950 ha (2300 ac); hummocky to ridged ice contact terrain with some inclined segments. Slopes mainly 9-30% with inclusions of class 4 and 7 topography.

CRW6 (Carway) Soil Unit

CRW6 is a compound soil unit that features ice contact terrain with stratified glaciofluvial soils in the Southern Foothills (Fig B15). It occurs in areas classed as agroclimate 4H, equated with the distribution of thick Black soils. Vegetation is mainly grassland although some areas have been cultivated and others are covered by aspen forest.

The Orthic Black CRW (Carway) series is one of the major soils (20-50%). Coarser textured variants such as cCRW and kDRW (Drywood) are another major group (20-50%). Other identified series included DRW (Drywood), LNB (Lundbreck) and OTP (Outpost). Finer textured variants such as fCRW are considered significant (10-30%) in CRW6/4-5, recurrent inclusions in CRW6/3.

CRW is developed in moderately calcareous, coarse textured (SL, <2% coarse fragments), glaciofluvial deposits. A taxadjunct occurs in very strongly to strongly calcareous material near Lees Lake. The coarser textured soils are distinctly or subtly stratified. Most have sandy (LS-S) layers at depth, others have gravelly layers, usually but not always at depth. The finer textured variants commonly have medium textured (SCL-L) layers through mid to lower parts of profiles. Two tracts in the Drywood area have extensive soils with medium textured and very gravelly medium textured layers at or near the surface.

Two CRW6 map units were recognized.

CRW6/3: 600 ha (1400 ac); undulating or terraced, occasionally with small ridges. Slopes mainly 2-5%; topography classes 2 and 4 usually included, sometimes significant.

CRW6/4-5: 450 ha (1200 ac); hummocky; sometimes gullied. Slopes mainly 5-15%; topography classes 3 and 6 often included, sometimes significant.

Recurrent inclusions are thin Black soils such as KNT and RND and wet soils of depressional sites. Occasional inclusions are Rego and Calcareous Black variants, till soils (DVG and kDVG), Orthic Eutric Brunisols (CONv), and Dark Gray variants.

CTBZ7 (Cardston-Beazer) Soil Unit

CTBZ7 is a compound soil unit that features subdominant Solonetzic or solonetzic-like soils. It occurs on the Cardston Plain (Fig. B10) and Goose Lake Bench, in areas classed as agroclimate 3H and 2HA. Both are equated with the distribution of thin Black soils. Some areas have been left in grassland, others have been cultivated.

Orthic Black soils, namely CTN (Cardston) series (20-50%) and BZR (Beazer) series (15-40%), are dominant. BZR dominates a few tracts but is minimal in others. Solonetzic variants, mainly Black Solodized Solonetz like PGN (Peigan) and Solonetzic Black like zCTN, constitute the significant group (15-30%). Black Solonetz, Gleyed Black Solonetz, Black Solod, and Solonetzic Gleysol soils also occur.

The CTBZ7 soil unit is characterized by a mixture of glaciolacustrine deposits and continental till with few clear sequences or boundaries. Normally, till occupies elevated portions of a landscape, glaciolacustrine the lower localities. The glaciolacustrine (lacustro-till) deposits are moderately to strongly calcareous and fine textured (mainly C-SiC, 2-15% coarse fragments). The till is mainly moderately calcareous and medium textured (CL-SiCL, 2-15% coarse fragments). CTN series is developed in the glaciolacustrine sediments, BZR in the till.

Rego and Calcareous Black soils such as CWY and PSO are occasional inclusions but dominate one eroded tract located between Cow and Todd creeks east of Chapel Rock. Other occasional inclusions are thick Black soils (DVG and kFSH), saline and associated wet soils of depressions and seeps, and medium textured soils of water-laid deposits (SOF).

Only one CTBZ7 map unit was recognized.

CTBZ7/3: 2950 ha (7200 ac); undulating, often on an overall incline; sometimes gullied or channelled. Slopes mainly 2-5%; topography classes 2 and 4 usually included, class 2 sometimes significant and dominates two tracts near Springridge; class 4 sometimes significant. BZR is often minimal where there is substantial class 2 slopes.

CTN1 (Cardston) Soil Unit

CTN1 is a simple soil unit encompassing glaciolacustrine terrain on the Cardston Plain, mostly on the Cow Creek Bench (Fig. B7, B21). The majority occurs in areas classed as agroclimate 3H, a significant proportion in areas classed as 2HA. Both are equated with the distribution of thin Black soils. Most of the CTN1 unit is associated with native grassland.

The Orthic Black CTN (Cardston) series is dominant (40-70%). As part of a glacial lake basin, CTN1 landforms are composed of moderately to strongly calcareous, fine textured (C-SiC-HC, 2-15% coarse fragments), glaciolacustrine (lacustro-till) sediments.

Two CTN1 map units were recognized.

CTN1/2: 1100 ha (2800 ac); level to undulating plain. Slopes mainly 0-2% but significant class 3 topography in all tracts. Two tracts at the north end of Pincher M.D. have substantial PNR (Pincher) soils.

CTN1/3: 2100 ha (5200 ac); undulating terrain, sometimes on an overall incline; often channelled. Slopes mainly 2-5%; significant class 2 topography except in one tract west of Pincher Creek townsite which contains significant class 4 slopes.

Recurrent or nearly recurrent inclusions are:

* nongravelly, varved, glaciolacustrine deposits (PNR soils);
* Rego and Calcareous Black variants (CWY and rCWY), mainly in cultivated areas;
* till soils (BZR);
* thick Black soils (kFSH) that reflect moister conditions;
* wet soils (Gleyed subgroups, Gleysolics and water) of potholes, sloughs and seeps.

Occasional inclusions are Orthic Eutric Brunisols with very thin Ah, and saline plus Solonetzic variants associated with the wet soils.

CTN2 (Cardston) Soil Unit

CTN2 is a compound soil unit that encompasses glaciolacustrine landforms dotted with potholes and sloughs. It occurs mainly on the Cardston Plain (Fig. B7), in areas classed as agroclimate 3H and 2HA Both are equated with thin Black soils. Most CTN2 areas are cultivated, some have been left in native grassland.

The Orthic Black CTN (Cardston) series is the dominant soil (40-50%). Wet soils of potholes and sloughs are significant (15-20%). These range from imperfectly drained Gleyed Black variants (of CTN) through Gleysolic soils like JAT (Joanto) to small water bodies such as sloughs. As part of a glacial lake basin, CTN2 landforms are composed of moderately to strongly calcareous, fine textured (C-SiC-HC, 2-15% coarse fragments), glaciolacustrine (lacustro-till) sediments.

Recurrent inclusions are till soils (BZR), thick Black soils (kFSH and DVG), and Rego and Calcareous Black variants (CWY and rCWY), mainly across knoll tops. Occasional inclusions are nongravelly, varved, glaciolacustrine sediments (PNR soils) and solonetzic plus saline variants sometimes associated with the wet soils.

Only one CTN2 map unit was recognized.

CTN2/3: 900 ha (2200 ac); undulating, grading to hummocky in some localities. Slopes mainly 2-5%; topography classes 2 and 4 usually included, sometimes significant.

CTN3 (Cardston) Soil Unit

CTN3 is a compound soil unit encompassing glaciolacustrine terrain with significant saline soils, mainly on apron-like slopes below steeper bedrock controlled terrain. These landform patterns are common near the Cowley Basin-Goose Lake Bench boundary (Fig. B7). The majority of CTN3 occurs in areas classed as agroclimate 3H, a significant proportion in areas classed as 2HA. Both are equated with the distribution of thin Black soils. Approximately equal amounts have been cultivated or left in native grassland.

The Orthic Black CTN (Cardston) series is the dominant soil (30-50%). Saline variants like sCTN form the significant group (15-25%). As part of a glacial lake basin, CTN3 landforms are composed of moderately to strongly calcareous, fine textured (C-SiC-HC, 2-15% coarse fragments), glaciolacustrine (lacustro-till) sediments. The patchy salinity is classed weak to moderate with salts usually showing up below about 50 or 60 cm.

Recurrent inclusions are till soils (BZR; significant to codominant in a few tracts), Rego and Calcareous Black variants (CWY and rCWY), and wet soils (Gleyed subgroups and Gleysolics) associated with the wetter seeps. Occasional inclusions are thick Black soils (kFSH and DVG) and solonetzic variants (eg. zCTN and PGN) associated with the saline soils.

Only one CTN3 map unit was recognized.

CTN3/3: 1550 ha (3800 ac); inclined to undulating, sometimes with small channels on relatively long slopes. Slopes mainly 2-5%; topography classes 2 and 4 usually included, sometimes significant.

CWOD1 (Cowley-Oldman) Soil Unit

CWOD1 is a compound soil unit dominated by eroded Black soils. It occurs throughout the Cardston Plain (Fig. B2, B20) in areas classed as agroclimate 2HA and 3H. Both are equated with the distribution of thin Black soils. Most of these soils have been cultivated.

The Calcareous Black CWY (Cowley) series and Rego Black rCWY variant constitute the dominant group of soils (30-50%). These are associated with moderately to strongly calcareous, fine textured (C-SiC-HC, 0-15% coarse fragments), glaciolacustrine deposits. The Rego Black ODM (Oldman) series is significant to codominant (20-30%). It is developed in moderately to very strongly calcareous, nongravelly or slightly gravelly, medium textured (L-SiL-CL), fluviolacustrine, glaciolacustrine or fluvial sediments.

Three CWOD1 map units were recognized.

CWOD1/2: 650 ha (1600 ac); level to undulating plain with minor channels. Slopes dominantly 0-2%. One tract in the Fishburn area, where Foothills Creek empties onto the Cardston Plain, is a level fan dominated by ODM and SOF (Standoff) soils and only 10-20% clayey soils. Another tract, near Pincher Creek townsite, has substantial PNR (Pincher) soils.

CWOD1/3: 1700 ha (4200 ac); inclined to undulating, often with minor channels. Slopes mainly 2-5%; topography classes 2 and 4 often included, sometimes significant.

CWOD1/3T: 900 ha (2200 ac); fan and apron superimposed on terraces, terraced (bevelled) terrain, or channelled fans. Slopes mainly 0-5% on terrace treads, fans and aprons; 5-30% on included to significant terrace risers and channel banks. Often located in or beside major stream valleys (Fig. B2), the unit's fan and apron deposits are usually derived from the glaciolacustrine plain above and are therefore fine textured.

Recurrent inclusions are:

* fine textured Orthic Black soils, mainly PNR in CWOD1/2 (codominant in one tract near Pincher Creek townsite), CTN in CWOD1/3, or both in CWOD1/3T;
* medium textured Orthic Black soils (SOF) mainly in CWOD1/2 (codominant in one tract near Fishburn) and CWOD1/3T;
* coarser textured soils (rKNT, KNT, rBFT, RND, and others) mainly in CWOD1/3T;
* wet soils (Gleyed subgroups, Gleysolics and water), associated with depressions and high water tables.

Occasional inclusions are saline plus solonetzic variants associated with the wet soils, till soils (BZR and PSO) in CWOD1/3 only, and shallow lithic variants in CWOD1/3T only.

CWPS1 (Cowley-Parsons) Soil Unit

CWPS1 is a compound soil unit dominated by eroded Black soils. It is found in the southern Porcupine Hills and on elevated parts of the Cardston Plain (Fig. B2, B11, B20). The vast majority occurs in areas classed as agroclimate 3H, some tracts in areas classed as 2HA. Both are equated with the distribution of thin Black soils. Most CWPS1 soil areas have been cultivated.

All the major soils are Calcareous and Rego Blacks. A fine textured group, consisting of CWY (Cowley) series and rCWY variant, dominate (20-60%) most often, especially on the gentler sloping terrain. A medium textured till group, PSO (Parsons) series plus Calcareous Black rBZR (rego Beazer) variant, form the other group, also at 20-60% overall. The till soils are most abundant on rougher terrain.

The fine group occurs in moderately to strongly calcareous, fine textured (C-SiC-HC, 2-15% coarse fragments), glaciolacustrine (lacustro-till) deposits. The till group is developed in moderately to strongly calcareous, medium textured (CL-L-SiCL-SCL, 2-15% coarse fragments), continental and mixed origin tills.

Two CWPS1 map units were recognized.

CWPS1/3: 1950 ha (4800 ac); undulating, often on an overall incline; sometimes channelled. Slopes mainly 2-5%; class 4 topography often included, sometimes significant.

CWPS1/4R: 4500 ha (11 100 ac); blanket or deeper (estimated at 1-5 m) over ridged to hummocky or, occasionally, rolling bedrock. Slopes mainly 5-9%; topography classes 3 and 5 often included, sometimes significant. Three tracts along the Crowsnest R. near Lundbreck have relatively smooth, bevelled surfaces. These plus three other tracts near Tennessee Cr. contain significant shallow lithic soils.

Recurrent inclusions are Orthic Black soils (CTN and BZR), shallow lithic soils in CWPS1/4R (significant in some tracts), and wet soils (Gleyed subgroups, Gleysolics and water) plus associated saline variants in seeps and depressions. Occasional inclusions are medium textured soils of water-laid deposits (ODM and SOF), Dark Brown soils, and coarse textured variants (rKNT, gravelly PSO, rBFT, RND).

CWY1 (Cowley) Soil Unit

CWY1 is a simple soil unit dominated by eroded Black soils developed in glaciolacustrine sediments. It occurs throughout the Cardston Plain (Fig. B2, B7, B8, B11) in areas classed as agroclimate 2HA and 3H. Both are equated with the distribution of thin Black soils. Most CWY1 soil areas have has been cultivated.

The Calcareous Black CWY (Cowley) series and Rego Black rCWY variant constitute the dominant group of soils (40-80%). These are associated with moderately to strongly calcareous, fine textured (C-SiC-HC, 0-15% coarse fragments), glaciolacustrine deposits.

Two CWY1 map units were recognized.

CWY1/2: 9450 ha (23 300 ac); undulating to level plain. Slopes mainly 0-2%; class 3 topography usually included and often significant.

CWY1/3: 13 700 ha (33 800 ac); inclined and undulating; often channelled or gullied. Slopes mainly 2-5%; topography classes 2 and 4 often included, sometimes significant.

Recurrent inclusions are Orthic Black soils, mainly CTN and PNR, and wet soils (Gleyed subgroups, Gleysolics and water) plus associated saline variants in seeps and depressions. Occasional inclusions are medium textured soils in water-laid deposits (ODM and SOF), till soils (PSO and BZR), solonetzic variants in CWY1/2 only, and coarse textured variants (rKNT, rBFT, RND) in CWY1/3 only. Dark Brown soils are significant in a few tracts in the Tennessee and Nine Mile creek areas.

CWY2 (Cowley) Soil Unit

CWY2 is a compound soil unit dominated by eroded Black soils and encompassing glaciolacustrine landforms dotted with potholes and sloughs. It occurs mainly on the Cowley Basin (Fig. B9) in areas belonging to agroclimatic subclass 2HA (one small tract west of North Fork is class 3H). This is the warmest part of an area equated with thin Black soils. Most CWY2 soil areas have been cultivated.

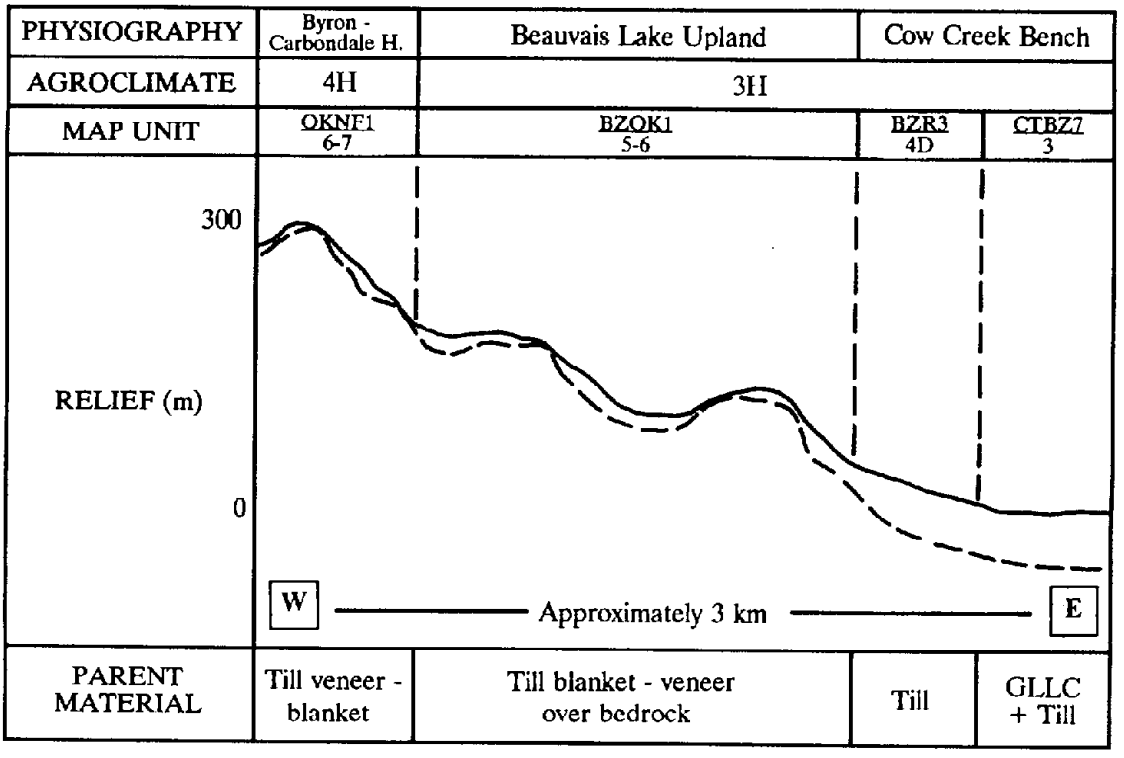


Figure B10. Landscape schematic showing topographic relationships among several map units mapped in the Maycroft-Todd Cr. area.

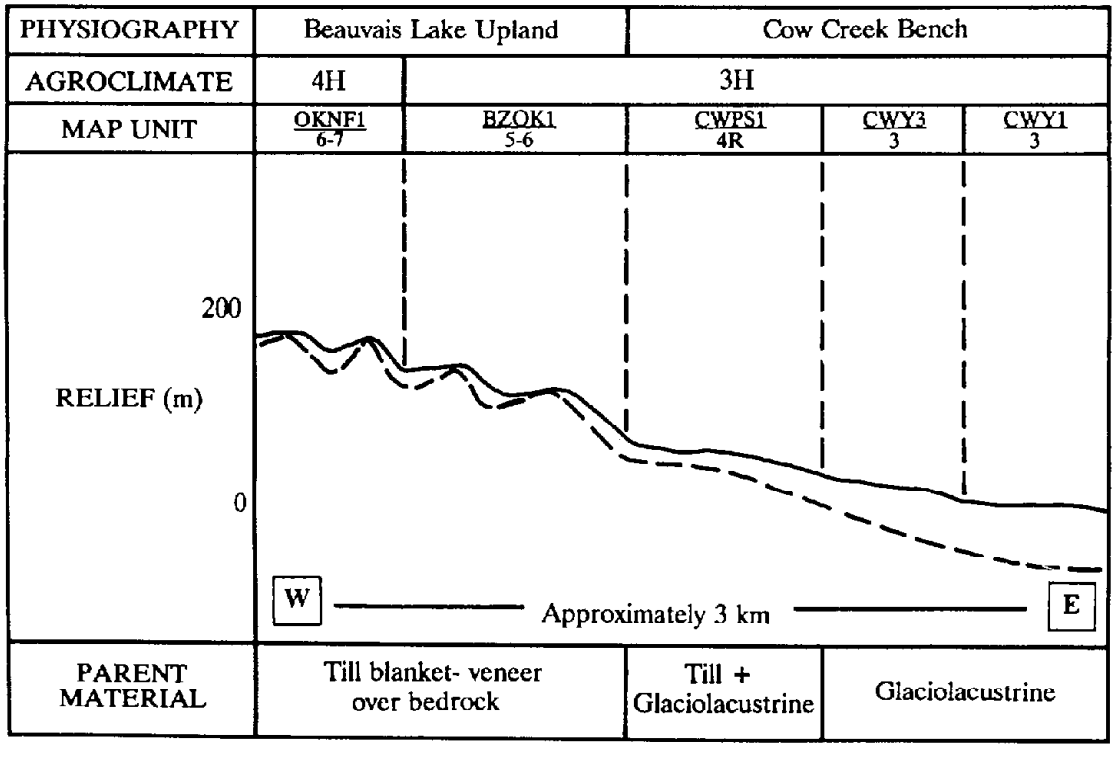


Figure B11. Landscape schematic showing topographic relationships among several map units mapped south of Lundbreck.

The Calcareous Black CWY (Cowley) series and Rego Black rCWY variant constitute the dominant group of soils (30-60%). Wet soils of potholes and sloughs are significant (15-25%). These range from imperfectly drained Gleyed Black variants (of CTN and CWY) through Gleysolic soils like JAT (Joanto) to small water bodies such as sloughs. As part of a glacial lake basin, CWY2 landforms are composed of moderately to strongly calcareous, fine textured (C-SiC-HC, 0-15% coarse fragments), glaciolacustrine sediments.

Recurrent inclusions are Orthic Black soils, mainly CTN (significant in one tract near Halifax Lake) and PNR. Occasional inclusions are saline and solonetzic variants sometimes associated with the wet soils, medium textured soils of water-laid deposits (ODM and SOF), and till soils (PSO and BZR).

Only one CWY2 map unit was recognized.

CWY2/3: 1300 ha (3200 ac); undulating, occasionally grading to hummocky in some localities. Slopes mainly 2-5%; topography classes 2 and 4 usually included, sometimes significant.

CWY3 (Cowley) Soil Unit

CWY3 is a compound soil unit that encompasses eroded Black soils plus saline variants. It occurs on the Cardston Plain, often on apron-like slopes that skirt the Porcupine Hills, Southern Foothills (Fig. B11), and their outliers. These areas are classed as agroclimate 2HA and 3H. Both are equated with the distribution of thin Black soils. Most CWY3 soil areas have been cultivated.

The Calcareous Black CWY (Cowley) series and Rego Black rCWY variant constitute the dominant (40-60% in CWY3/3) or codominant (20-50% in CWY3/2) group of soils. The Orthic Black PNR (Pincher) series is sometimes codominant (5-40%) in CWY3/2 and, in fact, dominates two tracts, one near Halifax Lake, the other near Pincher Creek townsite. Saline variants like sCWY form the significant group (15-25%).

As part of a glacial lake basin, CWY2 landforms are composed of moderately to strongly calcareous, fine textured (C-SiC-HC, 0-15% coarse fragments), glaciolacustrine sediments. The patchy salinity is classed weak to moderate with salts usually showing up below about 50 or 60 cm.

Two CWY3 map units were recognized.

CWY3/2: 950 ha (2300 ac); level to undulating plain; channelled. Slopes mainly 0-2% with inclusions of class 3 topography near channels. One tract along Cow Creek is a level fan or floodplain composed of fine textured fluviolacustrine or reworked glaciolacustrine sediments. It is dissected by numerous channels and contains significant coarser textured soils like ODM (Oldman) and KNT (Knight).

CWY3/3: 2000 ha (5000 ac); inclined, often with a superimposed undulating element; often channelled or gullied, especially below seeps. Slopes mainly long and 2-5%; topography classes 2 and 4 usually included, sometimes significant.

Recurrent inclusions in at least one of the map units, are:

* Orthic Black soils, mainly CTN in CWY3/2, undifferentiated CTN and PNR in CWY3/3);
* medium textured soils in water-laid deposits (ODM and SOF), mainly in CWY3/2;
* solonetzic soils (zCTN and PGN) associated with the saline variants, mainly in CWY3/2; and

* wet soils (Gleyed subgroups, Gleysolics and water) associated with seeps and depressions.

Occasional inclusions are till soils (PSO and BZR) in CWY3/3 only.

DRLN4 (Drywood-Lundbreck) Soil Unit

DRLN4 is a compound soil unit representing many stream terrace landscapes, mostly in major valleys that cut through the Southern Foothills (Fig. B15, B18) and Front Ranges. These areas are classed as agroclimate 4H and 5H. Vegetation is mainly native grassland although some tracts have been cultivated and others have substantial aspen forest.

The unit is characterized by three major soils with wide percentages of occurrence. DRW (Drywood) series plus gravelly kDRW taxadjunct, at 20-60% overall, and LNB (Lundbreck) series, at 15-50% overall, are both Orthic Black. The third group - Rego and Calcareous Black variants of DRW and LNB including rDRW and BUR (Burmis) - range from inclusion status (minimum about 5%) in some tracts to dominant (maximum about 60%) in others.

The major soils occur in discontinuous, medium to coarse textured veneer over glaciofluvial or fluvial gravel. Veneer textures are mainly L-SL-SiL, sometimes with a few gravels (kDRW). DRW, kDRW and rDRW have 30-100 cm of veneer over gravel. The gravel base is often moderately to very strongly calcareous, extremely gravelly to cobbly (>60% coarse fragments), and coarse textured (LS-S). Fewer coarse fragments (40-50%), finer textures (SL), and sandy to silty lenses and bands may also occur. A few tracts have weakly calcareous deposits, others extremely calcareous gravel. LNB and BUR are gravel soils with less than 30 cm of veneer.

Any of the three major soils may dominate but at the expense of the other two. Critically, DRLN4 has more than 30% of soils with the nongravelly to slightly gravelly veneer (DRW, kDRW, rDRW) to help differentiate it from the LNB1 soil unit.

Soils that have a "veneer" exceeding 1 m depth (MFT) are recurrent inclusions (significant in a few tracts). Occasional inclusions are thin Black soils (BFT and RND), Dark Brown variants, nongravelly coarse textured soils (CRW and cCRW), Dark Gray soils, and wet soils associated with high water tables.

Only one DRLN4 map unit was recognized.

DRLN4/3T: 3950 ha (9800 ac); terraced glaciofluvial and fluvial terrain near major streams; occasionally fluvial fan or apron deposited on terraces; sometimes channelled. Most tracts consist of multiple terrace treads (slopes 0-5%) separated by short steep risers (slopes 5-45%). A few tracts consist of a single large tread bounded by risers. The risers can severely hinder some cultivation and irrigation operations even though rarely occupying more than 30% of a tract.

DVBV1 (Dunvargan-Beauvais) Soil Unit

DVBV1 is a compound soil unit encompassing morainal parkland landscape, mainly on the Beauvais Lake Upland (Fig. B12, B13). These areas are classed as agroclimate 5H although grassland segments may be considered 4H. Vegetation is dominantly aspen forest with native grassland patches on southerly aspects across upper slopes and crests. Some DVBV1 has been cleared for rangeland or cultivation.

The unit is characterized by two or three major soil groups. Orthic Black DVG (Dunvargan) series and kDVG (paraskeletal) variant commonly form the dominant group (30-60%). The second group - Orthic Dark Gray BVA (Beauvais) series and kBVA (paraskeletal) variant - are usually significant to codominant (20-40%). In a few tracts the Dark Gray group is dominant, especially on steeper sloping terrain.

The third group - finer textured variants of both the Black and Dark Gray groups outlined above - range from absent to codominant among different tracts. The fine textured group occurs with the greatest regularity on gently sloping terrain (5-40% in DVBV1/4), less often where slopes are steeper (0-40% in the other DVBV1 map units). Areal extent of the fine soils is highest in several tracts, regardless of topography class, located in the Pecten area.

