GEOLOGY FIELD WORKSHOP FOR STAFF OF THE PRAIRIE WILDLIFE CENTRE

by

E.A. CHRISTIANSEN CONSULTING LTD.

REPORT 0018-001

for

PRAIRIE WILDLIFE SERVICE

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1.0 INTRODUCTION

The objective of the report is to: (1) to give a brief outline of major geological features of Canada along the Trans Canada Highway, (2) to give a geological overview of the Grassland Natural Region, (3) to focus specifically on the geology along Highway 1 between Ernfold and Gull Lake, and (4) to give a geological perspective of the Prairie Wildlife Centre property near Webb, Saskatchewan as set forth in the Contract for Project 6885, Canadian Wildlife Service.

2.0 MAJOR GEOLOGICAL FEATURES OF CANADA ALONG THE TRANS CANADA HIGHWAY

2.1 Introduction

The Trans Canada Highway crosses the Appalachian Region, St. Lawrence Lowlands, Canadian Shield, Interior Plains, and the Cordilleran Region (Fig. 1).

2.2 Appalachian Region

The Appalachian region of Canada comprises Nova Scotia, New Brunswick, Prince Edward Island, the Island of Newfoundland, and that part of the Province of Quebec that lies southeast of the Logan Fault.

The Appalachian region of Canada belongs to a larger unit commonly referred to as the Appalachian Mountain System streching from Alabama to Newfoundland, a distance of about 3200 kilometres. The Appalachian region of Canada is the northeast continuation of the New England physiographic province of Maine, New Hampshire, and Vermont.

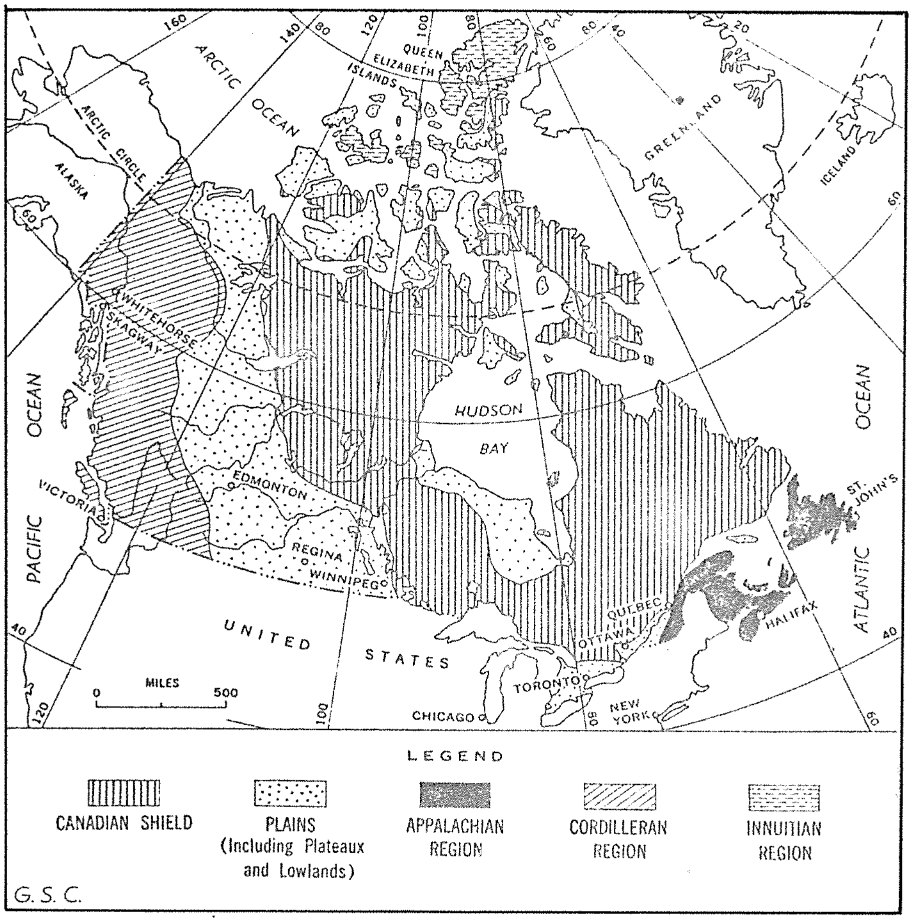

Figure 1. Physiographic and geologic regions of Canada.
From Stockwell (1957).