The DVG and BVA series are developed in moderately calcareous, medium textured (CL-L, 2-15% coarse fragments), continental and mixed origin tills. The kDVG and kBVA variants are developed in moderately to weakly calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain tills. Similar but less acidic versions occur occasionally in moderately to strongly calcareous mountain tills. The finer textured variants occur in weakly to moderately calcareous, fine textured (mainly C), slightly gravelly to gravelly (2-35% coarse fragments) till or shallow glaciolacustrine (lacustro-till) deposits.

Four DVBV1 map units were recognized.

DVBV1/4: 1050 ha (2600 ac); hummocky to ridged terrain. Slopes mainly 5-9%; topography classes 3 and 5 often included, sometimes significant.

DVBV1/4D: 1050 ha (2600 ac); long inclined slopes often with superimposed hummocky segments; often gullied. Slopes mainly 5-9%, topography classes 3 to 5 often included, sometimes significant.

DVBV1/5: 2600 ha (6400 ac); inclined, hummocky or ridged; several tracts with at least partial bedrock control of surface form; often gullied. Slopes mainly 9-15%; topography classes 6 and 4 often included, sometimes significant.

DVBV1/6: 1300 ha (3200 ac); inclined, hummocky or ridged; several tracts with at least partial bedrock control of surface form; sometimes gullied. Slopes mainly 15-30%; topography classes 5 and 7 often included, sometimes significant.

Recurrent inclusions, besides the finer textured variants mentioned above, are wet soils (Gleyed subgroups and Gleysolics) of seeps, potholes and drains, mainly in gently sloping landscapes (DVBV1/4 and DVBV1/4D). Occasional inclusions are coarser textured variants, mainly skeletal soils; Dark Gray Luvisols (LTC) in all but DVBV1/4; Rego and Calcareous Black and Dark Gray soils, important in a few DVBV1/5 tracts with high lime tills between Burmis and Maycroft; slopewash soils (MFT) in DVBV1/5 and DVBV1/6; Eutric and Dystric Brunisols in DVBV1/6 only; and shallow lithic soils (kOKY, kBDY) in DVBV1/6.

DVBV2 (Dunvargan-Beauvais) Soil Unit

DVBV2 is a compound soil unit encompassing morainal parkland landscape dotted with potholes, sloughs and drains. It occurs on the Beauvais Lake Bench (Fig. B12), in areas classed as agroclimate 5H although grassland segments may be considered 4H. Vegetation is dominantly aspen forest with native grassland patches on southerly aspects across upper slopes and crests.

The unit is characterized by three major soil groups. Orthic Black DVG (Dunvargan) series and kDVG (paraskeletal) variant form one codominant group (20-40%). Orthic Dark Gray BVA (Beauvais) series and kBVA (paraskeletal) variant constitute the other, also at 20-40%. Wet soils of the potholes, sloughs and drains are significant (15-25%). This last group ranges from imperfectly drained Gleyed subgroups related to DVG and BVA, through Gleysolic soils like POT (Pothole Creek), to small water bodies such as sloughs.

The DVG and BVA series are developed in moderately calcareous, medium textured (CL-L, 2-15% coarse fragments), continental and mixed origin tills. The kDVG and kBVA variants are developed in moderately to weakly calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain tills. Parent materials in the wet depressions tend to be finer textured than the surrounding upland till.

Two DVBV2 map units were recognized.

DVBV2/4: 2050 ha (5100 ac); hummocky, occasionally superimposed on an incline. Slopes mainly 5-9%; topography classes 3 and 5 often included, sometimes significant.

DVBV2/5: 650 ha (1600 ac); hummocky, occasionally superimposed on an incline. Slopes mainly 9-15%; topography classes 4 and 6 often included, sometimes significant.

Recurrent inclusions are coarser textured variants, mainly loamy-skeletal soils like OTP; finer textured variants, including gravelly fine textured soils (significant in a few tracts); and slopewash or stratified fan soils (MFT and TDCv). Occasional inclusions are Dark Gray Luvisols (LTC) and Eutric Brunisols.

DVBV6 (Dunvargan-Beauvais) Soil Unit

DVBV6 is a compound soil unit encompassing ice contact parkland landscape. It occurs mainly on the Beauvais Lake Upland, in areas classed as agroclimate 5H although grassland segments may be considered 4H. Vegetation is dominantly aspen forest with native grassland patches on southerly aspects across upper slopes and crests.

The unit is characterized by three major soil groups. Orthic Black DVG (Dunvargan) series and kDVG (paraskeletal) variant form one codominant group (20-40%). Orthic Dark Gray BVA (Beauvais) series and kBVA (paraskeletal) variant constitute the second, also at 20-40%. Coarser textured variants of both groups, mainly loamy-skeletal soils like OTP (Outpost), are significant to codominant (20-30%).

The DVG and BVA series are developed in moderately calcareous, medium textured (CL-L, 2-15% coarse fragments), continental and mixed origin tills. The kDVG and kBVA variants are developed in weakly to moderately calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain tills. The coarser textured variants occur mainly in weakly to moderately calcareous, very gravelly to cobbly (35-60% coarse fragments), coarse to medium textured (mainly SL-L), glaciofluvial (ice contact) deposits, perhaps fluvial mudflow in a few cases. Nongravelly and extremely gravelly coarse textured deposits are also included. Low lime parent materials are common; soils formed in them tend to have thick (often >1 m), neutral to acidic sola.

Two DVBV6 map units were recognized.

DVBV6/4: 850 ha (2100 ac); hummocky, ridged or inclined; occasionally gullied. Slopes mainly 5-9%; topography classes 3 and 5 often included, sometimes significant.

DVBV6/5-6: 1100 ha (2800 ac); hummocky, ridged or inclined; occasionally gullied. Slopes mainly 9-30%; topography classes 4 and 7 sometimes included.

Recurrent inclusions are wet soils (Gleyed subgroups, Gleysolics and water) of seeps, potholes and drains, mainly in DVBV6/4. Occasional inclusions are slopewash or stratified fan soils (MFT and TDCv), thin Black soils (BZR), Dark Gray Luvisols (LTC), finer textured variants in DVBV6/5-6, and Eutric or Dystric Brunisols.

DVBV9 (Dunvargan-Beauvais) Soil Unit

DVBV9 is a compound soil unit encompassing ice contact parkland landscape dotted with potholes, sloughs and drains. It occurs on the Beauvais Lake Upland (Fig. B12), in areas classed as agroclimate 5H although grassland segments may be considered 4H. Vegetation is dominantly aspen forest with native grassland patches on southerly aspects across upper slopes and crests.

The unit is characterized by four major soil groups. Orthic Black DVG (Dunvargan) series and kDVG (paraskeletal) variant form one group (20-30%). Orthic Dark Gray BVA (Beauvais) series and kBVA (paraskeletal) variant constitute the second, also at 20-30%. Coarser textured variants of both groups, mainly loamy-skeletal soils like OTP (Outpost), are significant to codominant (20-30%). Wet soils of the potholes, sloughs and drains are also significant to codominant (15-30%). This last group ranges from imperfectly drained Gleyed subgroups related to DVG and BVA, through Gleysolic soils like POT (Pothole Creek), to small water bodies such as sloughs.

The DVG and BVA series are developed in moderately calcareous, medium textured (CL-L, 2-15% coarse fragments), continental and mixed origin tills. The kDVG and kBVA variants are developed in moderately to strongly calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain tills. The coarser textured variants occur mainly in moderately to strongly calcareous, very gravelly to cobbly (35-60% coarse fragments), coarse to medium textured (mainly SL-L), glaciofluvial (ice contact) deposits, perhaps fluvial mudflow in a few cases. Parent materials in the wet depressions tend to be finer textured than the surrounding upland drift.

Occasional inclusions are Dark Gray Luvisols (LTC), finer textured variants, thin Black soils (BZR), slopewash soils (MFT), and Eutric Brunisols.

Only one DVBV9 map unit was recognized.

DVBV9/4-5: 2000 ha (5000 ac); hummocky, occasionally superimposed on an incline. Slopes mainly 5-15%; topography classes 3 and 6 sometimes included. One tract near Maycroft thought to include substantial mudflow and other fluvial products besides mountain till, all strongly to very strongly calcareous.

DVFS1 (Dunvargan-Fish Creek) Soil Unit

DVFS1 is a compound soil unit characterized by landforms of mixed till and glaciolacustrine materials. It occurs on the Beauvais Lake Upland (Fig. B14) and Goose Lake Bench. The majority of DVFS1 is associated with areas classed as agroclimate 4H, but a significant proportion occurs on the Goose Lake Bench in agroclimate 3H. Both classes are equated with the distribution of thick Black soils. Cultivation is common but some areas have been left in native grassland or aspen forest.

DVG (Dunvargan) series, at 20-50% overall, and kFSH (Fish Creek) taxadjunct, also at 20-50% overall, are the major soils. Both are classed as Orthic Black. Intergrades between the two are common and there is frequently no clear dominant, even in the rougher landscapes. The high lime kDVG (paraskeletal Dunvargan) variant is the dominant soil in

two tracts north of Burmis. One large tract in the Spread Eagle area, associated with agroclimate class 5H, is dominated by Orthic Dark Gray soils.

The DVFS1 soil unit is characterized by a mixture of continental or mixed origin till and glaciolacustrine deposits with few clear sequences or boundaries. Fine materials are even found on elevated portions of the terrain - positions that suggest supraglacial origin, or a till derived from argillaceous bedrock. The predominant till is moderately calcareous and medium textured (CL-SiCL, 2-15% coarse fragments); in two tracts north of Burmis, the till is strongly to very strongly calcareous and gravelly (15-35% coarse fragments). The glaciolacustrine (lacustro-till) deposits are moderately to strongly calcareous and fine textured (mainly C-SiC-HC, 2-15% coarse fragments). DVG series and variants are developed in the medium textured tills, kFSH taxadjunct in the fine textured deposits.

Two DVFS1 map units were recognized.

DVFS1/3: 1600 ha (3900 ac); undulating, occasionally with inclined or hummocky segments. Slopes mainly 2-5%; topography classes 2 and 4 usually included, sometimes significant. One large tract in the Spread Eagle area is dominated by fine textured Orthic Dark Gray soils and BVA (Beauvais) series.

DVFS1/4: 3600 ha (8900 ac); hummocky or undulating, occasionally ridged, often superimposed on an overall incline; occasionally gullied. Slopes mainly 5-9%; topography classes 3 and 5 usually included, sometimes significant 3. Two tracts in the Burmis area dominated by strongly to very strongly calcareous gravelly till.

Recurrent inclusions are wet soils (Gleyed subgroups, Gleysolics and water) of seeps, potholes and drains. Occasional inclusions are the fine textured Orthic Dark Gray soils (dominate a DVFS1/3 tract near Spread Eagle), thin Black soils (BZR and CTN), Calcareous and Rego Black soils, medium textured glaciolacustrine or slopewash soils (MFT), and coarser textured soils (OTP or CRW).

DVFS2 (Dunvargan-Fish Creek) Soil Unit

DVFS2 is a compound soil unit characterized by landforms composed of mixed till and glaciolacustrine materials and dotted with potholes, sloughs and drains. The majority occurs on the Beauvais Lake Upland in areas classed as agroclimate 4H; a few tracts extend into adjacent areas classed as 5H. This distribution spans much of the area of thick Black soils. Cultivation is common but substantial areas have been left in native grassland or aspen forest.

The kFSH (Fish Creek) taxadjunct (20-60%) and DVG (Dunvargan) series (20-50%) are codominant. Both are classed as Orthic Black. Intergrades between the two are common and there is frequently no clear dominant. MFT (Maycroft) series and a MFT-kFSH intergrade sometimes substitute for kFSH, and are significant to codominant in two tracts, one near Marr Lake and the other near Waterton Lakes National Park. Wet soils of the potholes, sloughs and drains are significant (15-25%). This last group ranges from imperfectly drained Gleyed subgroups related to kFSH and DVG, through Gleysolic soils like POT (Pothole Creek), to small water bodies such as sloughs.

The DVFS2 soil unit is characterized by a mixture of continental or mixed origin till and glaciolacustrine deposits with few clear sequences or boundaries. The till is mainly moderately calcareous and medium textured (CL-SiCL, 2-15% coarse fragments). The glaciolacustrine (lacustro-till) deposits are moderately to strongly calcareous and fine textured (mainly C-SiC-HC, 2-15% coarse fragments). DVG series is developed in the till,

kFSH in the glaciolacustrine material. Medium textured (L-SiL-CL) glaciolacustrine deposits are also important in the two tracts listed above.

Occasional inclusions are medium textured glaciolacustrine or slopewash soils such as MFT (significant in the two tracts listed above); solonetzic or related saline variants, often associated with the wet soils; Orthic Dark Gray soils including BVA; coarser textured variants (OTP or CRW); and thin Black soils (BZR and CTN).

Only one DVFS2 map unit was recognized.

DVFS2/3: 1250 ha (3100 ac); undulating to inclined. Slopes mainly 2-5%; topography classes 2 and 4 usually included, sometimes significant.

DVFS3 (Dunvargan-Fish Creek) Soil Unit

DVFS3 is a compound soil unit of the Beauvais Lake Upland (Fig. B13, B14) and Goose Lake Bench that features significant saline soils in mixed till-glaciolacustrine materials. It occurs in areas classed as agroclimate 4H and 3H, the latter on the Goose Lake Bench. Both classes are equated with the distribution of thick Black soils. Cultivation is common but some areas have been left in native grassland.

DVG (Dunvargan) series (20-50%) and kFSH (Fish Creek) taxadjunct (20-50%) are codominant. Both are classed as Orthic Black. Intergrades between the two are common and there is frequently no clear dominant. Saline variants like sFSH are significant (15-25%).

The DVFS3 soil unit is characterized by a mixture of continental or mixed origin till and glaciolacustrine deposits with few clear sequences or boundaries. The till is mainly moderately calcareous and medium textured (CL-SiCL, 2-15% coarse fragments). The glaciolacustrine (lacustro-till) deposits are moderately to strongly calcareous and fine textured (mainly C-SiC-HC, 2-15% coarse fragments). DVG series is developed in the till, kFSH in the glaciolacustrine material. The patchy salinity is classed as weak to moderate; salts show up mainly below about 50 or 60 cm.

Recurrent inclusions are solonetzic variants (Solonetzic Black, Black Solonetz, Solonetzic Gleysol, and others), normally associated with the saline soils, and wet soils (Gleyed subgroups, Gleysolics and water), also associated with the saline variants. Occasional inclusions are medium textured glaciolacustrine or slopewash soils (MFT), thin Black soils (BZR and CTN), and Calcareous and Rego Black variants.

Only one DVFS3 map unit was recognized.

DVFS3/3: 1400 ha (3500 ac); undulating to inclined, occasionally with hummocky segments; sometimes channelled. Slopes mainly 2-5%; topography classes 2 and 4 usually included, sometimes significant.

DVG1 (Dunvargan) Soil Unit

DVG1 is a simple soil unit encompassing morainal grassland landscape on the Beauvais Lake Upland (Fig. B13, B14), Goose Lake Bench and Porcupine Hills. The majority occurs in areas classed as agroclimate 4H, but a significant proportion occurs on the Goose Lake Bench in agroclimate 3H. Both classes are equated with the distribution of thick Black soils. Roughly equal proportions have been cultivated versus left in native grassland.

The Orthic Black DVG (Dunvargan) series, or the high lime kDVG (paraskeletal) variant in some cases, is the dominant soil (30-70%). DVG is developed in moderately calcareous,

medium textured (CL-SiCL-L, 2-15% coarse fragments), continental or mixed origin till; the variant in strongly to very strongly calcareous, gravelly (15-35% coarse fragments), mountain till.

Finer textured soils like kFSH (Fish Creek) taxadjunct are important (5-40%) in over half of the tracts mapped as DVG1/5R. The moderately calcareous fine textured (C, 2-15% coarse fragments) material may be shallow glaciolacustrine sediments of supraglacial origin, or clay till derived from argillaceous bedrock.

Six DVG1 map units were recognized.

DVG1/3: 1300 ha (3200 ac); undulating, often superimposed on an overall incline. Slopes mainly 2-5%; topography classes 2 and 4 often included, sometimes significant.

DVG1/4: 900 ha (2200 ac); hummocky terrain. Slopes mainly short and 5-9%; class 3 topography often included, sometimes significant.

DVG1/4D: 750 ha (1800 ac); long inclined slopes, often with superimposed hummocky segments; usually gullied. Slopes mainly 5-9%; topography classes 3 and 5 often included, sometimes significant. High lime kDVG (paraskeletal) variant is important in several tracts north of Burmis.

DVG1/4R: 700 ha (1800 ac); blanket or deeper (estimated at 1-5 m) over ridged to hummocky bedrock. Slopes moderately long and mainly 5-9%; topography classes 3 and 5 often included, sometimes significant. High lime kDVG (paraskeletal) variant is important in one tract in the Lees Lake area.

DVG1/5D: 1000 ha (2500 ac); long inclined slopes, often with a superimposed hummocky element; usually gullied. Slopes mainly 9-15%; topography classes 4 and 6 often included, sometimes significant. In several tracts the incline is controlled in part by bedrock. High lime kDVG (paraskeletal) variant is important in some tracts north of Burmis.

DVG1/5R: 1450 ha (3600 ac); blanket or deeper (estimated at 1-5 m) over ridged to hummocky bedrock. Slopes moderately long, mainly 9-15%; topography classes 4 and 6 often included, sometimes significant. Finer textured variants like kFSH significant to dominant in over half the tracts. High lime kDVG (paraskeletal) variant is important in one tract north of Burmis.

Recurrent inclusions in at least one of the map units are:

* thin Black soils (BZR), found mainly on southerly aspects or knoll crests (significant in a few tracts);
* finer textured variants (kFSH) especially on smoother terrain (DVG1/3, DVG1/4D), and in DVG1/5R;
* coarser textured variants, mainly loamy-skeletal soils like OTP, mainly in DVG1/4R;
* wet soils (Gleyed subgroups, Gleysolics and water) of potholes, sloughs, seeps, and drains, especially on gentler topography (DVG1/3, DVG1/4, DVG1/4D); and
* shallow lithic soils (OKYv and kOKY) in DVG1/4R and DVG1/5R.

Occasional inclusions are Calcareous and Rego Black soils in DVG1/4D, DVG1/4R, DVG1/5D, and DVG1/5R; Orthic Dark Gray soils (BVA and kBVA) in DVG1/4D, DVG1/4R, DVG1/5D, and DVG1/5R; slopewash soils (MFT) on lower parts of inclined slopes in DVG1/4D and DVG1/5D; and saline plus solonetzic variants in DVG1/3 only.

DVG2 (Dunvargan) Soil Unit

DVG2 is a compound soil unit featuring morainal grassland landscape dotted with potholes, sloughs and drains on the Beauvais Lake Upland (Fig. B12, B14) and Goose Lake

Bench (Fig. B9). The majority occurs in areas classed as agroclimate 4H, but a significant proportion occurs on the Goose Lake Bench in agroclimate 3H. Both classes are equated with the distribution of thick Black soils. Cultivation is common but substantial areas have been left in native grassland. Wet locales are often marked by patches of willow.

The Orthic Black DVG (Dunvargan) series is dominant (40-60%). Its parent material is moderately calcareous, medium textured (CL-SiCL-L, 2-15% coarse fragments), continental and mixed origin till. Wet soils of the potholes, sloughs and drains are significant at 15-25%. This group ranges from imperfectly drained Gleyed subgroups related to DVG, through Gleysolic soils like POT (Pothole Creek), to small water bodies such as sloughs. Parent materials in the depressions tend to be a bit finer textured than the surrounding upland till.

Two DVG2 map units were recognized.

DVG2/3: 1150 ha (2900 ac); undulating with some hummocky segments. Slopes mainly 2-5%; class 4 topography often significant.

DVG2/4: 8600 ha (21 200 ac); mainly hummocky. Slopes mainly 5-9%; topography classes 3 and 5 often included, sometimes significant. Medium textured glaciolacustrine and fluvial soils (mainly MFT) are significant in one tract near Waterton Reservoir and two tracts in the Burmis area. Fine textured glaciolacustrine soils (kFSH) are significant in two tracts in the Marr Lake area.

Recurrent inclusions are finer textured variants, including glaciolacustrine (kFSH) or clay till soils (significant in two DVG2/4 tracts listed above); and coarser textured variants, mainly loamy-skeletal soils like OTP, in DVG2/4. Occasional inclusions are medium textured glaciolacustrine or slopewash soils such as MFT (significant in three DVG2/4 tracts listed above); thin Black soils (BZR); saline or related solonetzic variants, often associated with the wet soils; and Orthic Dark Gray soils (BVA) in DVG2/4 only.

DVG6 (Dunvargan) Soil Unit

DVG6 is a compound soil unit encompassing ice contact grassland landscapes, mainly on the Beauvais Lake Upland. It occurs in areas classed as agroclimate 4H, although a few tracts extend into 5H areas. This distribution spans the area equated with thick Black soils. Vegetation is dominantly native grassland, often with small patches of aspen and willow. Parts of some tracts have been cultivated.

The Orthic Black DVG (Dunvargan) series or kDVG (paraskeletal) variants are the dominant soils (30-60%). Coarser textured variants, mainly loamy-skeletal soils like OTP (Outpost), are significant to codominant (20-30%).

DVG series is developed in moderately calcareous, medium textured (CL-SiCL-L, 2-15% coarse fragments), continental and mixed origin tills. The kDVG variants occur in weakly to very strongly calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain tills. The coarser textured variants occur mainly in weakly to very strongly calcareous, very gravelly to cobbly (35-60% coarse fragments), coarse to medium textured (mainly SL-L), glaciofluvial (ice contact) deposits. Nongravelly and extremely gravelly coarse textured deposits are also included. Low lime parent materials occur occasionally (mainly in the Kesler Lake and Pecten areas); soils formed in them tend to have thick (often >1 m), neutral to acidic sola. High lime parent materials also occur occasionally (mainly in the Burmis area); soils formed in them have fairly thin sola.

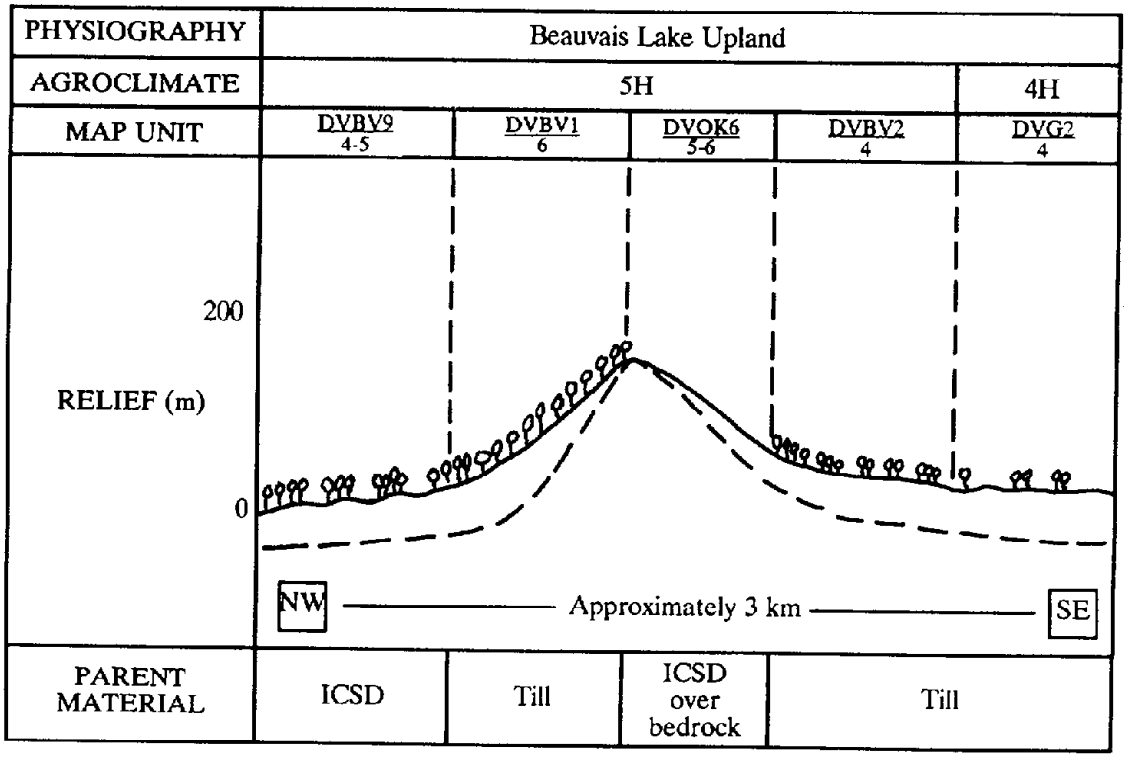


Figure B12. Landscape schematic showing topographic relationships among several map units mapped north of Pecten.

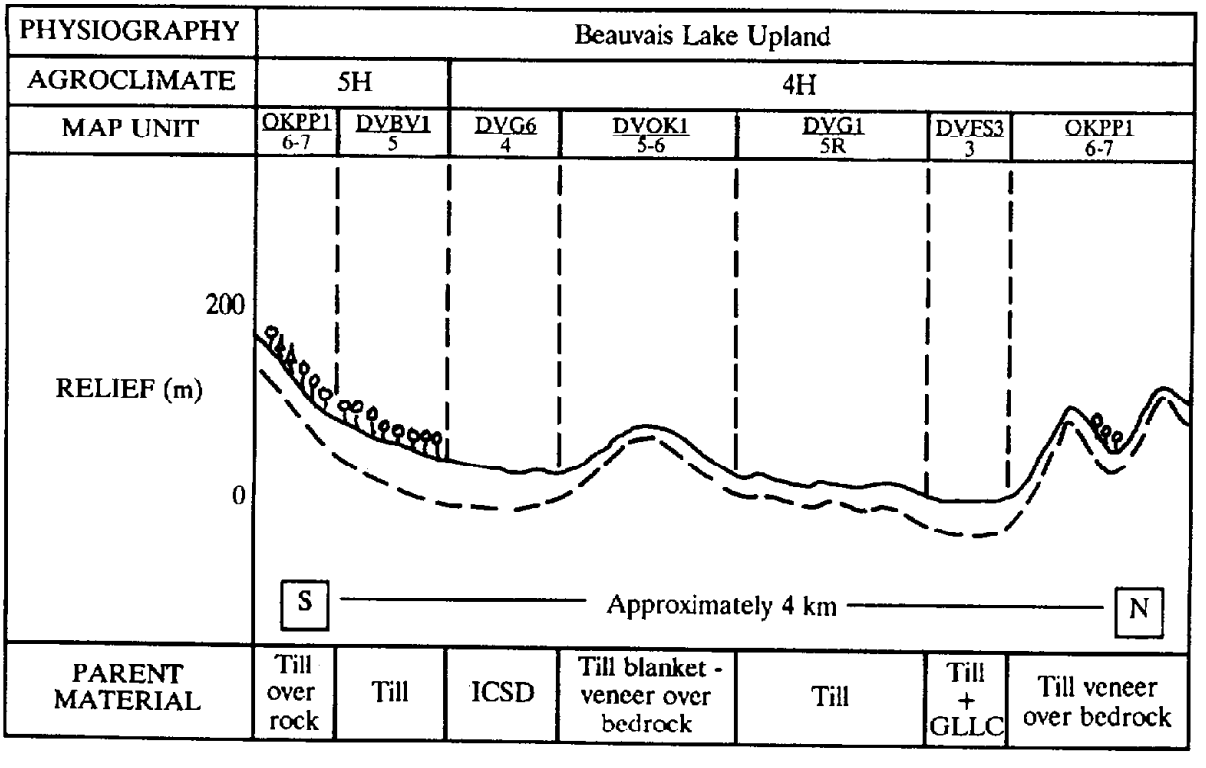


Figure B13. Landscape schematic showing topographic relationships among several map units in the Marna Lake area.

Three DVG6 map units were recognized.

DVG6/4: 1750 ha (4300 ac); hummocky to ridged, occasionally on an overall incline; sometimes gullied. Slopes mainly 5-9%; topography classes 3 and 5 often included, sometimes significant. One tract in Kesler Lake area has low lime parent materials.

DVG6/5: 1250 ha (3100 ac); hummocky to ridged, occasionally on an overall incline; sometimes gullied. Slopes mainly 9-15%; topography classes 4 and 6 often included, sometimes significant. Includes both weakly and strongly calcareous materials in different areas.

DVG6/6: 700 ha (1700 ac); inclined to hummocky or ridged terrain; sometimes gullied. Slopes mainly 15-30%; topography classes 5 and 7 often included, sometimes significant.

Recurrent inclusions are wet soils (Gleyed subgroups, Gleysolics and water) of seeps, potholes and drains mainly in DVG6/4; and thin Black soils (BZR and RFD) mainly in DVG6/6. Occasional inclusions are Orthic Dark Grays (BVA and kBVA); rego variants, mainly Rego and Calcareous Blacks; and slopewash or fluviolacustrine soils (MFT).

DVG9 (Dunvargan-Beauvais) Soil Unit

DVG9 is a compound soil unit encompassing ice contact grassland landscapes dotted with potholes, sloughs and drains. It occurs on the Beauvais Lake Upland (Fig. B14, B15), in areas classed as agroclimate 4H. This class is equated with the distribution of thick Black soils. Vegetation is dominantly native grassland, often with patches of willow and aspen. The willow often mark wet locales.

The unit is characterized by three major soil groups. Orthic Black DVG (Dunvargan) series is dominant (30-50%). Coarser textured variants, mainly loamy-skeletal soils like OTP (Outpost), are significant to codominant (20-30%). Wet soils of the potholes, sloughs and drains are also significant to codominant (15-25%). This last group ranges from imperfectly drained Gleyed subgroups related to DVG, through Gleysolic soils like POT (Pothole Creek), to small water bodies such as sloughs.

DVG series is developed in moderately calcareous, medium textured (CL-SiCL-L, 2-15% coarse fragments), continental and mixed origin tills. The coarser textured variants occur mainly in moderately to strongly calcareous, very gravelly to cobbly (35-60% coarse fragments), coarse to medium textured (mainly SL-L), glaciofluvial (ice contact) deposits, or perhaps fluvial mudflow in a few cases. Parent materials in the wet depressions tend to be finer textured than the surrounding upland drift. Overall, carbonate content may vary somewhat and gravelly mountain till is important in only one or two tracts.

Two DVG9 map units were recognized.

DVG9/4: 1850 ha (4500 ac); hummocky to ridged; occasionally gullied. Slopes mainly 5-9%; topography classes 3 and 5 often included, sometimes significant.

DVG9/5: 3150 ha (7800 ac); hummocky to ridged; occasionally gullied. Slopes mainly 9-15%; topography classes 4 and 6 often included, sometimes significant.

Occasional inclusions are thin Black soils (BZR and RFD), Orthic Dark Gray soils (BVA and kBVA), finer textured variants (kFSH), and slopewash soils (MFT).

DVMF1 (Dunvargan-Maycroft) Soil Unit

DVMF1 is a compound soil unit of the Porcupine Hills (Fig. B1) and Beauvais Lake Upland that features mixed morainal and fluvial or glaciolacustrine landforms. It occurs

in areas classed as agroclimate 4H, equated with the distribution of thick Black soils. All of some tracts and parts of others have been cultivated. Where uncultivated, vegetation is native grassland, often with small patches of aspen and willow.

DVG (Dunvargan) series (30-50%), and MFT (Maycroft) series (30-50%), are the major soils. Both are classed as Orthic Black. Either may dominate and intergrades between the two are common.

The unit is most often typified by fluvial or fluviolacustrine fan and apron deposits overlying continental or mixed origin till; less often by a mixture of till and glaciolacustrine deposits with few clear sequences or boundaries. The till is mainly moderately calcareous and medium textured (CL-SiCL-L, 2-15% coarse fragments), sometimes strongly to very strongly calcareous and gravelly (15-35% coarse fragments). The water-laid deposits are moderately to strongly calcareous and medium textured (mainly L-SiL-CL, <2% coarse fragments). Similar versions may have a few fine gravels. DVG series is developed in the till, MFT in the water-laid deposits.

Recurrent inclusions are thin Black soils (BZR and SOF) and wet soils (Gleyed subgroups, Gleysolics and water) of seeps, potholes and drains. Occasional inclusions are coarser textured variants (OTP or CRW), Calcareous and Rego Black variants, fine textured soils (kFSH), and soils with very thick Ah horizons (rPPE).

Only one DVMF1 map unit was recognized.

DVMF1/3D: 1300 ha (3200 ac); discontinuous fluvial (or fluviolacustrine) apron to blanket (to veneer) over undulating to inclined till on valley bottoms; dissected by channels and gullies. Slopes mainly 2-5%; class 4 topography often significant. Tracts in the Hatfield Hill-Pine Ridge area are undulating to hummocky till plus glaciolacustrine deposits.

DVOK1 (Dunvargan-Ockey) Soil Unit

DVOK1 is a compound soil unit that features till overlying bedrock ridges and hills of the Southern Foothills (Fig. B14) and Porcupine Hills. It occurs in areas classed as agroclimate 4H, sometimes extending into areas of 5H. These are equated with the distribution of thick Black soils. Vegetation is mainly native grassland, occasionally with small patches of aspen and shrubs.

Orthic Black DVG (Dunvargan) series, or kDVG (paraskeletal) variants are the dominant soils (30-60%). Shallow lithic Orthic Blacks, mainly OKYv and kOKY (climatic and paraskeletal Ockey) variants, form the significant group (15-30%).

All the major soils are developed in a variety of tills. The tills vary from weakly to strongly calcareous and from slightly gravelly to gravelly (2-35% coarse fragments). Medium textures (CL-SiCL-L-SCL) reflect local bedrock, especially amongst the mountain tills. In a few areas fine textured (C) parent material is common; probably a till derived from local argillaceous bedrock. Across upper slopes and crests the till is shallow, overlying residual material and bedrock. The residuum, when present, ranges from non- to very strongly calcareous, nongravelly to very gravelly. It is weathered from shale or sandstone. Overall, most materials are moderately calcareous.

Occasional inclusions that are significant in a few tracts include thin Black soils which resemble BZR (Beazer) and fine textured soils somewhat like kFSH (Fish Creek). The thin Black soils are most common in tracts located in the Connelly Creek area, a par-

ticularly dry part of the foothills. Other occasional inclusions are bedrock outcrops (low areal extent in almost all tracts); coarser textured variants, mainly loamy-skeletal soils (OTP); rego variants, including Rego and Calcareous Blacks plus Brunisols; Rego Black soils developed in deep fluvioeolian deposits (rPPE); and Orthic Dark Gray soils (BVA and kBVA).

Only one DVOK1 map unit was recognized.

DVOK1/5-6: 3450 ha (8500 ac); blanket to veneer over ridged or hummocky, occasionally inclined, bedrock; sometimes gullied. Slopes mainly 9-30%; topography classes 4 and 7 often included.

DVOK6 (Dunvargan-Ockey) Soil Unit

DVOK6 is a compound soil unit that features ice contact deposits overlying bedrock ridges and hills, mainly of the Beauvais Lake Upland (Fig. B12). Two tracts are located in the Front Ranges. The vast majority occurs in areas classed as agroclimate 4H; a few tracts occur in the warmest parts of areas classed as 5H, usually on southerly aspects. Climatically, the unit is equated with the distribution of thick Black soils. Vegetation is mainly native grassland, occasionally with small patches of aspen and shrubs.

All the major soils are classified as Orthic Black. DVG (Dunvargan) series or kDVG (paraskeletal) variants are the dominant soils (30-50%). Coarser textured variants, mainly loamy-skeletal soils like OTP (Outpost) and shallow lithic OTP, are significant to codominant (20-30%). Shallow lithic till soils, mainly OKYv and kOKY (climatic and paraskeletal Ockey) variants, form the other significant group (15-25%).

The DVG and OKY soils, including variants, are developed in a variety of tills. The tills vary from weakly to strongly calcareous and from slightly gravelly to gravelly (2-35% coarse fragments), and are mainly medium textured (CL-L-SCL). The coarser textured variants occur in weakly to very strongly calcareous, very gravelly to cobbly (35-60% coarse fragments), coarse to medium textured (mainly SL-L), glaciofluvial (ice contact) deposits. Across upper slopes and crests, the till or ice contact materials are shallow, overlying residual material and bedrock. The residuum, when present, ranges from non- to very strongly calcareous, nongravelly to very gravelly. It is weathered from shale or sandstone. Overall, most materials are moderately to strongly calcareous.

Occasional inclusions are Orthic Eutric Brunisols with very thin Ah horizons, thin Black soils (BZR and RFD), Rego Black soils developed in deep fluvioeolian deposits (rPPE), and bedrock outcrops.

Only one DVOK6 map unit was recognized.

DVOK6/5-6: 2250 ha (5600 ac); blanket to veneer over ridged or hummocky, occasionally inclined, bedrock; sometimes gullied. Slopes mainly 9-30%; topography classes 4 and 7 often included.

FRK1 (Frank) Soil Unit

FRK1 is a compound soil unit encompassing steep colluvial slopes of the High Rock Ridges (Fig. B16). It occurs in areas classed as agroclimates 6H to 7H, extending from Montane into Subalpine ecoregions (Pettapiece *et al.* 1980). Vegetation is mixed coniferous forest, mainly lodgepole pine with Douglas fir at lower elevations, with spruce and subalpine fir at higher elevations.

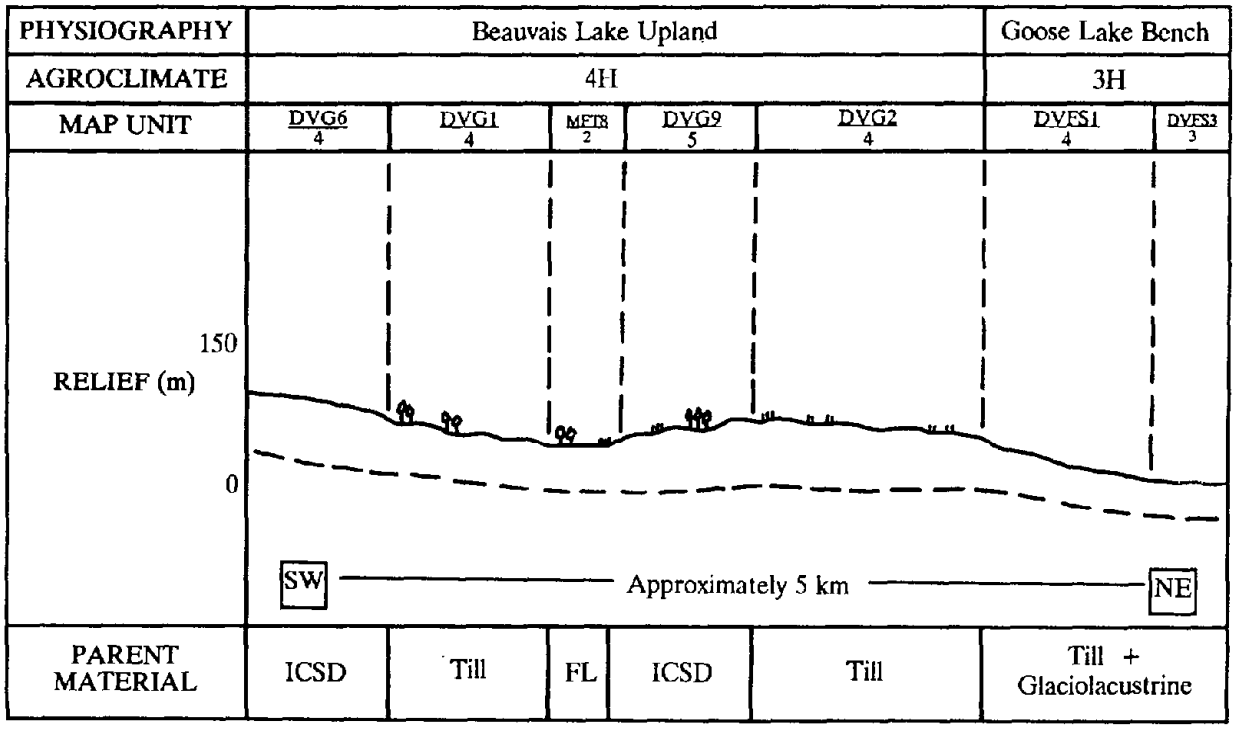


Figure B14. Landscape schematic showing topographic relationships among several map units of the Lynch Lakes area.

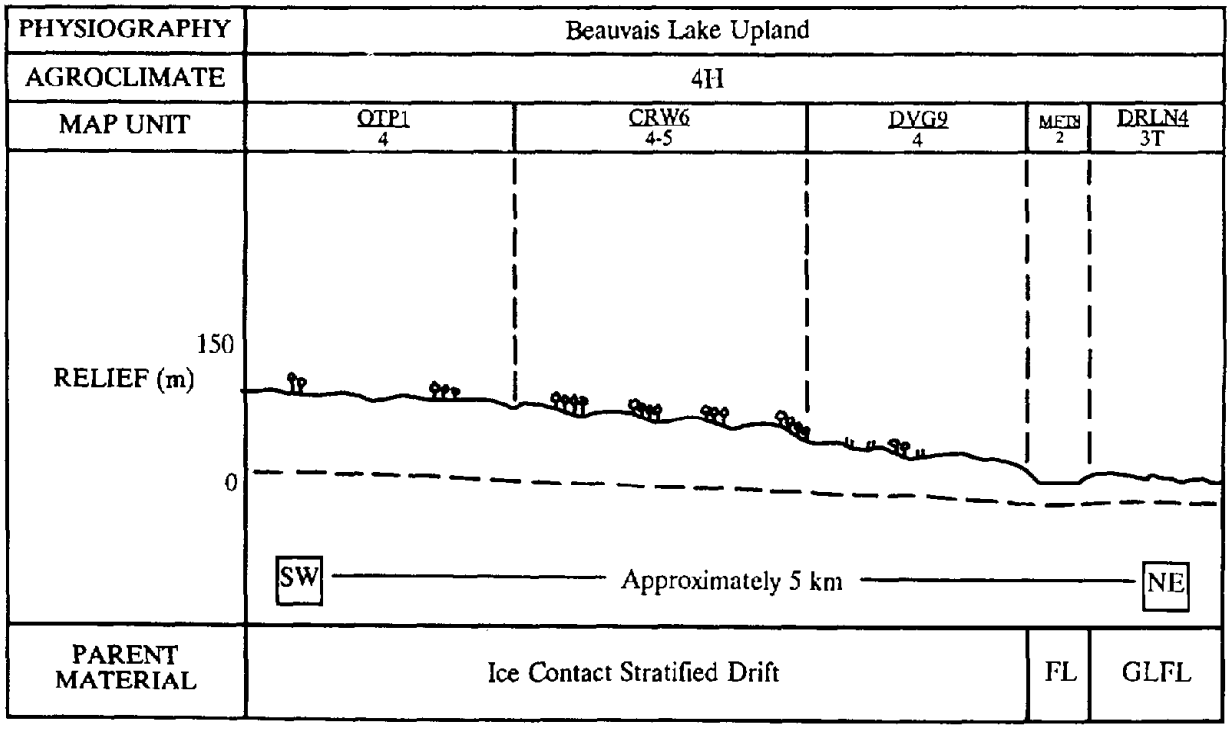


Figure B15. Landscape schematic showing topographic relationships among several map units of the Park View area.

The Orthic Eutric Brunisol FRK (Frank) series plus weakly, moderately, or extremely calcareous versions are the dominant soils (30-50%). The lFRK (shallow lithic) variant is significant (15-30%). The colluvium is normally very gravelly to cobbly (35-60% coarse fragments) and coarse to medium textured (SL-L-SiL), but varies from weakly to extremely calcareous. Strongly to extremely calcareous deposits are the rule. Coarse fragments and underlying bedrock are mainly limestones.

Recurrent inclusions are Regosolic soils, mainly Orthic and Cumulic subgroups of the Regosol and Humic Regosol great groups; various till soils (SPR, WLB or similar versions) on lower slopes and gentler terrain; and bedrock outcrops. Occasional inclusions are non- to weakly calcareous soils, sometimes found on lower slopes in association with noncalcareous bedrock, and grassland or avalanche chute soils with humus-rich upper sola.

Only one FRK1 map unit was recognized.

FRK1/8-9: 950 ha (2300 ac); blanket to veneer over inclined bedrock; apron at the base of some tracts. Slopes mainly 45-100%. A tract on the slope of Mt. Tecumseh has some avalanche tracks; another on Sentry Mtn. has gullies.

FRK4 (Frank) Soil Unit

FRK4 is a compound soil unit encompassing steep, rocky, colluvial slopes of the High Rock Ridges (Fig. B16). It occurs in areas classed as agroclimates 6H to 7H, extending from Montane to Subalpine ecoregions (Pettapiece *et al.* 1980). Vegetation is open coniferous forest, mainly lodgepole pine and Douglas fir, or shrubland.

The Orthic Eutric Brunisol FRK (Frank) series and lFRK (shallow lithic) variant, or similar low lime or high lime soils, are the dominant group (40-60%). Various Regosolic soils, mainly Orthic Regosols or Humic Regosols on higher slopes and Cumulic Regosols or Humic Regosols on lower slopes, are significant (20-30%).

The colluvium is normally very gravelly to cobbly (35-60% coarse fragments) and coarse to medium textured (SL-L-SiL), but varies from weakly to extremely calcareous. Strongly to extremely calcareous deposits are the rule. The coarse fragments and underlying bedrock are mainly limestones.

The only recurrent inclusion is bedrock outcrop. Occasional inclusions are non- to weakly calcareous soils, sometimes found on lower slopes in association with noncalcareous bedrock; till soils (SPR, WLB or similar versions) on lower slopes and gentler terrain; and grassland or avalanche chute soils with humus-rich upper sola.

Only one FRK4 map unit was recognized.

FRK4/8-9: 2100 ha (5200 ac); blanket to veneer over inclined bedrock; apron (talus or fluvial mudflow) at the base of some tracts; occasionally avalanched. Slopes mainly 45 to >100%.

KNT6 (Knight) Soil Unit

KNT6 is a compound soil unit that features ice contact terrain with stratified glaciofluvial soils on the Cow Creek (Fig. B17) and Goose Lake benches. It occurs in areas classed as agroclimate 3H, the coolest part of an area equated with thin Black soils. Roughly equal amounts have been cultivated (some of these areas are irrigated) versus left in grassland.

The Orthic Black KNT (Knight) series is one of the major soils (20-50%). Coarser textured variants such as cKNT or gravelly versions (kKNT) constitute the other major group, also at 20-50% overall.

KNT is developed in moderately calcareous, coarse textured (SL, <2% coarse fragments), glaciofluvial deposits. The coarser textured soils are distinctly or subtly stratified. Most have sandy (LS-S) layers at depth, others have gravelly layers throughout or at depth. Calcareousness may vary from weak to strong.

Two KNT6 map units were recognized.

KNT6/3: 350 ha (900 ac); undulating or terraced. Slopes mainly 2-5%; class 4 topography usually included, sometimes significant.

KNT6/4: 550 ha (1400 ac); hummocky, sometimes on an overall incline or with undulating segments; occasionally gullied. Slopes mainly 5-9%; class 3 topography often included, sometimes significant.

Recurrent inclusions are Rego and Calcareous Black variants, mainly on eroded knolls (significant in several tracts), and thick Black soils (CRW and cCRW), mainly in KNT6/4. Occasional inclusions are medium textured soils such as SOF and ODM (significant in two KNT6/4 tracts south of Cowley), gravel soils (RND and BFT), till soils (BZR), and wet soils in some depressions (KNT6/4 only).

LNB1 (Lundbreck) Soil Unit

LNB1 is a simple soil unit representing some stream terrace landscapes, mostly in major valleys that cut through the Southern Foothills (Fig. B18). It occurs in areas classed as 4H and 5H agroclimate. Climatically, the unit is equated with the distribution of thick Black soils. Vegetation is mainly native grassland, occasionally with small patches of aspen.

The Orthic Black LNB (Lundbreck) series is the dominant soil (50-60%). It is developed in moderately calcareous, extremely gravelly to cobbly (>60% coarse fragments), coarse textured (LS-S), glaciofluvial gravel. Fewer coarse fragments (40-50%), finer textures (SL), and sandy to silty lenses and bands may also occur. Sometimes the gravel is strongly to extremely calcareous, especially in the Maycroft area. A medium to coarse textured veneer (L-SL-SiL) sometimes covers the gravel. Soils with greater than 30 cm of the veneer (DRW, MFT and others) make up 30% or less of the unit.

Soils like DRW and kDRW that have 30-100 cm of medium to coarse textured veneer over the gravel are recurrent inclusions. Occasional inclusions are Rego and Calcareous Black soils (BUR and BURv), Orthic Eutric Brunisols with very thin Ah, till-like soils (kDVG and OTP), Orthic and Calcareous Dark Brown variants, and soils in which the medium textured veneer exceeds 1 m in depth (MFT).

Only one LNB1 map unit was recognized.

LNB1/3T: 400 ha (1000 ac); terraced glaciofluvial terrain near major streams; occasionally contains hummocky locales; sometimes channelled. Tracts consist of single or multiple terrace treads with slopes of 0-5%. Unusually long, steep risers (slopes 9 to >70%) bound most tracts on at least two or three sides and separate multiple treads. The significant amount of risers (20-30%) can hinder vehicular access.

MAC1 (Macleod) Soil Unit

MAC1 is a simple soil unit representing stream terrace landscape along the Oldman R., on the Cowley Basin (Fig. B19), an area classed as agroclimate 2AH. Vegetation is mainly grassland.

Calcareous Dark Brown MAC (Macleod) series and rMAC (Rego Dark Brown) variant are the dominant soils (50-70%). They occur in very strongly calcareous, extremely gravelly to cobbly (>60% coarse fragments), coarse textured (LS-S), glaciofluvial gravel. Fewer coarse fragments (40-50%), finer textures (SL), and sandy to silty lenses and bands may also occur. Sometimes the gravel is strongly or extremely calcareous. A medium textured veneer (mainly L) sometimes covers the gravel.

Soils such as rCFT (rego Crowfoot), with 30-100 cm of medium textured veneer, are recurrent inclusions. Similar soils with more than 1 m of "veneer" over the gravel (DIM and CIO) are also repetitive. Two tracts in the Oldman river valley south of Summerview feature aprons deposited on terraces, and likely have significant to codominant medium textured soils like rCFT, DIM and CIO. Occasional inclusions are nongravelly coarse textured soils (OSN and rOSN), Black soils (rBFT), Regosolic soils, and Orthic Dark Brown soils.

Only one MAC1 map unit was recognized.

MAC1/3T: 450 ha (1100 ac); terraced glaciofluvial terrain near major streams; apron on terraced terrain in two tracts located south of Summerview. Most tracts consist of multiple terrace treads (slopes 0-5%) separated by short steep risers (slopes 5-30%). A few tracts consist of a single large tread bounded by risers. The risers can hinder some uses.

MFT8 (Maycroft) Soil Unit

MFT8 is a compound soil unit characterized by floodplain landscape, mainly along streams that cut through the Southern Foothills (Fig. B4, B14, B15). It occurs in areas classed as agroclimate 4H, sometimes extending into areas classed as 5H. Climatically, the unit is equated with the distribution of thick Black soils. Dry to marginally wet segments are frequently cultivated for forage production. Where uncultivated, cover is grassland, aspen or cottonwood forest, and willow or other wetland vegetation.

The unit is characterized by three major soil groups with different proportions in different tracts. Rego and Calcareous Black rMFT (Maycroft) variants are one major group (20-50%). Wet soils of the lowest lying locales, usually affected by high water tables, are the second major group (10-50%). The most prevalent of these is grMFT (Gleyed Rego Black) variant but various Gleysolic soils and water bodies (sloughs and beaver ponds) are included. The third group - Orthic Black MFT series - ranges from inclusion status (minimum about 5%) in some tracts to dominant (maximum 40%) in others. Any of the three major soils may dominate but at the expense of the other two.

MFT and its variants are developed in moderately calcareous, medium textured (L-SiL-CL, <2% coarse fragments), fluviolacustrine or fluvial deposits. Similar soils developed in materials that are weakly or strongly calcareous, fine textured (C-CL-SiC-SiCL), or contain some gravels (up to 15% coarse fragments not uncommon) may also occur.

Two MFT8 map units were recognized.

MFT8/2: 800 ha (2000 ac); level to undulating, occasionally terraced; sometimes chan-

nelled. Slopes mainly 0-2%; significant class 3 topography. Finer textured variants important in at least one tract (near Lynch Lakes), perhaps others.

MFT8/3: 1500 ha (3700 ac); undulating, fan or apron, level, or terraced; often channelled. Slopes mainly 2-5%; topography classes 2 and 4 often included, sometimes significant. Gravelly to very gravelly (mudflow) soils important in at least two tracts (north of Burmis), perhaps others.

Recurrent inclusions are soils like DRW and rDRW with nongravelly veneers overlying gravel, mainly in MFT8/2. Occasional inclusions are fine textured (C-SiC) variants that resemble rMFT and grMFT (sometimes significant to codominant in MFT8/2), Orthic and Gleyed Dark Gray soils (TDCv and TDC) in MFT8/3, till soils (kDVG or kBVA) in MFT8/3, gravel soils (LNB and BUR) in MFT8/2, and Regosolic soils in MFT8/2.

MGOT5 (McGillivray-Outpost) Soil Unit

MGOT5 is a compound soil unit encompassing ice contact, Montane parkland landscape on benchlands of the Crowsnest R. valley in the Front Ranges (Fig. B4, B5). It occurs in areas classed as agroclimate 5H bordering on 6H. Vegetation is mainly Douglas fir, Douglas fir-lodgepole pine, or Douglas fir-lodgepole pine-aspen forest with patches (20-50% overall) of native grassland.

The unit is characterized by three major soil groups. The Eluviated Eutric Brunisol MGV (McGillivray) series is dominant (30-40%) and occurs under forest. Another group - Orthic Black OTP (Outpost) series and Calcareous Black rOTP variant - are associated with the grassland patches. These range from inclusion status (minimum about 5%) in some tracts to significant (maximum 25%) in others. Finer textured variants of both groups, but especially the grassland soils, constitute the third group. These also range from inclusion status (minimum about 5%) to significant (maximum 30%). Identified soils of the last group include kDVG (Dunvargan) variant and a fine textured version of OTP.

The till-like landforms of MGOT5 are composed mainly of strongly to very strongly calcareous, very gravelly to cobbly (35-60% coarse fragments), medium to coarse textured (L-SL), glaciofluvial (ice contact) deposits. Finer textured variants are developed in till or till-like deposits that contain fewer coarse fragments (15-35%) than the glaciofluvial material, especially in upper horizons.