In Canada, the Appalachian region as a whole is a gently southeasterly sloping upland dissected by valleys and broader lowlands developed in belts of more easily erodible rocks. Much of the area is bounded by irregular coastlines forming deep embayments.

The Appalachian region of Canada is underlain mainly by Paleozoic rocks although both older and younger formations are present. The region underwent mountain building twice: the first at the close of the Ordovician, and the second, during Devonian time. These disturbances developed northeast trending structures which are so apparent in the physiography of the region.

2.3 St. Lawrence Lowlands

The St. Lawrence Lowlands (Fig. 1) are plain-like areas floored by unfolded Paleozoic rocks. The Niagara Falls are developed in interbedded limestones, dolomites, shales, and sandstones of this region. The bedrock is covered for the most part with thick deposits of glacial drift which is composed of glacial till, glacio-fluvial sands and gravels, and glacio-lacustrine silts and clays. Raised beaches surround the Great Lakes attesting to the presence of larger deeper glacial lakes in the region.

2.4 Canadian Shield

The Canadian Shield is a region of Precambrian rocks that forms the backbone of Canada (Fig. 1). The topography ranges from flat featureless plains to mountainous country. Although most of the Canadian Shield is a glacially eroded surface, sufficient deposition of glacial deposits has taken place to de-arrange drainage and produce a myriad of lakes so characteristic of the region. Most of the economic minerals come from this region, and much of the water power is generated here.

2.5 Interior Plains

The Interior Plains are underlain by Paleozic, Mesozic, and Cenozic rocks. The nearly horizontal rocks of this stable region are covered by a thick mantle of drift which is up to 300 metres thick. This region is composed of grasslands, forest, and tundra embracing parts of the prairie provinces of Manitoba, Saskatchewan, and Alberta, northeastern British Columbia, and much of the western District of Mackenzie, Northwest Territories. The Trans Canada Highway via Winnipeg, Regina, and Calgary traversed the southern prairie portion of this region.

2.6 Cordilleran Region

The Cordilleran Region forms part of the Circum-Pacific orogenic belt which is composed of a 800 - kilometre belt of mountains and plateaux, trenches, valleys, and fiords (Fig. 2). From east to west, the Trans Canada Highway crosses: (1) the Rocky Mountain Thrust Belt, (2) the Interior System of Mountains and Plateaux, and (3) the Western System of Mountains.

The Rocky Mountain Thrust Belt is composed of subparallel, west-dipping thrusts that produce narrow, linear mountain ranges from the resistant carbonate rocks. The Rocky Mountains were thrust eastward to form a distinct boundary with the foothills of Alberta. The western boundary is well marked by the Rocky Mountain Trench.