Recurrent inclusions are Orthic Gray Luvisols similar to MGV, namely SPRr and kSPR (thin and skeletal Spruce Ridge) variants, and Rego Black gravel soils such as BUR. Occasional inclusions are Orthic Eutric Brunisols (MGVv), shallow lithic variants, Orthic Dark Gray and Dark Gray Luvisol soils (all with Ahe horizons), wet soils of depressional sites, slopewash soils (MFT or TDC), and bedrock outcrops.

Only one MGOT5 map unit was recognized.

MGOT5/5R: 1100 ha (2800 ac); blanket or deeper (estimated at 1-5 m) over hummocky to ridged bedrock; often channelled. Slopes mainly 9-15%; topography classes 4 and 6 usually included, sometimes significant. Two tracts near Blairmore lack bedrock control.

ODM6 (Oldman) Soil Unit

ODM6 is a compound soil unit that features eroded Black soils in ice contact terrain, mainly on the Cardston Plain (Fig. B20). The vast majority occurs in areas classed as

agroclimate 3H, a few tracts in areas of subclass 2HA. Both are equated with the distribution of thin Black soils. Cultivation is widespread.

The Rego Black ODM (Oldman) series and related Calcareous Black rSOF (Standoff) variant constitute a major soil group (20-50%). Coarser textured soils such as Rego and Calcareous Black rKNT (Knight) variants, or gravelly versions, form the other major group at 15-40% overall.

The ice contact terrain is comprised of mixed glaciolacustrine and glaciofluvial deposits in most cases. ODM and rSOF are developed in strongly calcareous, medium textured (L-SiL-CL, <2% coarse fragments), glaciolacustrine deposits. The coarser textured soils occur mainly in coarse textured (SL, <2% coarse fragments) glaciofluvial sediments. Others have sandy (LS-S) layers at depth, still others have gravelly layers at depth or gravel fragments scattered throughout. Calcareousness may vary from moderate to very strong. A tract in the Lundbreck area features mounds of medium and coarse textured ice contact deposits lying on a flatter surface formed by fine textured glaciolacustrine material.

Two ODM6 map units were recognized.

ODM6/3: 800 ha (2000 ac); undulating, occasionally terraced. Slopes mainly 2-5%; topography classes 2 and 4 usually included, sometimes significant.

ODM6/4: 1250 ha (3000 ac); hummocky, sometimes on an overall incline or with undulating segments; occasionally gullied. Slopes mainly 5-9%; class 3 topography often included, sometimes significant. Fine textured soils like rCWY and CWY (Cowley) are important in one tract near Lundbreck. Calcareous Black rSOF and Orthic Black SOF (Standoff) important in some small tracts along the Oldman R. near Tanner.

Recurrent inclusions are Orthic Black soils (SOF and KNT) and finer textured soils (CWY and rCWY). Occasional inclusions are thick Black soils (MFT and CRW), gravel soils (BFT and RND) in ODM6/3, till soils (BZR and PSO) in ODM6/4, and wet soils of depressions.

OKNF1 (Ockey-North Fork) Soil Unit

OKNF1 is a compound soil unit that features shallow till overlying bedrock ridges and hills of the Byron-Carbondale Hills and adjacent parts of the Beauvais Lake Upland (Fig. B10, B11). Two other tracts with similar appearance but somewhat different soil patterns are located in the Front Ranges near Crowsnest Pass. The majority occurs in areas classed as agroclimate 4H, notably north of the Crowsnest R. Several tracts occur in areas classed generally as agroclimate 5H but are situated on warm, dry, usually south facing slopes that might be considered as belonging to 4H. Vegetation is mainly native grassland, occasionally with patches of aspen and shrubs.

The unit is characterized by three major soil groups. Shallow lithic Orthic Blacks, mainly OKYv and kOKY (climatic and paraskeletal) variants, constitute one group and account for 20-40% of the soil unit. A shallow lithic Orthic Eutric Brunisol, NFK (North Fork) series or a climatic variant thereof, is the second major soil (20-30%). NFK is most common across upper slopes and crests, often under low shrub-grassland vegetation, and has very thin Ah (4-9 cm). The third group - deeper variants such as DVG, kDVG, BZR and others - occur where the till is deeper than 1 m, on about 10-30% of the unit. These deeper soils may total up to 40% of a few tracts.

Two tracts near Crowsnest Pass are dominated by soils like NFK occurring under open coniferous forest. They contain few to no Chernozemic or chernozemic-like soils. Deeper till soils are mainly Orthic and Eluviated Eutric Brunisols or Orthic Gray Luvisols.

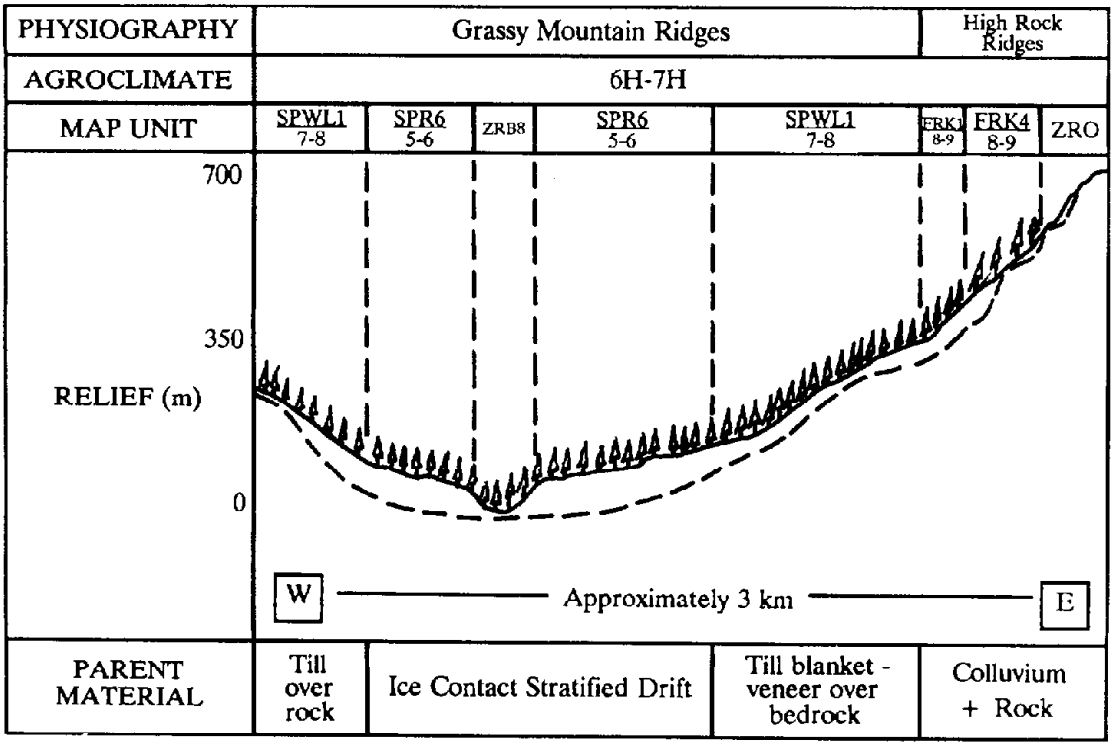


Figure B16. Landscape schematic showing topographic relationships among several map units mapped in the Lyons Cr.-Turtle Mtn. area.

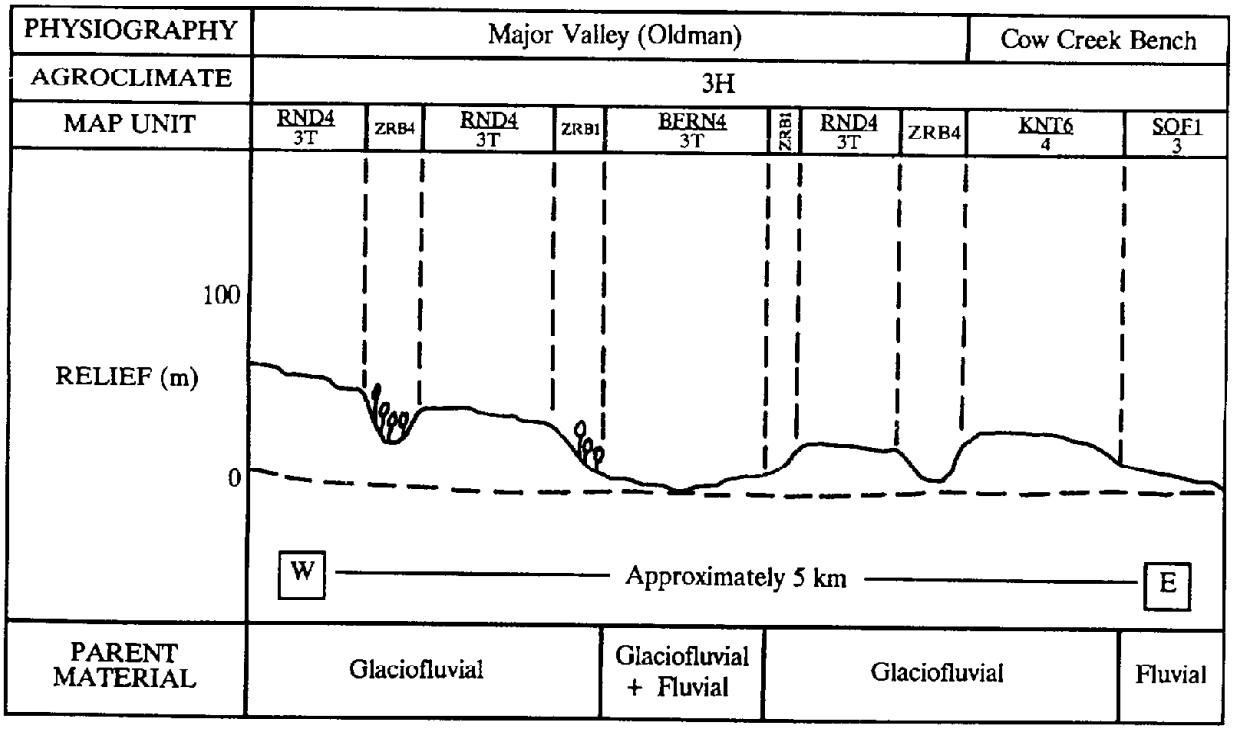


Figure B17. Landscape schematic showing topographic relationships among several map units mapped along the Oldman R. east of Maycroft.

The tills vary from weakly to strongly calcareous and from slightly gravelly to gravelly (2-35% coarse fragments). Medium textures (CL-L-SCL) reflect local bedrock influence. Residual material may be present between overlying till and consolidated bedrock. The residuum, when present, ranges from non- to very strongly calcareous and gravelly to very gravelly. It is weathered from sandstone or shale.

Recurrent inclusions are rego variants, including Rego and Calcareous Blacks plus Regosolics; Rego Black soils developed in deep fluvioeolian deposits (rPPE) and bedrock outcrops. Occasional inclusions are Dark Brown soils (BEVv), skeletal colluvial soils (like FRK), and Orthic and Eluviated Dystric Brunisols in noncalcareous materials under patches of coniferous forest.

Only one OKNF1 map unit was recognized.

OKNF1/6-7: 8950 ha (22 100 ac); veneer to blanket overlying ridged to hummocky, occasionally inclined, bedrock; sometimes gullied. Slopes mainly 15-45%; topography classes 5 and 8 often included. Colluvial soils account for up to 20% of a few tracts but are particularly apparent on steep rocky segments of a few tracts between Burmis and Chapel Butte.

OKPP1 (Ockey-Porcupine) Soil Unit

OKPP1 is a compound soil unit that features shallow till plus deep fluvioeolian deposits overlying prominent, southeast-northwest trending, bedrock ridges of the Beauvais Lake Upland (Fig. B13). The vast majority occurs in areas classed as agroclimate 4H. Two tracts, one near Beauvais Lake, the other near Lees Lake, occur in areas classed generally as 5H. Vegetation is mainly native grassland on southwesterly aspects; grassland, shrubland or aspen forest on northeasterly aspects.

The unit is characterized by two major soil groups. Shallow lithic Orthic Blacks, mainly OKYv and kOKY (climatic and paraskeletal) variants, form one group which accounts for 20-40% of the unit. It occupies southwesterly aspects. Rego Black rPPE (Porcupine) variant is the other major soil (20-40%). It occurs on northeast facing lee slopes.

The OKY soils occur in shallow tills. The tills vary from moderately to strongly calcareous and from slightly gravelly to gravelly (2-35% coarse fragments). Medium textures (CL-L-SCL) reflect local bedrock. Residual material may be present between overlying till and consolidated bedrock. The residuum, when present, ranges from weakly to very strongly calcareous, gravelly to very gravelly. It is weathered from sandstone or shale.

The rPPE variant and similar soils are developed in weakly to strongly calcareous (usually moderate), medium to coarse textured (mainly SL-L, <2% coarse fragments), fluvioeolian material. It originated as wind blown detritus picked up from exposed surfaces on windward slopes. After deposition on lee slopes, the material was subjected to slopewash flow, slumping and soil creep. Thus the soil materials are layered and the soils have very thick Ah horizons. Orthic Eutric Brunisols developed in the same material occur with or substitute for rPPE under mixedwood forest in the two coolest tracts.

Recurrent inclusions are:

* deep thick Black soils (DVG and kDVG),
* shallow lithic Orthic Eutric Brunisols with thin Ah horizons (NFK),
* Orthic Eutric Brunisols developed in fluvioeolian deposits (significant in two tracts), and
* bedrock outcrops on all ridge crests.

Occasional inclusions are Rego variants, including Rego and Calcareous Blacks plus Regosolics; coarser textured variants, mainly loamy-skeletal soils (OTP); and deep thin Black soils (BZR).

Only one OKPP1 map unit was recognized.

OKPP1/6-7: 1800 ha (4500 ac); morainal veneer and fluvioeolian blanket overlying ridged bedrock. Slopes mainly 15-45%; topography classes 5 and 8 often included.

OKY4 (Ockey) Soil Unit

OKY4 is a compound soil unit that features shallow till overlying bedrock ridges and hills of the Porcupine Hills (Fig. B1). It occurs mainly in areas classed as agroclimate 4H, sometimes extending into adjacent areas classed as 3H or 5H. Vegetation is mainly native grassland, occasionally with patches of aspen, Douglas fir, limber pine, and shrubland.

The unit is characterized by three major soil groups. Shallow lithic Orthic Blacks, mainly OKYv and kOKY (climatic and paraskeletal Ockey) variants, constitute one group which accounts for 20-40% of the unit. Rego variants of both shallow lithic and deeper soils form the second major group (20-30%). It consists of Calcareous and Rego Black or Dark Brown soils plus some Regosolics, mainly Orthic Regosol or Orthic Humic Regosol. The third group - deep Orthic Black soils such as DVG and BZR - occur where the till is deeper than 1 m, on about 15-30% of the unit. Other soils in this group are kDVG, kBZR and BZRv (Orthic Eutric Brunisol). All deeper soils may total up to 50% of a few tracts.

The tills vary from moderately to strongly calcareous and from slightly gravelly to gravelly (2-35% coarse fragments). Medium textures (CL-SiCL-SCL-L) reflect local bedrock. Residual material may be present between overlying till and consolidated bedrock. The residuum, when present, ranges from non- to very strongly calcareous and nongravelly to very gravelly. It is weathered from sandstone or shale.

Recurrent inclusions are shallow lithic Orthic Eutric Brunisols (NFK), Rego Blacks developed in deep fluvioeolian deposits (rPPE), and bedrock outcrops. Occasional inclusions are shallow lithic Orthic Dark Grays (kBDY) and Dark Gray Luvisols (LTC or kLTC).

Only one OKY4 map unit was recognized.

OKY4/6-7: 4800 ha (11 900 ac); veneer to blanket over inclined, ridged or hummocky bedrock; sometimes gullied. Slopes mainly 15-45%; topography classes 5 and 8 often included.

OSCF1 (Olsen-Crowfoot) Soil Unit

OSCF1 is a compound soil unit encompassing ice contact terrain along the Oldman R. on the Cowley Basin (Fig. B19), an area classed as agroclimate 2AH. Vegetation is mainly grassland.

Calcareous Dark Brown OSN (Olsen) series is dominant (30-50%). It occurs in very strongly calcareous, coarse textured (SL, <2% coarse fragments), glaciofluvial deposits. The Calcareous Dark Brown rCFT (Crowfoot) variant, commonly occupying knoll tops, is significant (20-40%). It occurs in very strongly calcareous, layered, glaciofluvial deposits. The modal sequence is 30-100 cm of medium textured (L, <2% coarse fragments) veneer overlying extremely gravelly to cobbly (>60% coarse fragments), coarse textured (LS-S) gravel. Fewer coarse fragments (40-50%), finer textures (SL), and sandy to silty lenses and bands may also occur. Sometimes the gravel is strongly or extremely calcareous.

All inclusions are recurrent. These are:

* gravel soils (<30 cm of veneer) such as MAC,
* Rego Dark Brown variants of OSN and rCFT,
* stratified medium over coarse textured soils (OAS),
* Calcareous and Rego Black soils (rKNT or ODM), and
* wet soils, mainly Gleyed subgroups and Gleysolics of the few small depressions.

Only one OSCF1 map unit was recognized.

OSCF1/5: one tract of 200 ha (500 ac); hummocky terrain. Slopes mainly 9-15%; inclusions of topography classes 4 and 6.

OSOA6 (Olsen-Oasis) Soil Unit

OSOA6 is a compound soil unit that features eroded Dark Brown soils in ice contact terrain along the Oldman R. on the Cowley Basin (Fig. B19), an area classed as agroclimate 2AH. Much has been cultivated, some parts have been left in grassland.

The unit is characterized by three major soil groups. Coarse textured Calcareous and Rego Dark Browns, namely OSN (Olsen) series and rOSN (rego) variant, form the dominant group (30-40%). Stratified Calcareous and Rego Dark Brown soils, namely rOAS (Oasis) variants, constitute the second group (20-30%). Coarser textured variants that contain sandy or gravelly layers form the third group, significant at 15-25%. Members of this last group normally occur across knoll and hill tops.

The ice contact terrain is comprised of mixed glaciofluvial deposits. OSN and rOSN are developed in very strongly calcareous, coarse textured (SL, <2% coarse fragments) deposits. The rOAS soils are similar at depth, but have 30-100 cm of medium textured (L-SiL, <2% coarse fragments) veneer. The coarser textured variants are clearly stratified and contain substantial sandy (LS-S) or gravelly (15 to 60% coarse fragments) layers. Gravel soils like MAC or similar soils with a veneer (rCFT) are included in this group. Calcareousness may vary from strong to extreme.

Two OSOA6 map units were recognized.

OSOA6/3: 500 ha (1200 ac); undulating. Slopes mainly 2-5%; topography class 4 usually included, sometimes significant.

OSOA6/4: one tract of 400 ha (1000 ac); hummocky. Slopes mainly 5-9%; significant class 3 topography.

All inclusions are recurrent in at least one map unit. These inclusions are finer textured variants like DIM, CIO and BKE; Calcareous and Rego Black soils like rKNT; and wet soils, mainly Gleyed subgroups and Gleysolics of the few small depressions.

OTBV1 (Outpost-Beauvais) Soil Unit

OTBV1 is a compound soil unit encompassing stony, ice contact, parkland landscapes of the Beauvais Lake Uplands and major river valleys (Fig. B18). It occurs in areas classed as agroclimate 5H although grassland segments may be considered 4H. Vegetation is dominantly native grassland with patches of aspen forest where the soils are less stony.

The unit is characterized by two major soils. Orthic Black OTP (Outpost) series is one major soil, at 20-60% overall, and dominates most tracts. Orthic Dark Gray kBVA (paraskeletal and stony Beauvais) variants constitute the second group, at 15-50% overall.

The kBVA soils are significant in most tracts, codominant to dominant in a few (at the expense of OTP).

The ice contact materials are composed primarily of weakly to moderately calcareous, very cobbly to gravelly or stony (35-60% coarse fragments), coarse to medium textured (SL-L), glaciofluvial deposits. Mountain tills - usually weakly to moderately calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL) deposits - are significant in most tracts. Soils developed in the weakly calcareous deposits, most abundant in the southwest quadrant of the survey area, tend to have thick (often >1 m), neutral to acidic sola. Thinner soils developed in strongly to very strongly calcareous deposits occur in the Maycroft and Blairmore areas. Unusual, very gravelly to gravelly, fine textured (C) deposits are important in a tract located south of Pecten.

Three OTBV1 map units were recognized.

OTBV1/4: 1050 ha (2600 ac); inclined to hummocky, sometimes includes terraces; occasionally channelled or gullied. Slopes mainly 5-9%; topography classes 3 and 5 often included, sometimes significant. Clayey-skeletal and clayey-paraskeletal soils, including Dark Gray Luvisols, are important in one tract near Pecten.

OTBV1/5: 1100 ha (2700 ac); inclined, hummocky or ridged, sometimes includes terraces; occasionally gullied. Slopes mainly 9-15%; topography classes 6 and 4 often included, sometimes significant.

OTBV1/6-7: 1550 ha (3900 ac); inclined, hummocky or ridged; often gullied. Slopes mainly 15-45%; class 5 topography often included. Widest percentage of kBVA soils; barely significant in a few tracts. High lime parent materials common in the Blairmore and Maycroft areas.

Recurrent inclusions are Orthic Black till soils, like kDVG or a similar fOTP variant, and wet soils (Gleyed subgroups, Gleysolics and water) of seeps, potholes and drains. Occasional inclusions are finer textured variants, including glaciolacustrine "plugs" and clayey-skeletal soils (important in one OTBV1/4 tract); Luvisolic soils, mainly Dark Gray Luvisols; coarser textured (extremely gravelly) variants (LNB); Brunisolic soils, mainly Orthic and Eluviated Eutric Brunisols (minor Dystric Brunisols), on the steepest slopes; Dark Brown variants, also on steep slopes; slopewash or stratified fan soils (MFT and TDCv); Orthic Dark Gray till soils (BVA) in OTBV1/4; and rego variants, mainly Rego and Calcareous Black soils.

OTP1 (Outpost) Soil Unit

OTP1 is a simple soil unit featuring stony, ice contact, grassland landscapes of the Beauvais Lake Upland (Fig. B15) and major river valleys. The majority occurs in areas classed as agroclimate 4H; a few tracts in areas classed generally as 5H. Climatically, the unit is equated with thick Black soils. Vegetation is mainly native grassland, often with small patches of aspen forest.

The Orthic Black OTP (Outpost) series is the dominant soil (40-60%). It is developed in moderately calcareous, very cobbly to gravelly or stony (35-60% coarse fragments), coarse to medium textured (SL-L), glaciofluvial (ice contact) deposits. Strongly to very strongly calcareous deposits might occur in the Park View area, but certainly dominate in the Maycroft area. Very to extremely gravelly, very coarse textured (LS-S) deposits are important in two small tracts near Waterton Lakes NP boundary.

Two OTP1 map units were recognized.

OTP1/4: 1200 ha (2900 ac); hummocky to ridged. Slopes mainly 5-9%; topography classes 3 and 5 often included.

OTP1/5: 1400 ha (3500 ac); hummocky, ridged or, occasionally, inclined; sometimes gullied. Slopes mainly 9-15%; topography classes 4 and 6 often included, sometimes significant. Two small tracts near Waterton dominated by sandy-skeletal (LNB) soils.

Recurrent inclusions are:

* Orthic Black till soils (kDVG or DVG),
* Orthic Dark Gray soils (BVA and kBVA),
* thin Black soils (RFD and kBZR),
* sandy-skeletal soils like LNB (dominant in two small tracts near Waterton),
* finer textured variants (MFT and kFSH) developed in small glaciolacustrine "plugs" within the ice contact deposits, and
* wet soils (Gleyed subgroups, Gleysolics and water) of seeps, potholes and drains.

Occasional inclusions are Dark Brown variants.

PSO1 (Parsons) Soil Unit

PSO1 is a simple soil unit encompassing eroded Black soils on morainal terrain of the southern Porcupine Hills. It occurs in areas classed as agroclimate 3H, the coolest part of an area equated with thin Black soils. The vast majority of each tract is cultivated.

The Rego Black PSO (Parsons) series and Calcareous Black rBZR (rego Beazer) variant constitute the dominant group of soils (50-70%). These are associated with moderately to strongly calcareous, medium textured (CL-L, 2-15% coarse fragments), continental or mixed origin tills.

Recurrent inclusions are Orthic Eutric Brunisols like BZRv (sometimes significant), Orthic Black soils (BZR), finer textured variants (CWY and rCWY), and shallow lithic soils (OKY and NFK). Occasional inclusions are coarser textured soils (kBZR and RFD)

Only one PSO1 map unit was recognized.

PSO1/4R: 1000 ha (2400 ac); blanket or deeper (estimated at 1-5 m) over ridged to hummocky bedrock. Slopes moderately long and mainly 5-9% (mostly 7-9%); topography class 5 usually significant.

RND4 (Rinard) Soil Unit

RND4 is a compound soil unit representing some stream terrace landscapes, mostly along major valleys that cut through the Southern Foothills and Cardston Plain (Fig. B17). The vast majority occurs in areas classed as agroclimate 3H; one tract along the Waterton R. near Fishburn occurs in an area classed 2HA. Both classes are equated with the distribution of thin Black soils. Vegetation is mainly grassland.

The Orthic Black RND (Rinard) series is the dominant soil at 40-70%. Calcareous and Rego Black variants, such as rRND variant or BUR (Burmis) series, range from inclusion status (minimum about 5%) in some tracts to codominant (maximum 40%) in others.

The unit's glaciofluvial landforms are composed of moderately to extremely calcareous, extremely gravelly to cobbly (>60% coarse fragments), coarse textured (LS-S), glaciofluvial gravel. Fewer coarse fragments (40-50%), finer textures (SL), and sandy to silty lenses

and bands may also occur. A medium to coarse textured veneer (L-SL-SiL) sometimes covers the gravel. Medium textured and related soils with the veneer (SOF, BFT and others) make up 30% or less of the unit to differentiate it from BFRN4 soil unit.

Soils such as BFT, which have 30-100 cm of medium textured veneer over the gravel, are recurrent inclusions. Occasional inclusions are medium to coarse textured soils (SOF and KNT), where the "veneer" exceeds 1 m in depth, and thick Black soils (LNB and DRW).

Only one RND4 map unit was recognized.

RND4/3T: 1500 ha (3700 ac); terraced glaciofluvial terrain near major streams; terrace treads may have rough surfaces (undulating); often channelled. Most tracts consist of multiple terrace treads (slopes 0-5%) separated by short steep risers (slopes 5-45%). A few tracts consist of a single large tread bounded by risers. The risers and dissections may hinder some uses.

SOBZ1 (Standoff-Beazer) Soil Unit

SOBZ1 is a compound soil unit of the Cardston Plain (one tract in the Porcupine Hills) that features landforms of mixed glaciolacustrine or fluvial plus till materials, mainly on the Goose Lake and Cow Creek benches (Fig. B21). It occurs in areas classed as agroclimate 3H. This is the coolest part of the area equated with thin Black soils. Parts of all tracts have been cultivated, the remainder has been left in grassland.

SOF (Standoff) series or a climatic variant thereof, at 20-40%, and BZR (Beazer) series, also at 20-40%, are the major soils. Both are classed as Orthic Black. Either may dominate (usually SOF) and intergrades between the two are common.

The unit is most often typified by a mixture of glaciolacustrine and till deposits with few clear sequences or boundaries; less often by fluvial or fluviolacustrine fan and apron deposits overlying till. The water-laid deposits are moderately to strongly calcareous and medium textured (mainly L-SiL-CL, <2% coarse fragments). Similar versions may have a few fine gravels. The continental or mixed origin till is mainly moderately calcareous and medium textured (CL-SiCL-L, 2-15% coarse fragments), sometimes strongly calcareous. SOF series is developed in the water-laid deposits, BZR in the till.

Recurrent inclusions are:

* finer textured soils (CTN), which sometimes substitute for BZR;
* coarser textured variants (KNT, BFT and others), substituting for SOF;
* Rego variants, including Rego and Calcareous Black soils and Orthic Eutric Brunisols with very thin Ah; and
* wet soils (Gleyed subgroups, Gleysolics and water) of seeps, potholes and drains.

Occasional inclusions are saline and Solonetzic variants, often associated with the wet soils.

Only one SOBZ1 map unit was recognized.

SOBZ1/3: 1050 ha (2600 ac); undulating terrain; often gullied or channelled. Slopes mainly 2-5%; significant class 4 topography. A tract in the Ashvale area is comprised of discontinuous fluvial or fluviolacustrine apron to blanket over undulating to inclined till in a valley bottom.

SOF1 (Standoff) Soil Unit

SOF1 is a simple soil unit that encompasses various fluviolacustrine, glaciolacustrine and fluvial landscapes of the Cardston Plain (Fig. B21). The majority occurs in areas classed as agroclimate 3H, a few tracts in areas classed as 2HA. Both are associated with the distribution of thin Black soils. Roughly equal proportions have been cultivated versus left in grassland.

The Orthic Black SOF (Standoff) series, or a climatic variant thereof, is the dominant soil (40-70%). SOF is developed in strongly calcareous, medium textured (mainly L-SiL-CL, <2% coarse fragments), fluviolacustrine, glaciolacustrine or fluvial sediments. Similar versions may contain a few fine gravels or be developed in moderately to very strongly calcareous materials.

Recurrent inclusions are coarser textured variants (BFT, KNT, gravelly SOF, RND and others), and thick Black soils like MFT (sometimes significant), representing moister conditions. Occasional inclusions are Rego and Calcareous Black soils (ODM and rSOF); finer textured soils (PNR and CTN); and wet soils plus related saline variants associated with potholes, seeps and high water tables.

Only one SOF1 map unit was recognized.

SOF1/3: 750 ha (1900 ac); apron or fan deposited on terraces or on undulating to level bottomland within a valley; or undulating glaciolacustrine terrain hanging above major valleys. Slopes mainly 2-5%; topography classes 2 and 4 often included, sometimes significant.

SPBE1 (Spruce Ridge-Bellevue) Soil Unit

SPBE1 is a compound soil unit, primarily of the Grassy Mountain Ridges, featuring till overlying bedrock ridges and hills (Fig. B22). It occurs in areas classed as agroclimate 5H and 6H. Vegetation is mainly lodgepole pine or lodgepole pine-Douglas fir forest, with significant Montane grassland on the dry southerly aspects in conjunction with shallow soils.

Orthic Gray Luvisols, namely SPR (Spruce Ridge) series and a thin SPRr taxadjunct, are dominant (30-50%). They are associated with the forested segment. Combined microclimatic and edaphic conditions associated with the grasslands result in significant (15-30%) Orthic Dark Brown and Black soils, namely BEVv (Bellevue till) and kOKY (paraskeletal Ockey) variants.

Deep to shallow mountain tills characterize the unit. Chemically these range from weakly to very strongly calcareous. The lower lime tills reflect local bedrock and are prevalent across the tops of tracts where the soils are shallowest. Carbonate content generally increases downslope, as does till depth, and reflects regional limestone sources. Physically, the tills are mainly gravelly to cobbly (15-35% coarse fragments) and medium textured (L-CL). Residual material may be present between overlying till and consolidated bedrock. The residuum, when present, ranges from non- to weakly calcareous and is usually very gravelly, having been weathered from reasonably hard sandstone or shale.

Recurrent and important inclusions are:

* coarser textured variants, mainly loamy-skeletal soils like kSPR or MGV (sometimes significant), in ice contact deposits on lower slopes;

* Eluviated and Orthic Dystric Brunisols, mainly WLB and WLBv (sometimes significant), on forested lee slopes near the tops of tracts; and
* bedrock outcrops.

Occasional inclusions are shallow lithic Orthic Eutric Brunisols (NFK) associated with the grassland, Eluviated and Orthic Eutric Brunisols occurring in deep till, Dark Gray Luvisol and Orthic Dark Gray soils (kLTC and kBVA), and slopewash (TDCv) plus associated wet soils of seeps (TDC).

Only one SPBE1 map unit was recognized.

SPBE1/6-7: 1800 ha (4500 ac); blanket to veneer over ridged, hummocky or, occasionally, inclined bedrock. Slopes mainly 15-45%; topography classes 5 and 8 often included.

SPLT1 (Spruce Ridge-Leighton Centre) Soil Unit

SPLT1 is a compound soil unit that encompasses forested morainal landscapes, primarily of the Southern Foothills (Fig. B6, B23). These areas are classed as agroclimate 5H and 6H. Vegetation is mainly lodgepole pine or mixedwood forest.

The unit is characterized by two major soil groups. Orthic Gray Luvisols, namely SPR (Spruce Ridge) series and SPRv (thick) variant, form one group at 20-50% overall. Dark Gray Luvisols, namely the kLTC (paraskeletal Leighton Centre) variant, constitute the other at 15-50% overall. The SPR/SPRv group usually dominates the steeper sloping map units (SPLT1/6, SPLT1/7) although kLTC may dominate a few tracts. Conversely kLTC dominates all SPLT1/5 tracts except for two located along Gold Creek near Frank.

The morainal landforms of this unit are comprised of non- to moderately calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain tills. Weakly calcareous materials seem to be most extensive. Soils developed in the low lime deposits tend to have thick (often >1 m), acidic to neutral sola. Carbonate content and till depth tend to increase downslope in many tracts.

Three SPLT1 map units were recognized.

SPLT1/5: 600 ha (1400 ac); inclined, often with superimposed hummocky or ridged locales, occasionally bedrock controlled; sometimes gullied. Slopes mainly 9-15%; topography classes 4 and 6 often included, sometimes significant. Two tracts near Frank (in Front Ranges) dominated by SPRv and SPR soils, the rest by kLTC variant.

SPLT1/6: 1550 ha (3900 ac); inclined, often with superimposed hummocky or ridged locales, or blanket over hummocky and ridged bedrock; often gullied. Slopes mainly 15-30%; topography classes 5 and 7 often included, sometimes significant.

SPLT1/7: 550 ha (1300 ac); gullied inclined terrain, occasionally with a superimposed hummocky element reflecting underlying bedrock. Slopes mainly 30-45%; topography class 6 often included, sometimes significant.

Recurrent inclusions in at least one of the map units are:

* Eluviated Dystric and Eutric Brunisols which resemble SPRv and SPR soils (significant in a few tracts);
* coarser textured variants, mainly loamy-skeletal soils (kSPR);
* Orthic Dark Gray till soils (kBVA); and
* wet soils (Gleyed subgroups and Gleysolics) of seeps, potholes and drains.

Occasional inclusions are shallow lithic soils plus bedrock outcrops, important in SPLT1/6, especially in an area southeast of Gladstone Valley; and various slopewash soils (TDCv).

SPLT9 (Spruce Ridge-Leighton Centre) Soil Unit

SPLT9 is a compound soil unit, of the Beauvais Lake Upland (Fig. B6), that encompasses forested ice contact landscape dotted with sloughs and drains. It occurs in areas classed as agroclimate 5H, perhaps 6H in one or two cases. Vegetation is mainly lodgepole pine or mixedwood forest.

The unit is characterized by four major soil groups. Orthic Gray Luvisols, namely SPR (Spruce Ridge) series and SPRv (thick) variant, commonly form one codominant group (20-30%). Dark Gray Luvisols, namely kLTC (paraskeletal Leighton Centre) variant, are the second codominant group (20-30%). Coarser textured variants of both groups, mainly loamy-skeletal ice contact soils, are also significant to codominant (15-30%). Wet soils of the drains and sloughs are significant (15-25%). The last group ranges from imperfectly drained soils related to SPR and kLTC, through Gleysolic soils like POT (Pothole Creek), to small water bodies such as sloughs.

The moraine-like ice contact landforms of this unit are comprised of mountain tills and glaciofluvial deposits. The tills are mainly gravelly to cobbly (15-35% coarse fragments) and medium textured (L-CL). The glaciofluvial deposits are very gravelly to cobbly (35-60% coarse fragments) and coarse to medium textured (mainly SL-L). Chemically, both range from non- to moderately calcareous. Weakly calcareous materials are the most extensive. Soils developed in the low lime deposits tend to have thick (often >1 m), acidic to neutral sola. Parent materials of the wet depressions tend to be finer textured than materials of surrounding uplands.

Recurrent inclusions are Eluviated Dystric and Eutric Brunisols which resemble the SPRv and SPR soils. Occasional inclusions are Orthic Dark Gray "slopewash" soils (TDCv) and Orthic Dark Gray till soils (kBVA).

Only one SPLT9 map unit was recognized.

SPLT9/4-5: 600 ha (1400 ac); hummocky to ridged ice contact terrain; often gullied or channelled. Slopes mainly 5-15%; topography classes 3 and 6 usually included. One tract located southeast of Gladstone Valley contains less than significant (<15%) coarse textured soils.

SPR1 (Spruce Ridge) Soil Unit

SPR1 is a simple soil unit that encompasses forested morainal landscapes on valley walls and benchlands in the Front Ranges (Fig. B4). It is located in areas classed as agroclimate 6H. Vegetation is mainly lodgepole pine forest.

Orthic Gray Luvisols, namely SPR (Spruce Ridge) series and SPRr (thin) taxadjunct, are the dominant soils (50-70%). These are developed in moderately to very strongly calcareous, gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain tills. Carbonate content generally increases downslope, as does till depth, and reflects regional limestone sources. Also, tills in major valleys such as the Crowsnest tend to have higher lime content than tills of tributary valleys, for example, Blairmore Creek valley.

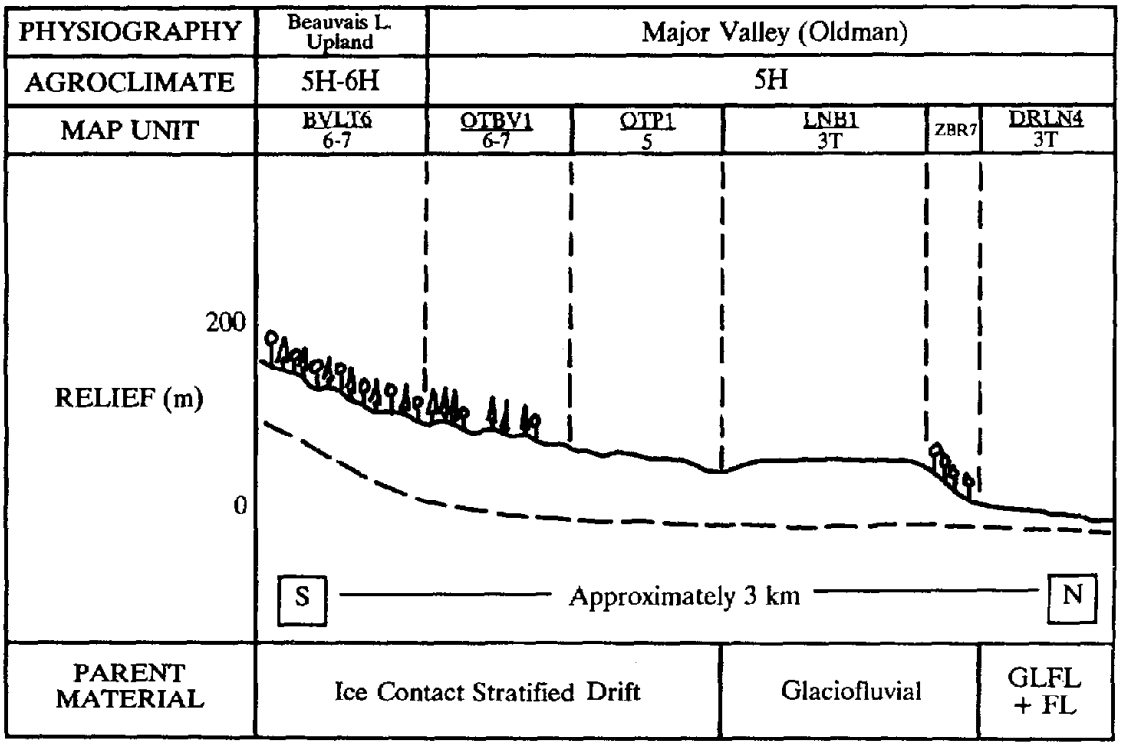


Figure B18. Landscape schematic showing topographic relationships among several map units mapped along the Oldman R. west of Maycroft.

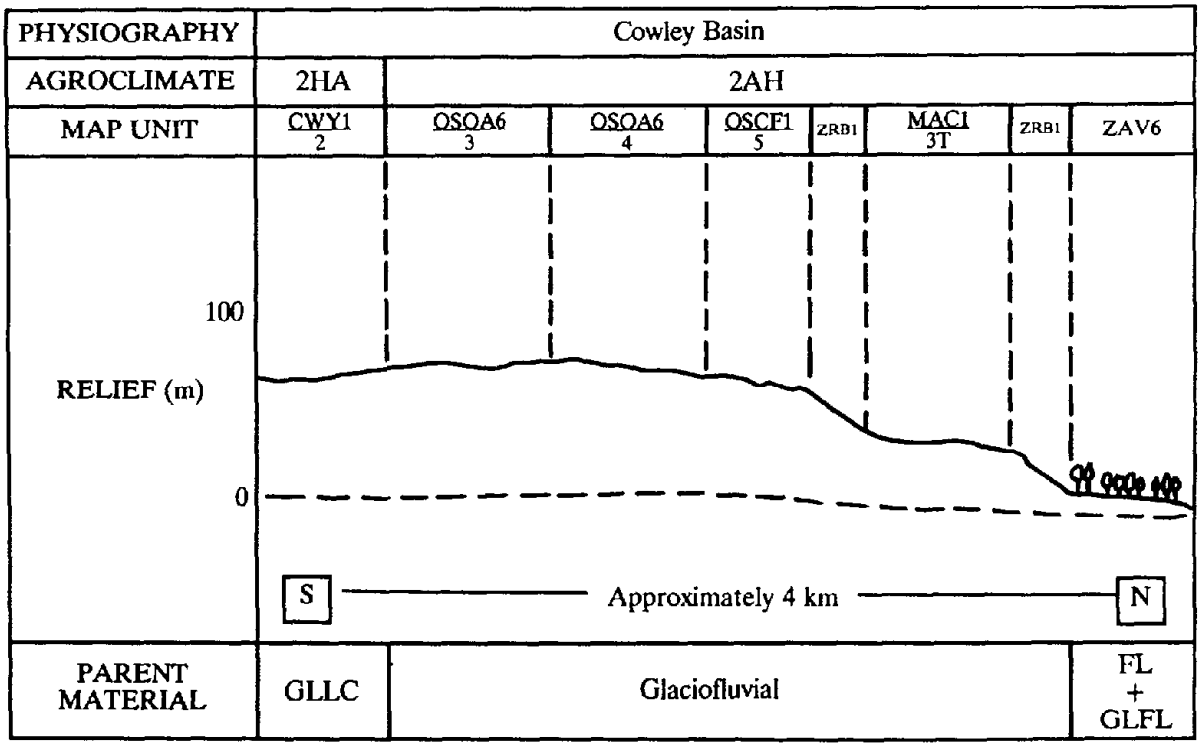


Figure B19. Landscape schematic showing topographic relationships among several map units mapped between the Oldman R. and Pincher Cr. east of Pincher Station.

Recurrent inclusions are:

* coarser textured variants, mainly loamy-skeletal soils like kSPR and MGV of ice contact deposits;
* thick Orthic Gray Luvisols (SPRv) in non- to weakly calcareous till (significant in one tract below Mt. Tecumseh);
* Eluviated Dystric Brunisols associated with SPRv in low lime till (important in one tract below Mt. Tecumseh);
* Eluviated Eutric Brunisols associated with SPRr and SPR in calcareous tills; and
* wet soils (Gleyed subgroups and Gleysolics) of seeps, potholes and drains.

Occasional inclusions are Brunisolic Gray Luvisols and shallow lithic variants.

Only one SPR1 map unit was recognized.

SPR1/5-6: 700 ha (1800 ac); inclined to hummocky terrain, occasionally controlled by underlying bedrock (blanket); often gullied. Slopes mainly 9-30%; topography class 7 often included.

SPR6 (Spruce Ridge) Soil Unit

SPR6 is a compound soil unit that encompasses forested ice contact terrain on benchlands and lower valley walls in the Front Ranges (Fig. B4, B16, B22). It is located in areas classed as agroclimate 6H often bordering on 5H. Vegetation is mainly lodgepole pine forest.

The unit is characterized by two major soil groups. Orthic Gray Luvisols, namely SPR (Spruce Ridge) series and SPRr (thin) taxadjunct, constitute one major group (20-50%), and usually dominate. Coarser textured variants, mainly loamy-skeletal soils like MGV (McGillivray), kSPR and similar more acidic soils, form the other group, also at 20-50%.

Paraskeletal segments of the ice contact landforms are composed of gravelly to cobbly (15-35% coarse fragments), medium textured (L-CL), mountain tills. The skeletal segments (coarser textured variants) consist of very gravelly to cobbly (35-60% coarse fragments), coarse to medium textured (SL-L), glaciofluvial or fluvial mudflow deposits. Chemically, the materials are mainly moderately to very strongly calcareous. Carbonate content generally increases downslope, as does till depth, and reflects regional limestone sources. Non- to weakly calcareous deposits are important (sometimes dominant) in tracts along Gold Creek and near Gladstone Valley.

Recurrent inclusions are non- to weakly calcareous Orthic Gray Luvisols (thick SPRv) and Dystric Brunisols (WLB and WLBv), any of which may be significant in a few tracts; Dark Gray Luvisols (kLTC); and wet soils (Gleyed subgroups and Gleysolics) of seeps, potholes and drains. Occasional inclusions are Eluviated Eutric Brunisols similar to the SPR soils; Orthic Eutric Brunisols on some steep dry aspects; slopewash fluvial soils (TDCv); Brunisolic Gray Luvisols; finer textured variants, mainly clayey to clayey-skeletal soils in glaciolacustrine "plugs"; and shallow lithic variants.

Only one SPR6 map unit was recognized.

SPR6/5-6: 2750 ha (6800 ac); hummocky, ridged or inclined ice contact terrain; often gullied. Tracts along Gold Creek contain fluvial (mudflow) aprons and fans. Slopes mainly 9-30%; topography classes 7 and 4 often included, sometimes significant. Non- to weakly calcareous deposits and associated acidic soils important in Gold Creek and Gladstone Valley areas.

SPWL1 (Spruce Ridge-Willoughby) Soil Unit

SPWL1 is a compound soil unit that features till overlying prominent bedrock ridges and hills of the Grassy Mountain Ridges (Fig. B16). It occurs in areas classed as agroclimate 6H and 7H, extending from Montane into Subalpine ecoregions (Pettapiece *et al.* 1980). Vegetation is mixed coniferous forest, mainly lodgepole pine or lodgepole pine-Douglas fir forest at lower elevations, lodgepole pine with spruce or subalpine fir at higher elevations.

The unit is characterized by two major soil groups. Orthic Gray Luvisols constitute one major group (30-60%), and usually dominate. Identified members of this group are SPR (Spruce Ridge) series, SPRr (thin) taxadjunct, and SPRv (thick) variant. Eluviated and Orthic Dystric Brunisols form the other group (20-40%). Identified members are WLB (Willoughby) series, WLBv (subgroup) variant, and lWLB (shallow lithic) variant. The WLB soils are associated with noncalcareous deposits, prevalent across the tops of tracts.

Deep to shallow mountain tills characterize the unit. Chemically these range from non- to very strongly calcareous. Non- to weakly calcareous tills reflect local bedrock and are prevalent across the tops of tracts where the soils are shallowest. Carbonate content generally increases downslope, as does till depth, and reflects regional limestone sources. The highest lime till (and SPRr soils) occur on lower slopes, especially those facing major valleys like the Crowsnest.

Physically, the tills are gravelly to cobbly (15-35% coarse fragments) and medium to coarse textured (L-SL-CL-SCL). Residual material may be present between overlying till and consolidated bedrock. A veneer composed of coarse to medium textured (SL-L, 2-15% coarse fragments), fluvioeolian material overlies the till, mainly on upper lee slopes. Veneer over till is a feature of the various WLB soils.

Recurrent inclusions are:

* coarser textured variants, mainly loamy-skeletal soils (kSPR) in ice contact deposits on lower slopes (very stony till soils, perhaps reflecting local quartzitic strata, dominate the tract on Bluff Mountain);
* non- to weakly calcareous colluvial soils, mainly on the steepest rocky sections;
* finer textured variants, mainly fine-clayey soils derived from argillaceous bedrock (especially important in the tract on the lower slopes of Mt. Tecumseh); and
* bedrock outcrops.

Occasional inclusions are drier soils with thin Ah horizons occurring on small grassland patches, Eluviated and Orthic Eutric Brunisols, "slopewash" (TDCv) plus associated wet soils of seeps (TDC), and Brunisolic Gray Luvisols.

Only one SPWL1 map unit was recognized.

SPWL1/7-8: 1850 ha (4600 ac); blanket to veneer over inclined or ridged bedrock. Slopes mainly 30-70%; topography classes 6 and 9 often included. Coarser textured variants important in one tract, finer textured variants in another.

TDBV2 (Todd Creek-Beauvais) Soil Unit

TDBV2 is a compound soil unit that features forested fluvial terrain with substantial wetland soils, mainly in the Southern Foothills (Fig. B23). It occurs in areas classed as agroclimate 5H, sometimes adjacent to areas of 6H. Vegetation is mainly mixedwood forest dominated by aspen and cottonwood. Parts of some tracts have been cleared for forage production.

The unit is characterized by three major groups of soils. Imperfectly drained Gleyed Dark Gray soils, namely TDC (Todd Creek) series, usually dominate (20-40%). Wetter soils (poorly and very poorly drained) constitute the second group, significant to codominant at 15-25%. It ranges from Gleysolics, including soils resembling POT (Pothole Creek), to small water bodies. Imperfectly drained Gleyed subgroups related to the various MFT (Maycroft) and BVA (Beauvais) soils are important in a few tracts. The third group - moderately well to well drained, till-like, Orthic Dark Gray soils - range from inclusion status (minimum 10%) in some tracts to significant or codominant (maximum 25%) in others. This last group is best represented by the kBVA (paraskeletal Beauvais) variant although others like fkBVA (clayey-paraskeletal) and fBVA (fine) also occur.

The fluvial terrain is distinctly layered, featuring discontinuous fluvial or slopewash veneer overlying till-like mudflow deposits. The veneer is mainly medium textured (L-CL, <2% coarse fragments), occasionally coarse textured (SL) or slightly gravelly to gravelly. The mudflow material is mainly medium textured (CL-L) and commonly ranges from gravelly to very gravelly (15-60% coarse fragments). Remnant gravelly mountain tills may also be present in some tracts. Chemically, the mudflow and till deposits range from non- to very strongly calcareous, depending on the local tills and source bedrock. Non- to moderately calcareous materials are prevalent in the Pecten and Gladstone Valley areas. Moderately to very strongly calcareous deposits are characteristic in the type area around Willow Valley.

Recurrent inclusions are:

* finer textured variants, including clayey-paraskeletal soils and other soils with a relatively nongravelly C-SiC veneer (important in a tract near Gladstone Valley);
* coarser textured variants with a very gravelly mudflow base or a gravelly veneer (like kTDC);
* stratified (veneer over mudflow) Orthic Dark Gray soils (TDCv); and
* medium textured Orthic Black soils (MFT).

Occasional inclusions are Orthic Black till soils (kDVG or finer versions), important in two small tracts near Pecten, and Dark and Orthic Gray Luvisols.

Only one TDBV2 map unit was recognized.

TDBV2/4: 1450 ha 3600 ac); fan, apron or inclined; often channelled. Slopes mainly 5-9%; significant class 3 topography. Stratified Orthic Dark Grays (TDCv), coarser or finer textured variants, and Orthic Black till soils are important in different tracts.

TDC6 (Todd Creek) Soil Unit)

TDC6 is a compound soil unit that features forested fluvial landforms with substantial coarse textured soils, mainly in major valleys that cut through the Southern Foothills. It occurs in areas classed as agroclimate 5H. Vegetation is mainly mixedwood forest dominated by aspen.

The unit is characterized by two major soil groups. Orthic and Gleyed Dark Gray soils, namely TDC (Todd Creek) series and its subgroup variant (TDCv), constitute one major group (20-50%). Coarser textured soils like kTDC (paraskeletal) variant form the other group, also at 20-50%.

The fluvial materials are layered, featuring discontinuous fluvial or slopewash veneer over till-like mudflow deposits. In TDCv and TDC soils, the veneer is medium textured (CL-L, <2% coarse fragments), and sometimes slightly gravelly (2-15% coarse fragments).

The mudflow material is also mainly medium textured (CL-L) but commonly ranges from gravelly to very gravelly (15-60% coarse fragments). In the coarser textured soils, the veneer is mainly gravelly to cobbly (15-35% coarse fragments), sometimes nongravelly and coarse textured (SL). A few coarse soils are very gravelly to cobbly throughout both veneer and mudflow base.

Chemically, the mudflow deposits range from non- to very strongly calcareous, depending on local tills and source bedrock. Non- to moderately calcareous materials are prevalent in the Pecten and Castle River areas. Moderately to very strongly calcareous deposits are common in the Gold Creek and Maycroft areas.

Recurrent inclusions are rego variants, namely Rego Dark Grays or Cumulic and Orthic Humic Regosols (perhaps dominant in the tract near Maycroft), and various Black soils (like DRW, LNB, MFT, and BUR). Occasional inclusions are Orthic Dark Gray till soils (kBVA), slopewash soils with very thick Ah horizons (rPPE or gravelly to cobbly versions thereof), wet soils (Gleyed subgroups, Gleysolics and water) of seeps and depressions, and Luvisolic soils.

Only one TDC6 map unit was recognized.

TDC6/5: 400 ha (1000 ac); fan or apron, sometimes deposited on terraces; often channelled. Slopes mainly 9-15%; topography classes 4 and 6 often included, sometimes significant. Coarse textured (SL) veneer dominates one tract near Pecten.

WLBE1 (Willoughby-Bellevue) Soil Unit

WLBE1 is a compound soil unit that features till overlying bedrock ridges and hills of the Byron-Carbondale Hills (Fig. B23) and Grassy Mountain Ridges. It occurs in areas classed as agroclimate 5H to 7H. Vegetation is dominantly Douglas fir or Douglas fir-lodgepole pine forest on north to east facing slopes; native grassland or shrubby grassland on the drier, warmer, southerly to westerly aspects in conjunction with shallow soils.

Forested segments dominate and are characterized by Eluviated and Orthic Dystric Brunisols at 30-50%. Identified members of this group are WLB (Willoughby) series, WLBv (subgroup) variant, and lWLB (shallow lithic) variant. Combined microclimatic and edaphic conditions associated with the grasslands result in significant (15-30%) Orthic Dark Brown soils, mainly BEV (Bellevue) series and its till variant (BEVv).