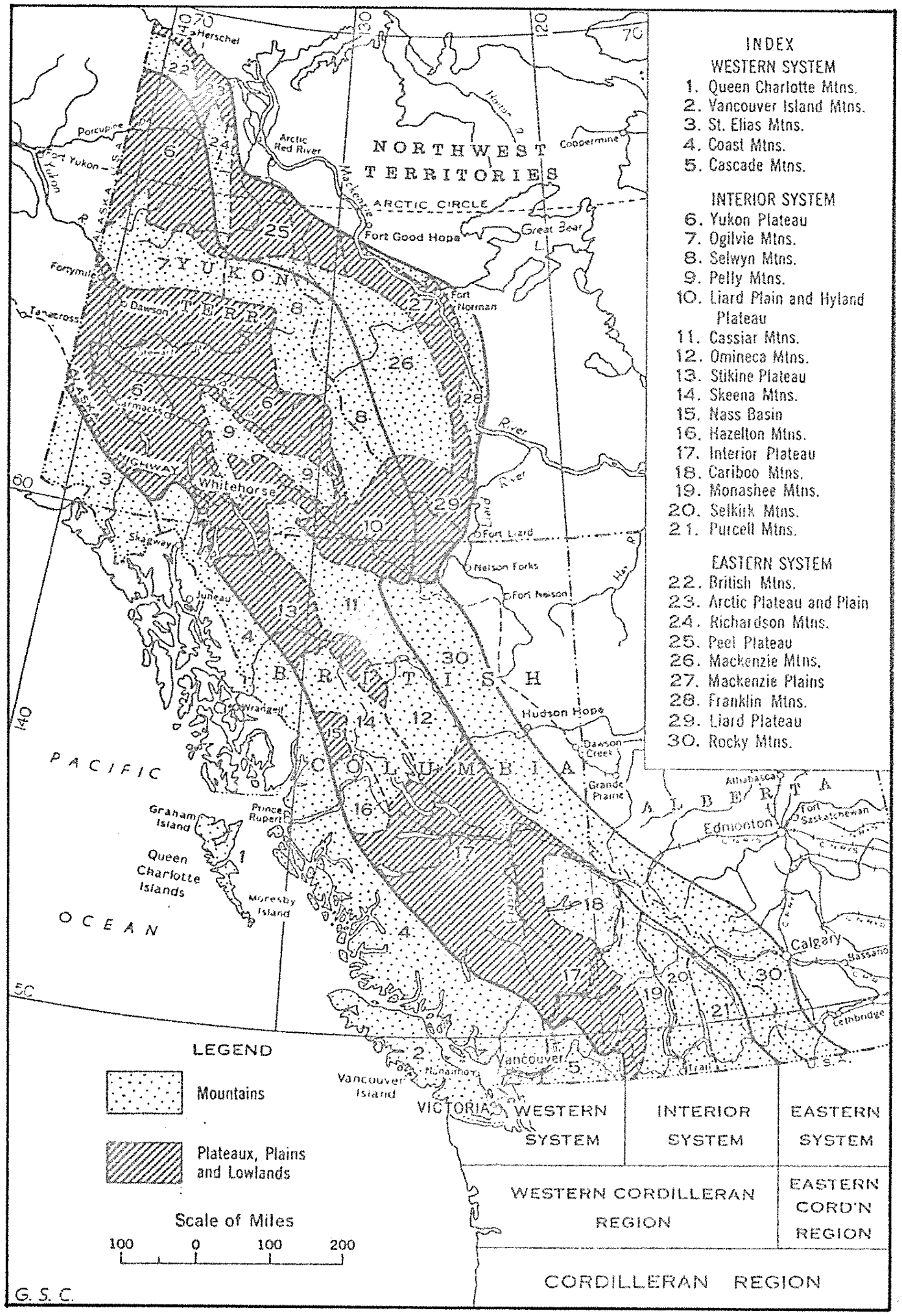

Figure 2. Physiographic divisions of the Cordilleran region. From Stockwell (1957).

The Interior System of southern British Columbia is composed of the Purcell, Selkirk, Monoshee, and Cariboo Mountains and the Interior Plateau. These four mountain groups, which occur between the Interior Plateau and the Rocky Mountain Trench, are separated from one another by distinct trenches. The Interior Plateau lies between these ranges of mountains and the Coast Mountains and is an old dissected upland.

The Coast Mountains (Fig. 2) rise abruptly from the Pacific Ocean toward the axis where peaks range from 2000 to 4000 metres. The Cascade Mountains project into British Columbia from the State of Washington. They lie on the east side of lower Fraser Valley which separates them from the coast Mountains and extend as far north as the Thompson River.

3.0 GEOLOGICAL OVERVIEW OF THE GRASSLAND NATURAL REGION

3.1 Introduction

The Grassland Natural Region encompasses southwestern Saskatchewan and southeastern Alberta (Fig. 3). The geology of this region is shown and discussed by Green (1971), McCrossan and Glaister (1964), McLean (1971), and Whitaker and Pearson (1972).

3.2 Geology

The Grassland Natural Region is underlain by Upper Cretaceous silts and clays and sands and sandstones and Tertiary sands and chert and quartzite gravels. These bedrock deposits were subsequently covered by 0 to 200 metres of glacial deposits.