The WLB soil group is developed in coarse to medium textured (mainly SL-L, 2-15% fine gravels and channers), fluvioeolian veneer overlying gravelly (15-35% coarse fragments), medium to coarse textured (mainly L-SL), mountain till. The fluvioeolian veneer originated as wind blown detritus picked up from exposed surfaces on windward slopes. After deposition on lee (northeasterly) slopes, the material was subjected to slopewash flow, slumping, wind throw of trees, and soil creep. Eluviated soils exist where surfaces have been the most stable.

Grassland segments feature discontinuous colluvium overlying discontinuous till overlying bedrock (or fractured residuum). The unconsolidated materials are gravelly or channery (15-35% coarse fragments) and medium to coarse textured (SCL-L-SL).

Chemically, the materials are dominantly non- to weakly calcareous, the soils acidic to neutral. They reflect non- to weakly calcareous bedrock that dominates the Byron-Carbondale Hills and Grassy Mountain Ridges. Calcareous soils sometimes occur: sporadi-

cally in association with the few calcareous strata; more consistently in lower slope tills, like those of the Crowsnest valley, that include material from remote limestone sources.

Recurrent inclusions are:

* Orthic Gray Luvisols, mainly the thick SPRv variant;
* shallow lithic Orthic Eutric Brunisols (NFK), associated with the BEV soils;
* non- to weakly calcareous colluvial soils, mainly on the steepest rocky sections, significant in a few tracts like those encompassing Robertson Peak near Bellevue and Wedge Mountain near Coleman; and
* bedrock outcrops.

Occasional inclusions are coarser textured variants, mainly loamy-skeletal soils of ice contact deposits or very stony tills that reflect local quartzitic strata; Dark Gray Luvisol and Orthic Dark Gray soils (kLTC and kBVA); Orthic and Eluviated Eutric Brunisols occurring in deep till; shallow lithic Orthic Black soils (kOKY); and very thick slopewash or fluvioeolian soils with indistinguishable horizons.

Only one WLBE1 map unit was recognized.

WLBE1/7-8: 15 150 ha (37 500 ac); blanket to veneer overlying ridged or inclined bedrock. Slopes mainly 30-70%; topography class 6 often included, sometimes significant. Two or three tracts in the Gold Creek area have barely adequate amounts of grassland to meet the concept. Another small tract in the same area is dominated by calcareous grassland soils and has substantial Luvisols on its northeasterly aspect.

THE MISCELLANEOUS UNITS

Introduction

Miscellaneous units encompass two broad types of landscapes: those with soils versus those with little or no soil as defined in the Canadian taxonomy (E.C.S.S. 1987b). Nonsoil units are either bedrock (ZRO) or water. Units with soils fall into either natural or man-made groups. Only one man-made unit, reclaimed mine land (ZDL), was recognized as a mapping unit. Other built-up areas were identified by name or feature.

Thus most of the miscellaneous units have naturally occurring soils; few if any of these soils have been recognized at the series level. Some units represent relatively young landscapes dominated by Regosolic soils. Others have extremely complex parent materials. Some tracts mapped as miscellaneous units extend through areas classed into more than one physiographic district and agroclimatic class.

To avoid proliferation of both map units and delineations, criteria for separating miscellaneous units with soils were kept simple. With a few exceptions, agroclimatic classes were divided into two broad groups: 4H and warmer, related to prairie grassland terrain, versus 5H and cooler, mainly forested landscapes. Another separation recognizes coarse fluvial deposits dominated by Regosolic soils. Among incised landforms, single bank terrain (eg. a valley wall) was separated from double opposing banks (eg. the entire valley cross-section).

Miscellaneous unit names are connotative, and many have been passed down through several decades of soil surveys in Alberta. Most miscellaneous units used in this survey were adapted from the Warner (Kjearsgaard *et al.* 1986) and Cardston (Brierley *et al.* In press) surveys. All symbols now begin with "Z" to facilitate electronic data storage and sorting.

ZAV1 (Alluvium) Miscellaneous Unit

ZAV1 (4800 ha, 11 800 ac) is a compound unit representing recent floodplain and terrace landscapes of broad, shallow, flat-bottomed gullies or valleys on the Cardston Plain (Fig. B20, B21), Goose Lake Bench, Beauvais Lake Upland, and southern Porcupine Hills. It occurs in areas classed as agroclimates 2HA, 3H and 4H, with a minor amount belonging to subclass 2AH (Dark Brown soil zone). Most tracts contain a meandering creek or river. Vegetation is mainly native grassland although some large terraces or floodplains are cultivated.

The soils of ZAV1 are unnamed. Rego Black soils dominate (30-60%). Rego Dark Brown soils substitute for the Blacks in the lower part of a tract along Beaver Creek that is located inside the Dark Brown soil zone. Soils that are morphologically similar to the Chernozemics but classed Orthic and Cumulic Humic Regosol are significant to codominant (20-40%). These have non-Chernozemic Ah horizons that reflect physical accretion in a recent fluvial environment.

Fluvial floodplain and terraces (sometimes fan or apron) dominate ZAV1 terrain. Slopes commonly range from 0-5% across such features. The fluvial materials are medium (L-CL-SiL-SiCL-SCL) or coarse (SL) textured, occasionally with a few gravels. Chemically, they range from moderately to very strongly calcareous, and are occasionally saline.

Short but relatively steep (slopes 9-45%) risers and banks often dissect ZAV1 landscapes into small parcels. Risers separate terrace treads. The lowest banks border abandoned and active stream channels. The highest banks mark the down-cut walls of the whole gully or valley relative to surrounding terrain. If large enough, the walls are mapped as ZRB1 rather than being included with ZAV1. Risers and banks can account for up to 50% of ZAV1 but rarely exceed 30 or 40%. ZRB4 miscellaneous unit is differentiated by having more valley or gully wall terrain (>50%) than floodplain and terraces.

Recurrent inclusions are Orthic and Cumulic Regosols, soils with little or no Ah, and wet soils (Gleyed subgroups, Gleysolics and water bodies) associated with high water tables and depressions. Occasional inclusions are Rego Dark Brown soils (lower reaches of Beaver Cr.); Orthic Black soils associated with the oldest highest terraces; saline variants associated with wet soils and seeps; and Solonetzic or solonetzic-like soils, also associated with the saline and wet soils.

ZAV6 (Alluvium) Miscellaneous Unit

ZAV6 (5700 ha, 14 000 ac) is a compound unit representing active floodplain and the youngest terraces along major streams that flow through the Southern Foothills and Cardston Plain (Fig. B2, B15, B19, B20). This basically "western" landscape occurs only along streams that emanate from the mountains. The unit ranges across areas classed as agroclimates 2AH to 5H, with the majority occurring in areas classed as 3H and 4H. Vegetation is quite uniform given the wide climatic range. Cottonwood forest (with aspen), tall willows, and patches of grassland or shrubby grassland form a characteristic pattern. Most tracts contain a braided river or creek. All or parts of most tracts are occasionally flooded, perhaps once in every 10 to 50 years.

The unnamed soils of ZAV6 are also quite uniform given the wide climatic range. Orthic Regosols dominate (40-60%). Cumulic Regosols with buried Ah horizons (former surfaces) are significant (20-40%). Both groups have surfaces that lack or have very thin (<10 cm) Ah horizons.

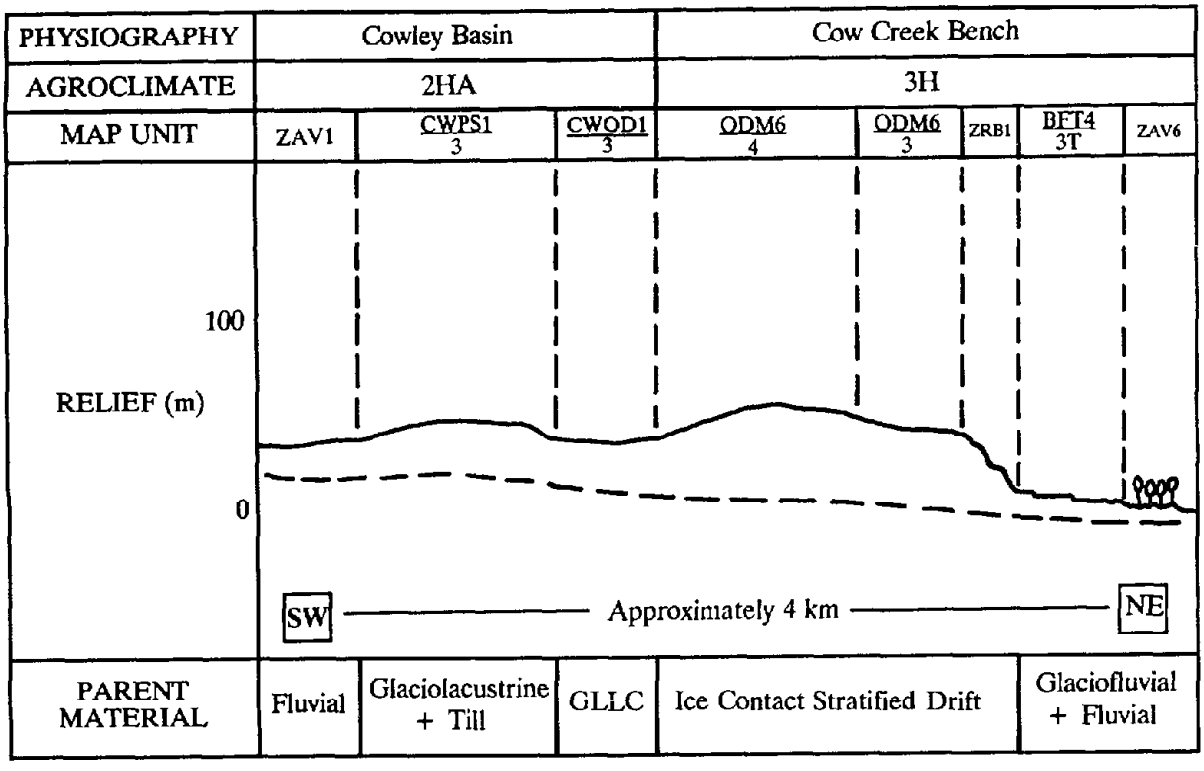


Figure B20. Landscape schematic showing topographic relationships among several map units mapped between the Oldman R. and Todd Cr. west of Tanner.

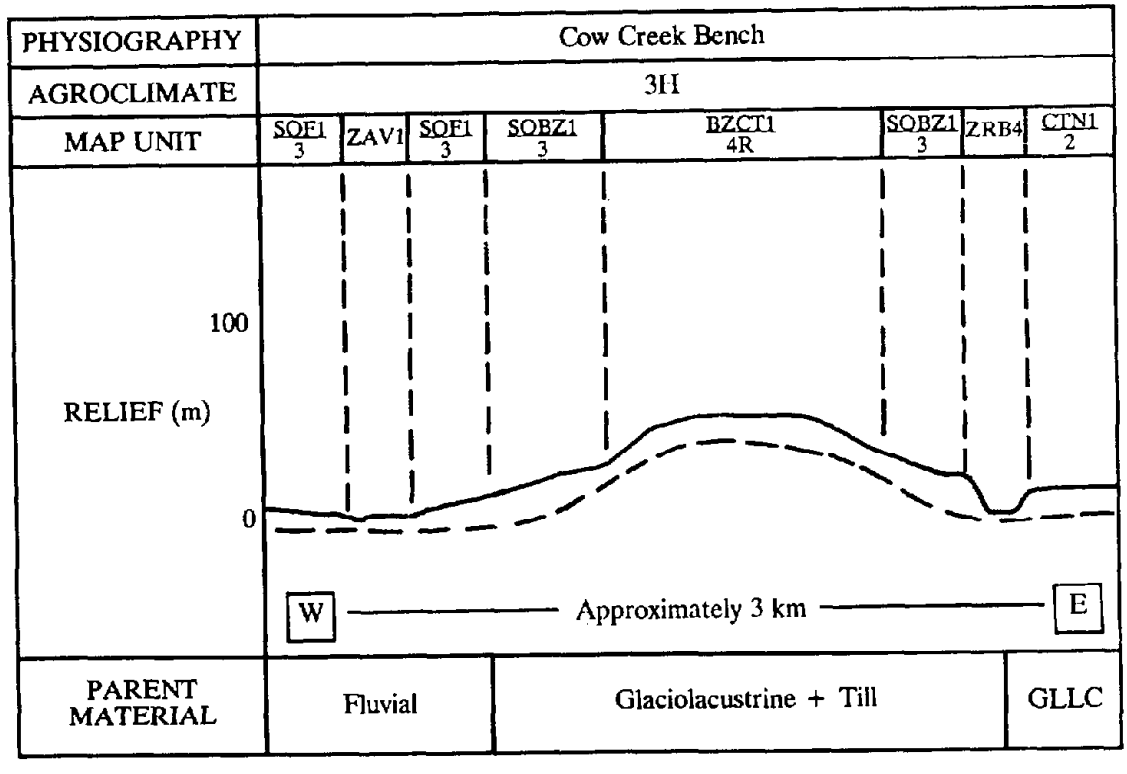


Figure B21. Landscape schematic showing topographic relationships among several map units mapped between Callum and Indian creeks east of Maycroft.

Floodplain and terraced landforms (sometimes fan) dominate ZAV6 terrain. Slopes commonly range from 0-5% across such features. Low, fairly steep (9-70%) risers and banks are usually included but rarely exceed 20% of a tract. Risers separate terrace treads. The lowest banks border abandoned and active stream channels. Large, steep, erosional banks (walls) that mark the edge of valleys containing ZAV6 are rarely included.

The glaciofluvial or fluvial materials comprising ZAV6 landforms are usually stratified, the most common sequence being discontinuous, medium to coarse textured veneer or blanket over gravel. Veneer textures are mainly L-SL-SiL, sometimes with a few gravels. The gravel base is mainly extremely gravelly to cobbly (>60% coarse fragments) and coarse textured (LS-S). Fewer coarse fragments (40-50%), finer textures (SL), and sandy to silty bands and lenses may also occur. Chemically, the materials range from weakly to extremely calcareous, normally from moderately to very strongly calcareous.

Soils with Ah horizons seem to always be included and are occasionally significant. These may be either Rego Blacks (Rego Dark Browns along the lower Oldman R. near Brocket) or Orthic and Cumulic Humic Regosols. Occasional inclusions are Orthic Black soils associated with the oldest, highest terraces, and wet soils (Gleyed subgroups, Gleysolics and water bodies) associated with high water tables and depressions.

ZAV7 (Alluvium) Miscellaneous Unit

ZAV7 (950 ha, 2300 ac) is a compound unit representing recent floodplain and terrace landscapes of shallow, flat-bottomed valleys in the Southern Foothills and Front Ranges (Fig. B4). The majority occurs in areas classed as agroclimate 5H, a significant proportion in areas classed as 6H. Vegetation is mostly mixedwood forest. Most tracts contain a meandering creek or river.

The unit is characterized by three major groups of soils. Orthic Eutric Brunisols, at 20-40%, occur most consistently. Various Regosolic soils range from inclusion status (minimum about 5%) in some tracts to dominant (maximum 40%) in others. This group includes Orthic and Cumulic subgroups of Regosol and Humic Regosol great groups. Wet soils of low lying locales, usually affected by high water tables, also range from inclusion status (minimum about 5%) to significant (maximum 25%). This last group includes Gleyed subgroups, various Gleysolic soils, and water bodies (sloughs and beaver ponds).

Floodplain and terraces (slopes 0-5%) or, occasionally, fans and aprons (slopes 5-9%) dominate ZAV7 terrain. Low but relatively steep (slopes 9-70%) risers and banks are usually included but rarely exceed 20% of a tract. Risers separate terrace treads. The lowest banks border abandoned and active stream channels. Large, steep, erosional banks (walls) that mark the edge of valleys containing ZAV7 are included in only a few cases.

The unit's deposits consist of fluvial, possibly fluviolacustrine or glaciofluvial, materials that are usually stratified and certainly variable. Textures range from medium (L-CL-SiL-SiCL-SCL) to coarse (SL-LS-S), fragment content from nongravelly (<2% coarse fragments) to extremely gravelly or cobbly (>60% coarse fragments, gravel). Gravel soils make up about 10-30% of the unit, less than in ZAV6. Chemically, the materials usually range from weakly to strongly calcareous.

Weakly developed Orthic Gray Luvisols and Eluviated Dystric Brunisols are sometimes included, and may be significant to codominant where the parent material is weakly calcareous. Such is the case in one tract along Allison Creek. Occasional inclusions are Orthic and Rego Dark Grays, Rego and Orthic Blacks, and finer textured (C-SiC) variants.

ZDL (Disturbed Land) Miscellaneous Unit

ZDL (250 ha, 600 ac) is a man-modified unit encompassing reclaimed coal mine sites and attendant slack piles in the Crowsnest River valley of the Front Ranges. Two tracts were delineated; one next to Blairmore, the other adjacent to Coleman.

Coal slack appears to be the main reconstruction material. A park is being created next to Blairmore where reclamation activities were still underway in 1987. The reconstructed landscape should resemble the original valley bottomland terrain, not unlike ZAV7. At Coleman, the valley bottomland bank (wall) was reconstructed as a semi-terraced incline. Grasses were used to revegetate the slopes. Unfortunately, some sites have recently (summer 1987) begun eroding so that other stabilization measures may be necessary.

ZGL1 (Gleysolics) Miscellaneous Unit

ZGL1 (800 ha, 2000 ac) is a compound unit that represents mappable potholes, slough bottoms and drains of the Cardston Plain, Goose Lake Bench, Beauvais Lake Upland, and Porcupine Hills. It occurs in areas classed mainly as agroclimates 2HA to 4H, all associated with the prairie grasslands. Vegetation ranges from diverse prairie wetland flora in warmer areas to willow-birch shrubland in cooler areas. Some tracts have been cultivated during a succession of dry years.

Poorly to very poorly drained Gleysolic soils, mainly Orthic and Rego Humic Gleysols, usually dominate (30-60%). Imperfectly drained Gleyed subgroups, particularly of Black soils, are normally significant (15-30%), occasionally codominant to dominant.

Undulating to level terrain or, occasionally, fans and aprons dominate ZGL1 terrain. Slopes are mainly 0-5%. The parent materials are mainly of fluvial, fluviolacustrine or lacustrine origin, occasionally glaciolacustrine or till. Textures range from fine (C-SiC-HC) to medium (CL-SiCL-SiL-L). Chemically, the deposits range from moderately to very strongly calcareous, and are occasionally saline.

Orthic and Rego Gleysols are often included and sometimes significant to codominant. Occasional inclusions are drier "undeveloped" soils like Rego Blacks and various Regosolics; water bodies such as sloughs and beaver ponds; drier well developed soils like Orthic Blacks; saline and associated solonetzic-like soils around sites of saline discharge; and Organic soils, present in at least one or two tracts.

ZGL7 (Gleysolic) Miscellaneous Unit

ZGL7 (800 ha, 2000 ac) is a compound unit that encompasses depressions, drains and valley bottoms in the Southern Foothills and Front Ranges (Fig. B5, B22). The majority occurs in areas classed as agroclimate 5H, a significant proportion in areas classed as 6H. Vegetation ranges from willow-birch shrubland to sedge fen, sometimes including "swampy" aspen and cottonwood overstory. A few tracts, or parts thereof, have been drained and cleared for forage production.

The unit is characterized by three major groups of soils. Poorly to very poorly drained Gleysolic soils, mainly Orthic and Rego Humic Gleysols, usually dominate (30-50%). Imperfectly drained Gleyed subgroups, particularly of Dark Gray and Black soils, range from inclusion status (minimum about 5%) in some tracts to significant or codominant (maximum 30%) in others. The third group, Humic Luvic Gleysols, replace Orthic Humic

Gleysols in some tracts. Also estimated at 5-30%, Humic Luvic Gleysols may in fact dominate a few tracts.

Undulating to level terrain or, occasionally, fans, aprons and terraces dominate ZGL7 terrain. Slopes are mainly 0-5%. The parent materials are mainly of fluvial, fluviolacustrine or lacustrine origin, occasionally glaciolacustrine or till. Textures commonly range from fine (C-SiC) to medium (CL-SiCL-SiL-L), fragment content from nongravelly to gravelly or cobbly (0-35% coarse fragments overall). Occasionally very gravelly to cobbly deposits may be found at depth. Chemically, the deposits range from weakly to very strongly or extremely calcareous.

Recurrent inclusions are:

* water bodies, mainly sloughs and beaver ponds (significant to codominant in some tracts);
* Orthic and Rego Gleysols, sometimes significant to codominant; and
* Organic soils (eg. Terric Humic Mesisol), sometimes significant to codominant. Several small tracts located southeast of Coleman are dominated by Organic soils. Part of one of these tracts has been drained and broken for forage production.

Occasional inclusions are drier soils such as Orthic Dark Gray soils, Orthic Black soils, Dark and Orthic Gray Luvisols, and coarse textured soils, for example LNB or kBRGv.

ZRB1 (Rough Broken) Miscellaneous Unit

ZRB1 (5700 ha, 14 000 ac) is a compound unit representing steep, stream-cut, erosional banks (gully or valley walls) next to major streams that cut through the Cardston Plain (Fig. B2, B17, B19, B20, B21) and adjacent parts of the Southern Foothills. It occurs in areas classed as agroclimates 2AH to 4H, all associated with the prairie grasslands. Vegetation is dominantly native grassland.

The unit is characterized by two major groups of soils. Orthic Black soils constitute one major group (30-60%), Rego Blacks the other (20-50%). Calcareous Black intergrades also occur. Orthic and Rego Dark Brown soils substitute for the Blacks in areas classed as agroclimate 2AH (the Dark Brown zone), mainly along the lower Oldman River valley.

Inclined usually gullied slopes of variable aspect characterize ZRB1. These are post-glacial erosional features, formed by the down- and side-cutting action of major streams. Slopes are listed at >9% but most are >15%. Sometimes hummocky, terraced or ridged patterns are superimposed on the incline, likely by slumping of blocks of material. Such features are particularly noticeable where the incline has been cut into coarse textured ice contact and glaciofluvial deposits, for example, along the Oldman River near Olin Creek.

Most ZRB1 terrain has been cut into various glacial and proglacial deposits. Thus textural variability is extreme. For example, several tracts are cut into fine textured glaciolacustrine deposits; others into extremely gravelly to cobbly, coarse textured, glaciofluvial gravel. Some ZRB1 terrain has been cut into a sequence of materials, for example, glaciolacustrine blanket or veneer overlying till overlying bedrock. Chemically, the materials range from moderately to extremely calcareous.

Inclusions are various Regosolic soils, mainly Orthic Regosols and Orthic Humic Regosols; Orthic Eutric Brunisols with very thin Ah horizons; and bedrock outcrops, important in a few deeply incised tracts like those along the Oldman River.

ZRB4 (Rough Broken) Miscellaneous Unit

ZRB4 (7450 ha, 18 400 ac) is a compound unit representing narrow gullies and ravines of eastern parts of the Southern Foothills, the Cardston Plain, and the southern Porcupine Hills. It occurs in areas classed as agroclimates 2AH to 4H, all associated with the prairie grasslands. Vegetation is dominantly native grassland, sometimes with shrubs or aspen along the narrow bottoms. Most tracts contain a small, usually seasonal stream. Some have been dammed by local land managers to store water for livestock and irrigation.

The unit is characterized by two major groups of soils, both unnamed. Rego Blacks plus various Regosolic soils, mainly Orthic Regosols and Orthic Humic Regosols, constitute one major group (30-60%). Orthic Blacks constitute the other (20-40%). Calcareous Black intergrades also occur. Rego and Orthic Dark Brown soils substitute for the Blacks in areas classed as agroclimate 2AH (the Dark Brown soil zone), mainly in the Summerview area.

ZRB4 is characterized by narrow floodplain and terrace complexes confined between two steep erosional banks (gully or ravine walls, Fig. B17). The steep banks dominate. These are post-glacial erosional features, formed by the down-cutting action of small streams. Slopes are listed at >9% but are usually greater than 15 or 30%. ZAV1 miscellaneous unit is differentiated by having less bank terrain (<50%) than floodplain and terraces.

Most ZRB4 terrain has been cut into various glacial and proglacial deposits. Thus textural variability is extreme. For example, several tracts are cut into fine textured glaciolacustrine deposits; others into extremely gravelly to cobbly, coarse textured, glaciofluvial gravel. Some ZRB4 terrain has been cut into a sequence of materials, for example, coarse textured ice contact deposits overlying till. Chemically, the materials range from moderately to extremely calcareous.

Inclusions are wet soils (Gleyed soils, Gleysolics and water) associated with the fluvial bottoms or manmade dams; Orthic Eutric Brunisols with very thin Ah horizons; and bedrock outcrops, important in a few deeply incised tracts like those on the Crowsnest and Castle rivers.

ZRB7 (Rough Broken) Miscellaneous Unit

ZRB7 (1500 ha, 3700 ac) is a compound unit representing steep, stream-cut, erosional banks (gully or valley walls) next to major streams cut through the Front Ranges (Fig. B18) and western parts of the Southern Foothills. The majority occurs in areas classed as agroclimate 5H, a significant proportion in areas classed as 6H. Vegetation is dominantly forest - coniferous (mainly lodgepole pine) forest in the cool moist Crowsnest valley, aspen forest in warmer areas near the prairie grasslands. Mixedwood forest also occurs, and patches of grassland are present on southerly aspects in the driest areas.

Orthic Eutric Brunisols are the dominant soils (30-60%). A second group, Eluviated Eutric Brunisols, range from inclusion status (minimum about 5%) in some tracts to significant or codominant (maximum 30%) in others.

Inclined usually gullied slopes of variable aspect characterize ZRB7. These are post-glacial erosional features, formed by the down- and side-cutting action of major streams. Slopes are listed at >30% but most are steeper than 45%. Sometimes hummocky, terraced or ridged patterns are superimposed on the incline, likely by slumping of blocks of material. Such features are apparent where the slope has been cut into coarse textured ice contact and glaciofluvial deposits, for example, along the Crowsnest R. near Coleman.

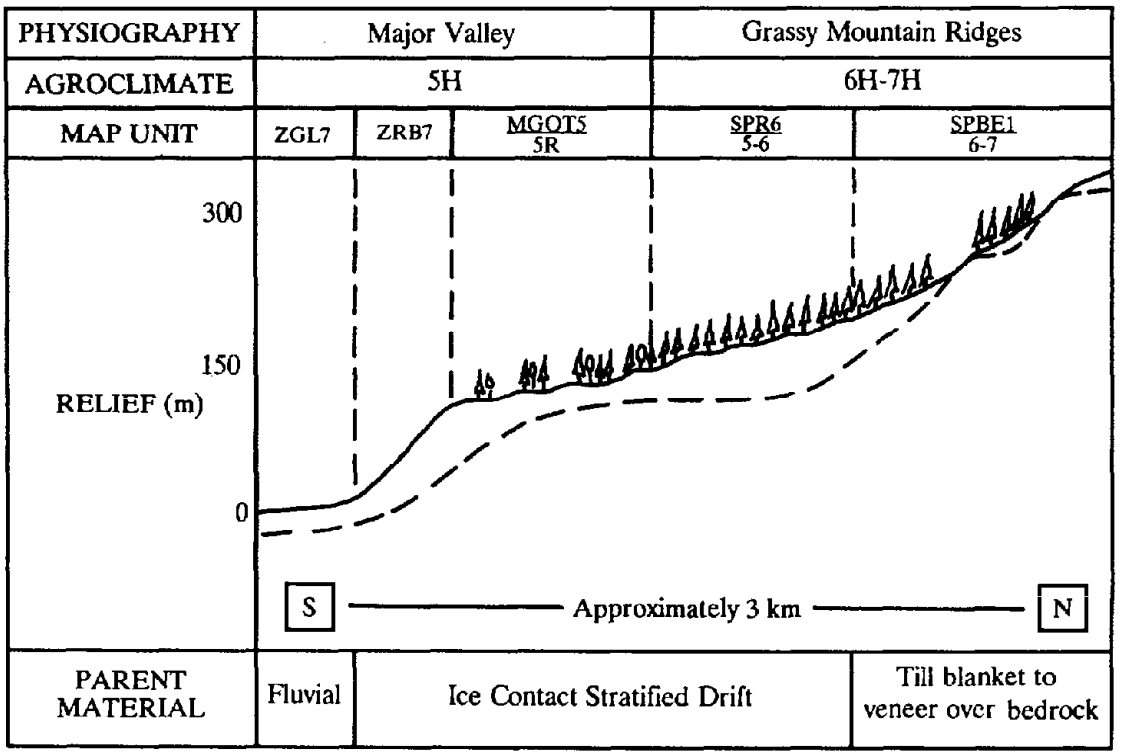


Figure B22. Landscape schematic showing topographic relationships among several map units mapped near Blairmore.

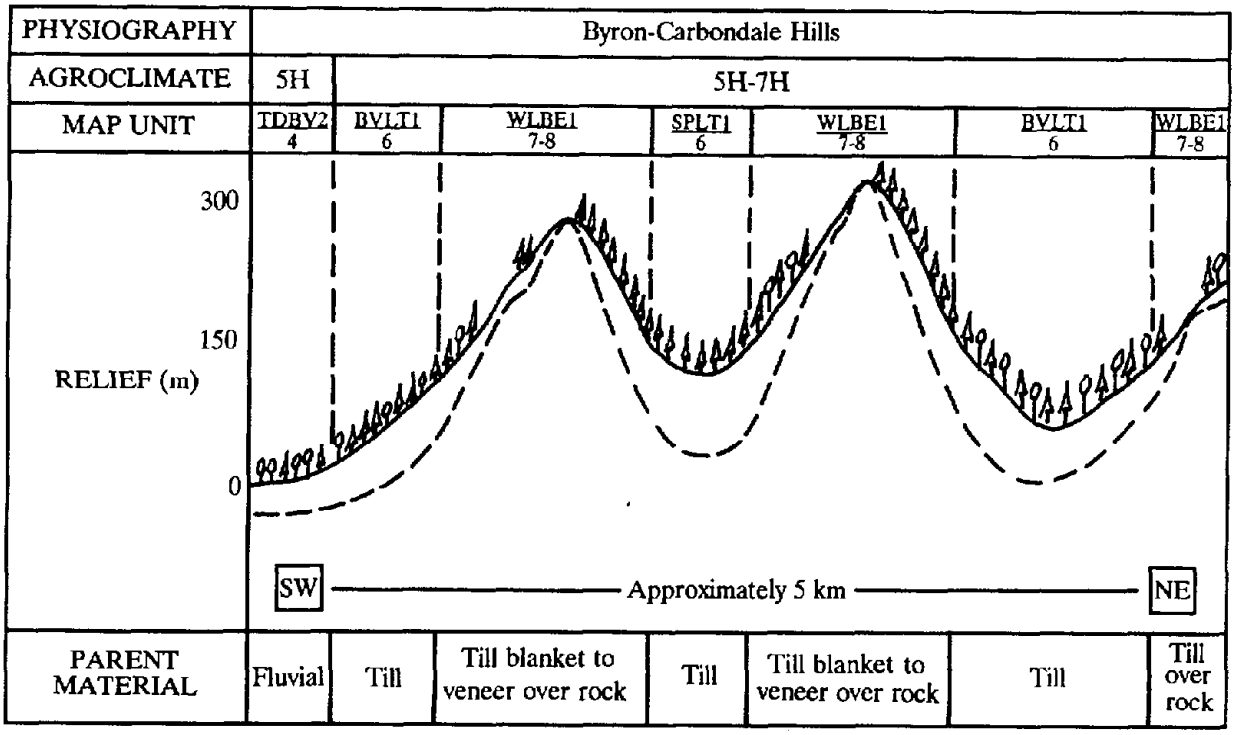


Figure B23. Landscape schematic showing topographic relationships among several map units mapped near the confluence of the Castle and Carbondale rivers.

Most ZRB7 terrain has been cut into various glacial and proglacial deposits. Thus textural variability is extreme. For example, several tracts are cut into medium textured tills; others into extremely gravelly to cobbly, coarse textured, glaciofluvial gravel. Some ZRB7 terrain has been cut into a sequence of materials, for example, glaciofluvial blanket or veneer overlying till overlying bedrock. Chemically, the materials range from weakly calcareous in the Pecten area to extremely calcareous in the Crowsnest valley.

Any of the inclusions listed below can be significant in some tracts. The inclusions are Dark and Orthic Gray Luvisols (sometimes codominant); Orthic and Eluviated Dystric Brunisols associated with noncalcareous materials; Dark Gray soils; Black or Dark Brown soils; various Regosolic soils, mainly Orthic Regosols and Orthic Humic Regosols; and bedrock outcrops.

ZRB8 (Rough Broken) Miscellaneous Unit

ZRB8 (2400 ha, 6000 ac) is a compound unit representing narrow gullies and ravines of the Southern Foothills and Front Ranges. The majority occurs in areas classed as agroclimate 5H, a significant proportion in areas classed as 6H. Vegetation is dominantly forest - coniferous (mainly lodgepole pine) forest in the cool moist Crowsnest valley, aspen forest in warmer areas near the prairie grasslands. Mixedwood forest also occurs, and patches of grassland are present on southerly aspects in the driest areas.

The unit is characterized by three major groups of soils, all unnamed. Orthic Eutric Brunisols are the dominant soils (30-60%). A second group, Eluviated Eutric Brunisols, range from inclusion status (minimum about 5%) in some tracts to significant or codominant (maximum 30%) in others. The third group, Dark and Orthic Gray Luvisols, also range from 5-30%.

ZRB8 is characterized by narrow floodplain and terrace complexes (slopes mainly 0-5%) confined between two steep erosional banks (gully or ravine walls) with slopes >30%. The banks dominate the landscape (Fig. B16). These are post-glacial erosional features, formed mainly by the down-cutting action of small streams. ZAV7 miscellaneous unit normally has very little bank terrain relative to floodplain and terraces.

Most ZRB8 terrain has been cut into various glacial and proglacial deposits. Thus textural variability is extreme. For example, several tracts are cut into medium textured tills; others into extremely gravelly to cobbly, coarse textured, glaciofluvial gravel. Some ZRB8 terrain has been cut into a sequence of materials, for example, coarse textured ice contact deposits overlying bedrock. Chemically, the materials range from weakly calcareous in the Pecten area to extremely calcareous in the Crowsnest valley.

Some inclusions are significant to codominant in a few tracts. These are Orthic and Eluviated Dystric Brunisols, associated with noncalcareous materials and Dark Gray soils of warmer areas. Occasional inclusions are wet soils (Gleyed soils, Gleysolics and water) associated with the fluvial bottoms; various Black soils; various Regosolic soils, mainly Orthic Regosols and Orthic Humic Regosols; and bedrock outcrops.

ZRO (Rock Outcrop) Miscellaneous Unit

ZRO (500 ha, 1200 ac) is a nonsoil unit of the High Rock Ridge mountain tops (Fig. B16). It occurs in areas classed as agroclimate 7H, stretching from Subalpine into Alpine ecoregions (Strong and Leggat 1981). The unit is mainly unvegetated. Small patches of shrubby, grassy or alpine tundra vegetation cling to protected sites (up to 20% overall).

Nonsoils consisting of consolidated bedrock, mainly limestones, dominate (40-70%). Regosolic soils, mainly Orthic and Cumulic Regosols, are significant (20-40%), and developed in a thin discontinuous mantle of colluvium. The highly calcareous, very gravelly to cobbly colluvium exists in veneer, blanket or, sometimes, fan (talus) landforms. Overall, the long steep (>70%) slopes are inclined and have dissected by couloirs.

Inclusions are Orthic Eutric Brunisols associated with the vegetated patches; firn or glacier, mostly in a cirque on the north side of Phillipps Pk.; and rock glacier, also on the north side of Phillipps Pk. The unit is mapped on Turtle Mountain including the Frank Slide scar, the Livingstone Range, Mt. Tecumseh, and Phillipps Peak.

ZSA (Saline Patches) Miscellaneous Unit

ZSA (150 ha, 400 ac) is a compound unit that represents mappable saline seeps, mainly on the Cardston Plain and in the Porcupine Hills. It occurs in areas classed as agroclimates 2AH to 3H. Undisturbed vegetation resembles the prairie wetland flora of ZGL1 (Gleysolic areas) but includes plants that tolerate salts. Where cultivated, salt concentrations are high enough to interfere with the growth of most cereal and some forage crops. Various non-indicator weeds soon take over sites where cultivation has been abandoned.

The unit is characterized by two major groups of soils, both unnamed. Saline variants of various Humic Gleysols and Gleysols constitute one major group (30-60%). Saline variants of Rego Blacks constitute the other (20-40%). This last group dominates one tract in the Springridge area, perhaps others. Similar saline Rego Dark Brown soils dominate three small tracts in the Summerview area. Imperfectly drained saline Gleyed subgroups, mainly of Black soils, occasionally substitute for the major soils.

Across any ZSA tract, the majority of soils may range from weakly to strongly saline (Eilers 1985). These soils occur in fine and medium textured glaciolacustrine (lacustro-till), fluviolacustrine, lacustrine, and fluvial deposits that are also calcareous. The unit is found on level, inclined and apron surfaces, commonly with slopes of 0-9%.

Other inclusions, besides the saline Rego Dark Brown soils and saline Gleyed subgroups mentioned above, are non-saline soils like CWY, rCWY, CTN, and others; and various solonetzic-like and Solonetzic soils.

Only tracts of roughly 5 ha or larger, located outside of any "XXX3" (eg. CWY3) tract, were mapped. Many small (<5 ha) saline seeps are present throughout the survey area but could not be consistently identified for labelling. Delineation of larger saline seeps within "XXX3" soil units, already defined as having significant saline soils, was considered redundant.

Water Bodies

Various mappable water bodies (3150 ha, 7700 ac) are shown as pale blue polygons on the soil maps. Several are shown with their official geographic names. Rivers, lakes and permanent or semi-permanent sloughs are included.

Other Miscellaneous Landscapes

Other miscellaneous landscapes include built-up and urban areas (1800 ha, 4500 ac), identified as towns, plants and other man-made features, and the Frank Slide (350 ha, 800 ac).

APPENDIX C
SELECTED SOIL INTERPRETATIONS

INTRODUCTION

Previous sections of this report deal with inherent soil and related terrain characteristics, their classification, and their distribution in the landscape. In Appendix C the soil and terrain characteristics, represented by 139 map and miscellaneous units, are regrouped, or interpreted, for three agricultural applications. These are land capability classification for arable agriculture, land capability for irrigation, and land capability ratings for range productivity.

The generalized ratings or capability classes are intended as guidelines for land use planners and managers. To determine a rating or class within each agricultural application, certain assumptions about the use must be made. Further, the most common or probable value must be selected where a range of values for any one characteristic can apply. Specific decisions about the typical or average properties for each mapping unit are not provided in the discussion that follows. But the end results, average or typical ratings, are listed (Table C3). Sufficient background information, including references, are also provided so that users of the report can re-interpret the mapping units using new sets of values. In addition to capability ratings, selected engineering data for some parent materials are listed (Table C4).

LAND CAPABILITY CLASSIFICATION FOR ARABLE AGRICULTURE

A new land capability classification system for Alberta was recently developed (A.S.A.C. 1987). It is more precise, rigorous and objective than the main system it replaces - the Canada Land Inventory (CLI): Soil Capability for Agriculture (Dept. of Forestry 1966, Brocke 1977). The basic concepts, however, are the same. Both systems have seven classes, with Class 1 having the highest capability (least limitations) and Class 7 the lowest capability (greatest limitations). General assumptions are also the same. Noteworthy among the seven assumptions (A.S.A.C. 1987) - present land use is not considered diagnostic, and off-farm economics including market accessibility are not considered.

Methodology

To become more objective than the CLI system, the new system adopted a quantitative indexing approach much like that of the Storie System (Storie 1933). A parcel of land to be rated starts with 100 index points. Points are deducted for different factors, according to predetermined scales and formula that rate the severity of each factor or limitation (A.S.A.C. 1987). The lowest set of index points remaining after deductions give the parcel of land its final rating, or capability class.

Three major components - climate, soils and landscape - are rated separately through the full index range (0-100) because each by itself can limit arable agriculture. Final ratings are based on the most limiting of the three, not on the accumulated total.

The seven capability classes, their definitions and index points are as follows.

Class 1 - no significant limitations for crop production (80-100 index points). Due to climatic limitations, there are no Class 1 lands in Alberta.

Class 2 - slight limitations that restrict the range of crops or require modified management practices (60-79 points).

Class 3 - moderate limitations that restrict the range of crops or require special management practices (45-59 points).

Class 4 - severe limitations that restrict the range of crops that can be grown or require special management practices or both (30-44 index points).

Class 5 - very severe limitations for sustained arable agriculture. Annual cultivation using common cropping practices is not recommended (20-29 index points).

Class 6 - such severe limitations that cropping is not feasible even on an occasional basis (10-19 index points).

Class 7 - no capability for arable agriculture (0-9 points).

Lands within any capability class are similar as to degree of limitation, not necessarily kind of limitation. Each class includes many different kinds of climate, soil and land characteristics, any one of which may be limiting for arable agriculture. The new system allows for the identification of specific factors, and the relative contribution of each through the point deduction indexing system. The most limiting factor(s) become land capability subclasses. For example, a parcel of land rated as 5T has very severe limitations (20-29 index points) with slope (T) being the main limiting factor. The three major components of the system and their associated subclasses are described below.

Climate (C), besides determining capability classes, can be used to classify soils and map their distribution, as described in previous sections of this report. Agroclimatic classes were established, based on an energy or heat (**H**) factor and a moisture or aridity (**A**) factor. The H subclass is assessed by effective growing degree days (EGDD), the A subclass by growing season precipitation minus potential evapotranspiration (P-PE).

For the soils component, either mineral (S) or organic (O) soils may be evaluated. Organic soils are uncommon in the Pincher-Crowsnest area, thus mineral soils and their subclass factors are emphasized. Mineral soil factors are divided into surface factors and subsoil factors. Surface factors are considered more important than subsoil factors, thus receive greater point deductions. Some factors are considered in both the surface and subsoil. Mineral soil factors and their identifying symbols are:

D - structure and consistence,
E - depth of Ah or Ap (topsoil),
F - organic matter content,
K - calcareousness,
M - texture,
N - salinity,
O - organic or peaty surface,
R, D, M - depth to nonconforming layer,
V - acidity or alkalinity,
W - drainage, and
Y - sodicity (saturation percentage).

The landscape component (L) takes into consideration ground surface and topographical features that can restrict arable agriculture. Landscape factors are slope steepness and length (**T**), stoniness (**P**) and landscape patterns (**J**) that present obstacles to cultivation practices.

The A.S.A.C. (1987) document provides a more detailed explanation of each factor. Guidelines, scales and formulas for determining point deductions are included. Deductions for all appropriate factors can be entered on a two-page form. By following the indexing sequence and formulas specified by the form, final index points can be calculated and a capability rating or class determined for any parcel of land.

Results

The new land capability system was designed to enable a variety of users to rate individual parcels of land, even those of only a few hectares in size. The system is less suited to rating generalized mapping units, particularly in the Pincher-Crowsnest survey where a map unit can represent several tracts of land with considerable variability in some factors. Often the variability in any one factor, especially in the soils component, will not be enough to change capability class. In a few cases, variability in one or more factors will change capability by one class, perhaps more than one class if the land belongs to a miscellaneous unit. Climate factors are most likely to cause rating changes.

Table C3 lists the median or conceptual (most typical) capability class(es) for each map and miscellaneous unit. As pointed out above, mapping units can have some factors that vary considerably. Indexing with different values, corresponding to the factor variability, may result in up to one capability class variance from the typical.

Summary

Approximately 30% (81 400 ha, 201 000 ac) of the survey is classified as land capability class 3. The main limitations that result in class 3 capability are inadequate heat units (H) or inadequate moisture supplying ability, a factor that relates texture (M) to moisture index. Excessive slope steepness and length (T) is also a factor in some map units.

All land belonging to capability class 3 is classed as agroclimate subclass 2AH, 2HA, or class 3H, and occurs in areas of Dark Brown and thin Black soils (Fig. 23). Most of this land occurs on the Cardston Plain, a significant portion on the Goose Lake Bench and in the Porcupine Hills (Fig. 2). Most of this land is cropped, mainly to barley and wheat.

Class 3 is the highest capability rating in the survey area, as determined on generalized mapping unit concepts. Some individual fields, especially in the Rouleau Lake - Springridge area, might be classified as capability class 2. Agroclimate would have to be warmer than 3H, moisture not too limiting (P-PE index around -300), and surface textures quite fine (SiL or finer) to fit class 2 limits.

Approximately 18% (49 900 ha, 123 000 ac) of the survey area is classified as land capability class 4. The main limitations (subclasses) are inadequate heat units (H), inadequate moisture supplying ability determined by texture (M) and moisture index, and excessive slope steepness and length (T). Other factors include salinity (N), excessive calcareousness (K), undesirable structure and consistence or shallow depth to a paralithic layer (D), and excessive stoniness (P).

Most of the land belonging to capability class 4 occurs in areas of thick Black soils (Fig. 23), and is classed as agroclimate 4H. Such areas are common in the Southern Foothills and Porcupine Hills (Fig. 2). The remainder occurs in areas of thin Black and Dark Brown soils where the climate is warmer and drier. The majority is used as rangeland and pasture, a significant portion is cropped to forages, oats and barley.

Approximately 18% (49 800 ha, 123 000 ac) of the survey area is classified as capability class 5. The main limitations (subclasses) are inadequate heat units (H), and excessive slope steepness and length (T). Other factors include inadequate moisture supplying ability due to coarse textures (M), excessive calcareousness (K), and excessive stoniness (P).

Most of the land belonging to capability class 5 is classed as agroclimate 5H, and occurs where the soils are transitional from Chernozemic to Luvisolic or Brunisolic. The predominant natural cover is decidious forest and the main agricultural use is grazing. Some of this land is cropped to forages.

Approximately 30% (80 100 ha, 198 000 ac) of the survey area is classified as land capability classes 6 and 7. Limiting factors include inadequate heat units (H), excessive slope steepness and length (T), excessive wetness (W), excessively coarse texture (M), excessive stoniness (P), and excessive rockiness (R).

Most of the land belonging to classes 6 and 7 occurs in the foothills and mountains. Most is forested in its natural state. Agricultural use is negligible and is limited to grazing.

LAND CAPABILITY FOR IRRIGATION

Introduction and Methodology

Land capability for irrigation is determined in much the same manner as capability for arable agriculture. A provincial system that evaluates soil and topographic qualities is used widely (Land Classification Branch 1983). Physical characteristics that affect water delivery systems, infiltration rates and water storage are emphasized. Chemical properties that affect water quality and crop growth are also important. Land in the Pincher Creek-Summerview area (Hardy Assoc. Ltd. 1986), Cowley area (Hardy BBT Ltd. 1987), and the Peigan Indian Reserve (Harron 1982) has been surveyed, using the Land Classification Branch (1983) guidelines to rate irrigability.

Land irrigation capabilities for the mapping units of the Pincher-Crowsnest area (Table C3) were determined by adding a climatic component to the Land Classification Branch (1983) procedures. The climatic factor is energy or heat units, measured as EGDD, and introduces economics into the ratings system. In the cooler climates, cropping options are limited, as is the economic return per unit area. Cropping options, including crops with high economic returns, are far more varied above about 1500 EGDD (A.S.A.C. 1987). Best possible irrigation capability, assuming that soil and topographic qualities are not limiting, are correlated with agroclimatic classes (A.S.A.C. 1987) and approximate EGDD ranges for the Pincher-Crowsnest area in Table C1.

Like the new arable agriculture rating system, the land irrigation capability system uses a semi-quantitative indexing approach to determine classes. Soil and topography are rated separately, with points awarded to different factors according to predetermined scales, modifiers and formulas (Land Classification Branch 1983). Points are multiplied to arrive at final rating categories for soils and for topography. The rating categories for climate (Table C1), soils and topography are compared to determine capability class. The most limiting category usually becomes the capability class, especially if its climate. Combinations of soil and topography categories in some cases dictate a capability class that is more restrictive than each by itself (Land Classification Branch 1983).

Table C1. Correlation of agroclimatic classes and subclasses, approximate EGDD, and best possible irrigation capability.

Agroclimatic Class or Subclass	Approximate EGDD	Best Possible Irrigation Capability
2AH	>1250	2C
2HA	1180-1250	3C
3H	1050-1180	4C
4H	950-1050	5C
5H	700-950	6C
6H	<700	6C

The six irrigability ratings (capability classes) are defined as follows.

Class 1 - excellent capability with no significant limitations for irrigation.

Class 2 - good capability with moderate limitations.

Class 3 - fair capability with moderately severe limitations.

Class 4 - restricted capability requiring special system design and/or special management.

Class 5 - not suitable for irrigation under existing conditions, but has sufficient potential to warrant additional investigation, possibly land improvements or reclamation.

Class 6 - non-irrigable.

Lands within any capability class are similar as to degree of limitation, not necessarily kind of limitation. The most limiting factor or factors are indicated as subclasses attached to the class symbol. A climatic limitation, namely insufficient heat units, is indicated as C. Soil and topography limitations, only some of which correspond to arable agriculture capability subclasses, are as follows.

Soil limitations:

- **D** - low permeability/undesirable structure,
- **E** - erosion damage,
- **I** - periodic flooding,
- **K** - shallow profile development,
- **M** - low moisture holding capacity,
- **N** - sodicity,
- **R** - shallowness to bedrock,
- **S** - salinity, and
- **W** - excessive wetness.

Topography limitations:

- **B** - brush/tree cover,
- **F** - surface drainage,
- **G** - steep slopes,
- **J** - field size, shape (obstacles),
- **P** - stoniness,
- **RB** - rough broken, and
- **U** - earth moving (for leveling and ditch construction).

Results

The irrigation capability system was designed to classify individual parcels of land. It is less suited to rating generalized mapping units, particularly in the Pincher-Crowsnest survey where a map unit can represent several tracts of land with variability in some factors. Variability will be sufficient in some cases, particularly climate, to change irrigation capability by one class. Table C3 lists the median or conceptual (most typical) capability

class(es) for each map and miscellaneous unit. These ratings can be used for preliminary stratification on a regional scale. Individual parcels of land will require further investigation to collect more detailed information. Table C3 also lists irrigability ratings (Land Classification Branch 1983) for comparison purposes.

Summary

Most of the Pincher Creek-Crowsnest Pass survey area is not well suited for irrigation. When the climatic component (C) is considered, only about 12% (31 500 ha, 78 000 ac) of the area is classified into capability class 3 and about 15% into class 4 (Table C3). The relatively cool climate of the area limits the cropping options to mainly cereal grains, forages and oilseeds. Thus the potential economic return per unit area is also limited.

In areas where agroclimate is the warmest (ie. subclass 2AH and Dark Brown soils, Fig. 14 and 23), soil factors such as erosion damage (E), low permeability/undesirable structure (D), salinity (S), low moisture holding capacity (M), and shallowness to bedrock (R) limit capability for irrigation. Topographic factors such as brush/tree cover (B), surface drainage (F), steep slopes (G), and irregular field shape and size (J) often limit capability for irrigation in other areas.

When climate is not a consideration as in the Land Classification Branch (1983) procedures, irrigability ratings may be substantially different than irrigation capability classes for some units (Table C3). Some of the capability class 3, 4 and 5 lands were re-classified as irrigability rating class 2 land when the adverse climate limitation was disregarded. Approximately 17% (46 700 ha, 115 00 ac) of the area is rated as class 2. The main limitations (subclasses) affecting the irrigability class 2 land are low permeability/undesirable structure (D), steep slopes (G), erosion damage (E), low moisture holding capacity (M), and excessive wetness (W).

LAND CAPABILITY RATINGS FOR RANGE PRODUCTIVITY

Capability ratings for range productivity gauge the relative abilities of different soil landscapes to produce forage, mainly native or comparable grasses and forbs. The ratings are qualitative estimates based on indirect measurements of climatic, soil, vegetative, and topographic factors. A tentative system to rate soil mapping units for range productivity was developed for recent soil surveys (Kjearsgaard *et al.* 1986, Brierley *et al.* In press). It evolved from various range condition and stocking rate guidelines (Wroe *et al.* 1972, Smoliak *et al.* 1988), and from methods of estimating range production from soil characteristics and precipitation (Cannon and Nielsen 1984).

Methodology

The starting point for the rankings is climate, with amount of precipitation being the most important factor. Thickness of topsoil (Ah horizon) and depth to carbonates (Ck horizon) are also important factors. Values for the three often linked variables can be estimated from the soil zones. Regression equations based on up to two of the three factors have been devised to estimate potential productivity (Cannon and Nielsen 1984). Potential productivity is estimated at roughly 1600 kg/ha on medium textured, Dark Brown, upland soils; 2000 to 3800 kg/ha on Black soils. At 45% carry-over of current year's growth, corresponding average yields, assuming good range condition, are roughly 700 kg/ha for Dark Brown, 900 to 1700 kg/ha for Black soils.

A seven class rating system, much like that for arable agriculture capability, has been developed for recent soil surveys (Kjearsgaard *et al.* 1986, Brierley *et al.* In press). Table C2 lists the classes, corresponding stocking rates, and estimated average dry matter yield. Assumptions include:

* 12 kg/day forage requirement per animal unit,
* 45% carry-over to maintain good range condition, and
* average yield estimated for good range condition at about half of the potential yield estimated for excellent range.

Table C2. Range productivity (capability) classes with corresponding stocking rates and average dry matter yield.

Capability Class	Stocking Rate (ha/AUY)[1]	Average Yield (kg/ha)[2]
1	<5	>1550
2	5-10	1550-775
3	10-16	775-500
4	16-24	500-325
5	24-36	325-220
6	36-60	220-130
7	>60	<130

Notes: 1. Hectares per animal unit year: divide by 5 to convert to acres per animal unit month.
2. Kilograms per hectare: multiply by 0.9 to convert to pounds per acre.

The classes above are based mainly on climate (**C**). Several other soil and landscape factors can adjust classes down or up. Symbols for the factors are borrowed from both the arable agriculture and irrigability ratings factors. The factors include fine earth texture and gravel (**M**), recent or eroded profiles identified as Rego and Calcareous subgroups or Regosolics (**E**), salinity (**N**), Solonetzic soils (**D**), Gleysolic soils or similar wetland (**W**), shallow depth to bedrock (**R**), topography (**T**), and bush or tree cover (**B**).

Results

Table C3 lists the median or conceptual (most typical) range productivity class for each map and miscellaneous unit. These ratings are only estimates, but can be used for preliminary stratification on a regional scale. The majority of rangeland in the survey area occurs in the Southern Foothills, Front Ranges and Porcupine Hills. However, all areas, including the extensively cultivated Cardston Plain, are rated so that potential for grazing can be compared across all landscapes.

Based on estimates of potential and average yields, most Black soils equate with Class 2 productivity (Table C2). Medium textured thick Blacks like DVG (Dunvargan) are situated at the high end of Class 2. In the moistest area northeast of Waterton Lakes NP, potential and average yields likely exceed 3400 and 1550 kg/ha respectively where mean annual precipitation exceeds 650 mm. Medium textured, thick Black, upland soils in this area likely fit Class 1.

Summary

Most of the Pincher Creek-Crowsnest Pass survey area is well suited for grazing according to the high capability ratings for range productivity (Table C3). Several map units, ac-

counting for about 29% of the map area, are rated as class 1 and 2. No other agriculture oriented capability classification system resulted in such high generalized ratings when determined with climate as a factor. More specifically, approximately 7% (19 400 ha, 48 000 ac) of the survey area is rated as class 1 capability for range productivity, 22% (60 200 ha, 149 000 ac) as class 2, 42% (113 400 ha, 280 000 ac) as class 3, 9% (24 900 ha, 62 000 ac) as class 4, 8% (21 300 ha, 53 000 ac) as class 5, and 9% (23 100 ha, 57 000 ac) as classes 6 and 7. The remaining 3%, mainly water bodies, is not rated.

Land rated as class 1 capability is non-forested and dominated by Orthic Black soils. It benefits from a significant proportion of potholes and sloughs which store moisture. Range productivity on most class 2 land is limited by climate (C), specifically moisture. Limiting factors on class 3 lands are mainly coarse texture (M), shallow depth to bedrock (R), weakly developed or eroded soils (E), and brush/tree cover (B). The same factors plus adverse topography (T) limit productivity on class 5 land. Limiting factors on class 6 and 7 lands include brush/tree cover (B), shallow depth to bedrock (R), and adverse topography (T).

Table C3. Land capability ratings for arable agriculture, irrigation and range productivity for all mapping units of the survey area.

Mapping Unit	Agricultural Capability	Irrigation Capability	Irrigability Rating[1]	Range Productivity
BDLT1/6-7	7T	6G	6G	6BR
BFRN4/3T	4M	4CJ	4MJ	3M
BFT4/3T	3M	4CJ	3ED	3M
BKE1/2	4MK	3ED	3ED	4E
BKE3/3	$3M^{80}$ $4MN^{20}$	5S	5S	4E
BKE6/3	3M	3ED	3ED	4E
BKVA6/4	$3M^{80}$ $4MD^{20}$	5R	5R	5ER
BRG6/3-4	6H	6C	6MB	6BM
BRG6/5-7	7T	6C	6MG	6BM
BUR1/3T	6MK	6M	6M	5ME
BUR5/4RT	5PMK	6M	6M	4ME
BUR5/5	5PMK	6M	6M	4ME
BVLT1/5	5H	6C	6B	4B
BVLT1/6	5HT	6G	6G	4B
BVLT6/5	5H	6C	6B	4B
BVLT6/6-7	7T	6G	6G	4B
BVLT9/5	$5H^{80}$ $6W^{20}$	6C	6BF	4B
BVOK1/6	5HT	6G	6G	5BR
BZCT1/3	3H	4C	2DG	2C
BZCT1/4D	3HT	4CJ	4J	2C
BZCT1/4R	3H	4CR	4R	2C
BZCT4/3	3H	4C	2DEG	2C
BZCT4/4D	3HT	4CJ	4J	2C
BZCT4/4R	3H	4CR	4R	2C
BZNF1/4	$3HM^{2}$	5R	5R	3R
BZNF4/5-7	6T	6GR	6GR	4RE
BZOK1/4-5	$4H^{3}$	5CR	5R	3R
BZOK1/5-6	5T	6GR	6GR	3R
BZOK4/4-6	$5T^{4}$	5RGJ	5RGJ	3R
BZR1/3	3H	4C	2G	2C
BZR1/4	3H	4CF	4F	2C

Table C3 continued.

Mapping Unit	Agricultural Capability	Irrigation Capability	Irrigability Rating[1]	Range Productivity
BZR1/4D	3HT	4CJ	4J	2C
BZR1/4R	3H	4CR	4R	2C
BZR1/5D	4T	5GJ	5GJ	2C
BZR2/3	$3H^{80}$ $6W^{20}$	5WF	5WF	1
BZR2/4	$3HTJ^{80}$ $6W^{20}$	5WF	5WF	1
BZR3/4D	4TJ	5S	5S	2C
BZR4/3R	3H	4CR	4R	2C
BZR4/4D	3HT	4CJ	4J	2C
BZR4/4R	3HT	4CR	4R	2C
BZR4/5D	4T	5GJ	5GJ	2C
BZR6/5	4TP	4GF	4GF	2C
COCR6/5-6	5H	6CG	6BG	4B
CRW6/3	4H	5C	2MG	2C
CRW6/4-5	4H	5C	4GF	2C
CTBZ7/3	$3H^{80}$ $4DN^{20}$	5DN	5DN	2C
CTN1/2	3H	4C	2D	2C
CTN1/3	3H	4C	2DG	2C
CTN2/3	$3H^{80}$ $6W^{20}$	5WF	5WF	1
CTN3/3	$3H^{80}$ $4MN^{20}$	5S	5S	2C
CWOD1/2	3M	3C	2DE	3E
CWOD1/3	3M	3C	2DEG	3E
CWOD1/3T	3M	4J	4J	3E
CWPS1/3	3HM	4C	2DEG	3E
CWPS1/4R	3HM	4CR	4R	3E
CWY1/2	3M	3C	2DE	3E
CWY1/3	3M	3C	2DEG	3E
CWY2/3	$3M^{80}$ $6W^{20}$	5WF	5WF	2CE
CWY3/2	$3M^{80}$ $4MN^{20}$	5S	5S	3E
CWY3/3	$3M^{80}$ $4MN^{20}$	5S	5S	3E
DRLN4/3T	4HM	5C	4MJ	3M
DVBV1/4	5H	6C	5B	3B
DVBV1/4D	5H	6C	5B	3B
DVBV1/5	5H	6C	5B	3B
DVBV1/6	6T	6G	6G	3B
DVBV2/4	$5H^{80}$ $6W^{20}$	6C	5BWF	2B
DVBV2/5	$5H^{80}$ $6W^{20}$	6C	5BWF	2B
DVBV6/4	5H	6C	5B	3B
DVBV6/5-6	5HT	6C	6G	3B
DVBV9/4-5	$5H^{80}$ $6W^{20}$	6C	5BF	2B
DVFS1/3	4H	5C	2DG	2C
DVFS1/4	4H	5C	4F	2C
DVFS2/3	$4H^{80}$ $6W^{20}$	5WF	5WF	1
DVFS3/3	4H	5S	5S	2C
DVG1/3	4H	5C	2G	2C
DVG1/4	4H	5C	4F	2C
DVG1/4D	4HT	5C	4J	2C
DVG1/4R	4HT	5C	4R	2C
DVG1/5D	5T	5CJ	5GJ	2C
DVG1/5R	4HT	5CR	5R	2C

Table C3 continued.

Mapping Unit	Agricultural Capability	Irrigation Capability	Irrigability Rating[1]	Range Productivity
DVG2/3	$4H^{80}$ $6W^{20}$	5W	5WF	1
DVG2/4	$4H^{80}$ $6W^{20}$	5WF	5WF	1
DVG6/4	4HTP	5C	4F	2C
DVG6/5	4HTP	5C	4GF	2C
DVG6/6	6T	5G	6G	2C
DVG9/4	$4HT^{80}$ $6W^{20}$	5WF	5WF	1
DVG9/5	$4HT^{80}$ $6W^{20}$	5WF	5WF	1
DVMF1/3D	4H	5C	4J	2C
DVOK1/5-6	6T	6GR	6GR	3R
DVOK6/5-6	6T	6GR	6GR	3R
FRK1/8-9	7T	6GR	6GR	7BTR
FRK4/8-9	7TR	6GR	6GR	7BTR
KNT6/3	3HM	4C	2MG	3M
KNT6/4	3HM	4CF	4F	3M
LNB1/3T	5M	6M	6M	4M
MAC1/3T	6M	6M	6M	5M
MFT8/2	$4H^{5}$	5CW	2EW	3B
MFT8/3	$4H^{5}$	5CW	2EWG	3B
MGOT5/5R	5HTP	6C	6BR	4B
ODM6/3	3HM	4C	2EMG	3E
ODM6/4	3HMT	4CF	4F	3E
OKNF1/6-7	7T	6GR	6GR	3R
OKPP1/6-7	7T	6GR	6GR	3R
OKY4/6-7	7T	6GR	6GR	3R
OSCF1/5	4M	4GF	4GF	4M
OSOA6/3	4M	3M	3M	4M
OSOA6/4	4M	4F	4F	4M
OTBV1/4	5HTP	6C	6BM	3B
OTBV1/5	6TP	6C	6BMF	3B
OTBV1/6-7	7TP	6G	6G	3B
OTP1/4	5TP	5M	5M	2C
OTP1/5	6TP	5M	5M	2C
PSO1/4R	3HMT	4CR	4R	3E
RND4/3T	5M	6M	6M	4M
SOBZ1/3	3H	4C	2G	2C
SOF1/3	3H	4C	2G	2C
SPBE1/6-7	7T	6G	6G	5RB
SPLT1/5	5HT	6C	6B	5B
SPLT1/6	6HT	6G	6B	5B
SPLT1/7	7T	6G	6G	6TB
SPLT9/4-5	$5H^{80}$ $6W^{20}$	6C	6G	4B
SPR1/5-6	6H	6G	6BF	5B
SPR6/5-6	6HTP	6G	6G	5B
SPWL1/7-8	7T	6G	6G	6TB
TDBV2/4	$5H^{80}$ $6W^{20}$	6C	6G	3B
TDC6/5	5HTP	6C	6BW	4B
WLBE1/7-8	7T	6G	5B	6BTR
ZAV1	$3HM^{70}$ $5TJ^{30}$	5JG	6G	3E
ZAV6	5M	5M	5M	5BEM

Table C3 continued.

Mapping Unit	Agricultural Capability	Irrigation Capability	Irrigability Rating[1]	Range Productivity
ZAV7	$5H^{80}$ $6W^{20}$	6C	5B	4B
ZDL	$5H^{6}$	6C	NR[7]	NR[7]
ZGL1	6W	5W	5W	2-4[8]
ZGL7	6W	6C	5W	4WB
ZRB1	6T	6G	6G	3E
ZRB4	$6T^{70}$ $3HM^{30}$	6GJ	6GJ	3E
ZRB7	7T	6G	6G	5TB
ZRB8	$7T^{70}$ $5H^{30}$	6GJ	6GJ	5TB
ZRO	7HTR	6GR	6GR	7RT
ZSA	6NMW	6S	6S	4NE

Notes: 1. Determined according to Land Classification Branch (1983) procedures which exclude consideraion of a climate component.
2. This rating does not consider that the soils are very susceptible to wind erosion due to exposure.
3. Located high on ridge tops, this terrain is usually inaccessible to machinery and susceptible to wind erosion.
4. Very complex terrain with some gently sloping patches that might be classified 4R or 4J.
5. Roughly 40% of these map units are also affected by imperfect to poor drainage (factor W).
6. Soils and topography not rated.
7. Not rated.
8. Variable due to climatic variability.

SELECTED ENGINEERING DATA

Twenty-one soil profiles were sampled to represent soil series and equivalents used in mapping the soils of the Pincher-Crowsnest area. These were newly identified, previously unsampled, or inadequately characterized series and variants. Eighteen had one or more C horizon (BC horizon in one case) that were submitted for routine engineering tests. Results of those tests are presented in Table C4, organized according to types of parent geomorphic materials as in the legend. Data from two other major soil series, CTN and BZR, that were sampled in Cardston MD (Brierley *et al.* In press) are included.

The engineering tests, based on standard procedures (C.S.S.C. 1978), included wet and dry sieve analysis (1, $^{3}/_{4}$ and $^{5}/_{8}$ inch and #4, #10, #40, and #200 sieves), and tests for liquid limit and plastic limit (Atterberg limits). The sieve data were used to plot grain size curves and, in conjunction with the Atterberg limit data, to determine the Unified soil classification (Portland Cement Association 1962) for each sample.

The limited number of samples and engineering tests are sufficient to give an overview of physical soil qualities which might affect certain engineering uses. The data may provide initial insights into properties such as load bearing capacity, aggregate suitability, shear strength, or filtration capacity. The selected data represent a portion of the total soil varability that is encountered throughout the survey area. On-site investigations and additional analyses are recommended to obtain more detailed information for specific uses and projects.

Table C4. Selected engineering data for selected subsoil samples.

Series[1]	Horizon	Percent Passing Sieve 3/4"	#4	#10	#40	#200	% LL[2]	PI[3]	Unified Class
Coarse textured, skeletal (extremely to very gravelly), gravel deposits:									
BUR	Ck3	42	22	17	9	3	NL	--	GP
LNB	Ck	54	25	16	4	1	NL	--	GW
MAC	Ck2	42	24	20	7	1	NL	--	GP
DRW	Ck	59	34	24	13	1	NL	--	GW
kBRGv	Ck	55	30	13	5	1	NL	--	GP
Fine textured, glaciolacustrine deposits:									
BKE	Ck3	100	100	99	99	96	55	30	CH
CWY	Ck2	100	100	100	100	96	53	30	CH
CTN	Ck	100	100	100	100	89	51	31	CH
Medium textured, water-laid (glacio- or fluviolacustrine, fluvial) deposits:									
OSN	Ck2	100	100	100	99	61	22	4	CL-ML
ODM	Ck2	100	100	100	98	82	28	9	CL
"	Ck3	100	99	99	99	77	23	5	CL-ML
MFT	Ck2	100	100	100	97	82	38	14	CL
"	Ck3	100	100	100	100	90	36	18	CL
Coarse textured, water-laid (glaciofluvial, fluvial) deposits:									
OSN	Ck3	100	100	100	98	44	NL	--	SM
"	Ck4	100	100	100	96	16	NL	--	SM
CONv	Ck1	100	100	100	99	42	NL	--	SM
"	Ck2	100	100	100	100	16	NL	--	SM
CRW	Ck1	100	100	100	96	25	20	2	SM
"	Ck2	100	100	100	96	18	NL	--	SM
Medium textured, skeletal, fluvial mudflow material:									
TDC	Ckgj	30	16	8	5	13	28	9	GC
Medium textured, skeletal, ice contact (till-like) material:									
MGV	Ck2	79	64	57	32	28	19	2	GM-SM
Coarse textured, gravelly, mixed till influenced by sandstone bedrock:									
NFK	Ck2	68	66	65	60	23	19	3	SM
Medium textured, mixed origin till:									
PSO	Ck2	100	99	98	92	68	33	16	CL
BZR	Ck	100	98	97	93	58	35	19	CL
Medium textured, gravelly, mountain till:									
WLB	IIBC3	97	81	69	36	33	23	7	SM-SC

Table C4 continued.

Series[1]	Horizon	Percent Passing Sieve 3/4"	#4	#10	#40	#200	% LL[2]	PI[3]	Unified Class
Medium textured, skeletal colluvium:									
FRK	Ck	27	17	17	16	11	35	2	GP-GM

Notes: 1. Or equivalent, eg. variant.
2. Liquid limit, expressed as % water on an oven dry basis. NL means non-liquid.
3. Plasticity index, calculated by subtracting plastic limit (% water) from liquid limit.

APPENDIX D
GLOSSARY OF TERMS

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

Apron A relatively gentle slope at the base of a steeper slope, and often formed by materials from the steeper slope. Some aprons are formed by coalescing fans.

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

Aspen Trembling aspen (*Populus tremuloides*).

Atterberg limits The moisture contents, expressed as percent water on an oven dry basis, at which a soil mass will change from one physical state to another. The Atterberg limits most useful for engineering purposes are liquid limit and plastic limit. **Liquid limit** is the moisture content at which a soil mass passes from plastic to liquid state. **Plastic limit** is the moisture content at which a soil mass passes from semi-solid to plastic state.

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. Bedrock usually outcrops were the unconsolidated materials are shallow.

Benchland The land situated in, or forming, a bench, or a land surface composed largely of benches (Gary *et al.* 1972). In this study, benchland refers to the upper part of a valley floor, extending from the base of a steep valley (mountain) wall to the **bottomland**. Benchland terrain consists mainly of hummocky and ridged landforms composed of glacial till and ice contact deposits, sometimes overlying bedrock at shallow depth.

Blanket A mantle of unconsolidated material thick enough (usually more than 1 m) to mask minor irregularities in the underlying material but retain its overall general topography.

Bottomland The stream-cut, lower portion of a valley floor; the lowest part of a mountain valley. Bottomland contains a stream, its floodplain, and, in some cases, terraces, some of which may be of glacial origin. Steep erosional banks mark the edge of the bottomland, and lead to the **benchland** above.

Calcareousness 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.

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

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

Channelled Describes a land surface that is crossed by a series of abandoned stream channels.

Channers See **coarse fragments.**

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 (refer to Fig. 18).

Clayey A particle size class, used mainly at the Family level of taxonomy, in which the fine earth portion contains 35% or more clay by weight and coarse fragments occupy less than 35% by volume.

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).

Coarse-loamy A **loamy** particle size class that has 15% or more by weight of fine to very coarse sands and less than 18% clay in the fine earth fraction.

Coarse-silty A **loamy** particle size class that has less than 15% by weight of fine to very coarse sands and less than 18% clay in the fine earth fraction.

Coarse textured A broad textural grouping that refers to soils or materials dominated by sand, loamy sand, and sandy loam textural classes (see Fig. 18).

Cobbles See **coarse fragments.**

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

Colluvium Any loose, heterogeneous and incoherent mass of soil material and rock fragments deposited chiefly by gravity (Gary *et al.* 1972). Movement includes slow dis-

placement such as soil creep and rapid events such as landslides, avalanches and rockfalls (E.C.S.S. 1987b).

Compound unit A soil or map unit that is characterized by two to four major soils or groups of soils. For example, BZCT1 is based on the codominant BZR (Beazer) and CTN (Cardston) series. As an example of the extreme, DVBV9 is characterized by four major groups of soils: DVG (Dunvargan) series and paraskeletal variant, BVA (Beauvais) series and paraskeletal variant, coarser textured variants of both the DVG and BVA groups, and imperfectly to very poorly drained soils (Gleyed subgroups, Gleysolics and water) of **potholes** and **sloughs**.

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

Control section The vertical section of soil upon which classification is based (E.C.S.S. 1987b). 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.

Cottonwood A generic term used in this report to include black cottonwood (*Populus trichocarpa*), balsam poplar (*Populus balsamifera*) and narrowleaf cottonwood (*Populus angustifolia*). Black cottonwood and balsam poplar are very similar and interbreed (Hosie 1969).

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

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

Edaphic (i) Of or pertaining to the soil. (ii) An ecological condition resulting from, or influenced by, factors inherent in the soil or other substrate rather than by climatic factors.

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

Eolian Well sorted materials, predominantly sand and silt, deposited by wind.

Erodible Susceptible to erosion. It may be expressed in terms such as highly erodible or slightly erodible.

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.

Erratic A transported rock fragment different from the bedrock where it lies. 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.

Fan A fan-shaped landform with a perceptible gradient from its apex to the toe.

Fine-clayey A **clayey** particle size class that has 35-60% clay in the fine earth fraction.

Fine earth Mineral soil material 2 mm equivalent diameter or smaller.

Fine-loamy A **loamy** particle size class that has 15% or more by weight of fine to very coarse sands and 18-35% clay in the fine earth fraction.

Fine-silty A **loamy** particle size class that has less than 15% by weight of fine to very coarse sands and 18-35% clay in the fine earth fraction.

Fine textured A broad textural grouping that refers to soils or materials dominated by clay, sandy clay, silty clay, and heavy clay textural classes (see Fig. 18).

Flags See **coarse fragments.**

Fluvial (alluvial) material Sediment deposited primarily by nonglacial flowing water, and by mudflows. The difference between glacial and nonglacial flow regimes is often indistinct, particularly in a historical sense.

Fluvioeolian material Sediment deposited by the combined action of water and wind. In this survey, fluvioeolian refers to material that was picked up from the windward side of bedrock ridges, deposited on the lee slopes of the same ridges, and then subjected to perturbations such as slopewash flow and soil creep.

Fluviolacustrine material Nongravelly medium textured (CL-SiCL-SiL-L) or finer sediments deposited by slowly moving water, both glacial and nonglacial. Material that is intermediate between fluvial and lacustrine materials as defined by E.C.S.S. (1987b). May also be termed fluvial lacustrine.

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

Glaciofluvial material Sediment deposited by flowing water in which volume and sediment load are strongly controlled by melting glacier ice.

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).

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.

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.

Horizon A layer of soil or soil material approximately parallel to the land surface; each horizon differs from genetically related layers in properties such as color, structure, texture, consistence, and chemical, biological, and mineralogical composition. Detailed definitions of the various horizons and layers may be found in *The Canadian System of Soil Classification* (E.C.S.S. 1987b).

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%.

Humus (i) The fraction of the soil organic matter that remains after most of the added plant and animal residues have decomposed. It is usually dark colored. (ii) Humus is also used in a broader sense to designate the humus forms referred to as forest humus, mainly mor, moder and mull. (iii) All the dead organic material on and in soil that undergoes continuous breakdown, change and synthesis.

Ice contact stratified drift Partially sorted material deposited in contact with melting glacier ice but with concomitant 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 stratified drift.** The individual materials are not mappable 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.

Inclined A sloping, unidirectional surface not broken by marked irregularities. Slopes are 2-70%.

Inclusion A soil (or other feature) that comprises up to 15 or 20% of a unit. Some soil and map units contain several inclusions that together add up to a substantial percentage. **Recurrent inclusions** seem to always be present. A recurrent inclusion is generically defined as occupying 5-20% of a map unit; the actual proportion within individual polygons may be as little as 1 or 2% and as high as 25 or 30%. **Occasional inclusions** aren't always present but occur with sufficient frequency to be recognized. An occasional inclusion is generically defined as occupying 0-10% of a

map unit. In a few cases, an occasional inclusion comprises a substantial proportion (ie. 20 or 30%) of a polygon. Inclusions are not listed on the map legend.

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).

Landscape A distinct association of landforms plus their natural covering of soils and vegetation, or modified versions thereof, that distinguish one part of the earth's surface from another part.

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 calcareousness classes.

Liquid limit See **Atterberg limits.**

Lithic A general term referring to soils with consolidated (hard) bedrock within 1 m. **Shallow lithic** is a more specific taxonomic term describing soils with bedrock at 50-100 cm from the surface (E.C.S.S. 1987b).

Loamy A particle size class, used mainly at the Family level of taxonomy, in which the texture of the fine earth includes loamy very fine sand, very fine sand, and finer textural classes (see Fig. 18) with less than 35% clay by weight, and coarse fragments occupy less than 35% by volume.

Loamy-skeletal A particle size class characterized by 35% or more by volume of coarse fragments with enough fine earth to fill interstices larger than 1 mm; the fine earth fraction is that defined for the **loamy** particle size class.

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 The most general of the apportionment terms. It includes the dominant or codominant, significant, and other soils of widely ranging percentage that are necessary to form an mental concept of a soil or map unit.

Map/Soil Unit Components (i) **Similar components** (soils or nonsoils) are alike in most properties and have similar interpretations for most common uses. (ii) **Dissimilar components** have many contrasting properties, or have one or two properties that differ widely, and usually affect management differently. (iii) **Nonlimiting components** (soils or nonsoils) do not affect the management of the map or soil unit in a significantly different way than other components. Similar soils and dissimilar soils with less severe restrictions for use than the predominant soil are examples of nonlimiting components. (iv) **Limiting components** require significantly different land use interpretations from the other components of the map unit. (E.C.S.S. 1987a.)

Medium textured A broad textural grouping that refers to soils or materials dominated by loam, silt loam, silt, silty clay loam, clay loam, and sandy clay loam textural classes (see Fig. 18).

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

Morainal Of, relating to, forming, or formed by a **moraine** (Gary *et al.* 1972).

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.

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).

Munsell color system A color designation system specifying the relative degrees of the three simple variables of color: **hue**, **value** and **chroma**. For example, 10YR $^{6}/_{4}$ 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.

Occasional inclusion See **inclusion.**

Outwash Sediments washed out by flowing water beyond the glacier 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.

Paraskeletal Material or soils with a coarse fragment content of 15-35%.

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.

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.

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

Plastic limit See **Atterberg limits.**

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.

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).

Profile, soil A cut or exposure through a soil body that reveals its horizons and layers, including parent material.

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

Recurrent inclusion See **inclusion.**

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

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

Rill A narrow, very shallow, intermittent, often incipient water course having steep sides. It presents no obstacle to tilling.

Riser The short, steep break in slope that separates successive treads of a terraced landform (Gary *et al.* 1972).

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

Salinity classes Five classes that represent the amount of soluble salts, expressed as decisiemens per meter (dS/m) averaged over two depth ranges, 0-60 (upper root zone) and 60-120 cm (lower root zone), in the soil (Eilers 1985). The classes are nonsaline (<2 dS/m in the upper zone &/or <4 dS/m in the lower zone), weakly saline (2-4 in upper &/or 4-8 dS/m in lower zone), moderately saline (4-8 in upper &/or 8-16 dS/m in lower zone), strongly saline (8-16 in upper &/or 16-24 dS/m in lower zone), and very strongly saline (>16 dS/m in the upper zone &/or >24 dS/m in the lower).

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.

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 (refer to Fig. 18).

Sandy A particle size class, used mainly at the Family level of taxonomy, in which the texture of the fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures (see Fig. 18); coarse fragments occupy less than 35% by volume.

Sandy-skeletal A particle size class characterized by 35% or more by volume of coarse fragments with enough fine earth to fill interstices larger than 1 mm; the fine earth fraction is that defined for the **sandy** particle size class.

Seep An area, generally small, where water, or another liquid such as oil, 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.

Shallow lithic See **lithic.**

Significant A major soil (or other feature) that is clearly subordinate (subdominant) to the dominant. Minimum proportions are 15% if the significant soil is **dissimilar** and **limiting** relative to the dominant, 20% if **similar** or **nonlimiting**. Maximum percentages are 30 or 40% depending on proportions of dominant soils.

Simple unit A soil or map unit that is characterized, therefore dominated, by one major soil or soil group (E.C.S.S. 1987a).

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 (refer to Fig. 18).

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

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 (E.C.S.S. 1987b).

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 (E.C.S.S. 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 the parent material has been modified and in which most plant roots are contained. It usually consists of A and B master horizons.

Stones See **coarse fragments.**

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, but usually are not, 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.

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).

Taxadjunct A soil unclassified at the series level but enough like a classified series that it is identified as that series for naming map and soil units. A taxadjunct is considered adjunct to but not part of the series for which it is named (E.C.S.S. 1987a).

Terraced A surface form consisting of a **riser** and the horizontal or gently inclined surface (**tread**) above it.

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 (refer to Fig. 18).

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.

Tract A piece of land with recognizable landform, soil and vegetation features that can be delineated as a polygon on a map. Tracts should be no smaller than 10 ha (25 ac) in size to be shown on 1:50 000 scale maps.

Tread The flat or gently sloping surface of natural, step-like landforms, as those of a **terraced** landform (Gary *et al.* 1972).

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 (E.C.S.S. 1987a). The series name plus a modifier identify the variant which may then be used in naming map/soil units.

Varve A distinct band representing the annual deposit of sedimentary materials, regardless of origin, likely in glacial waters. It usually consists of two layers, a thick light colored layer of silt and fine sand laid down in spring and summer, and a thin dark colored layer of clay laid down in the fall and winter.

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

Very-fine-clayey A **clayey** particle size class that has 60% or more clay in the fine earth fraction.

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