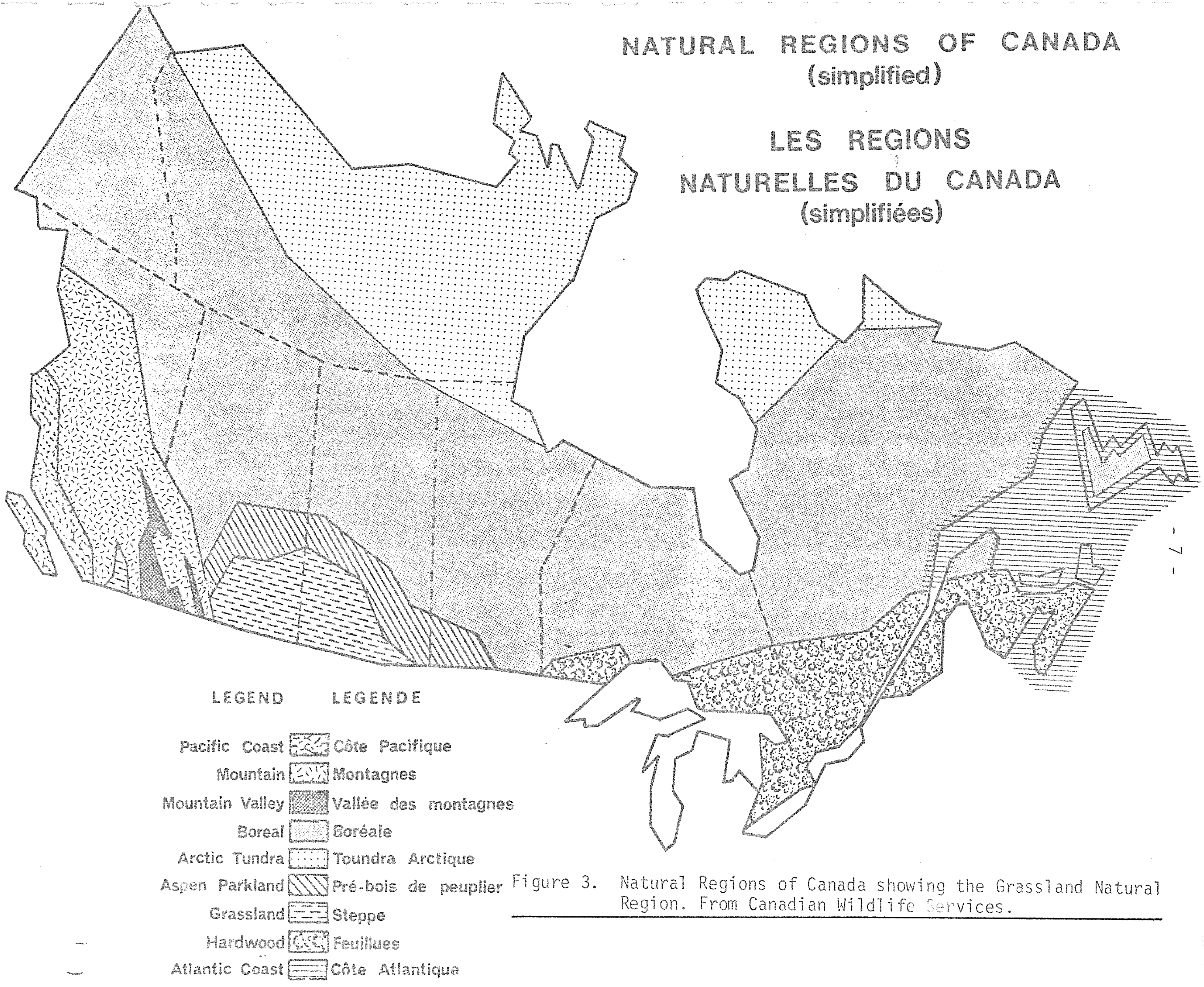

Figure 3. Natural Regions of Canada showing the Grassland Natural Region. From Canadian Wildlife Services.

During most of the late Cretaceous, a broad sea covered what is now the western Interior of North America from Alaska to the Gulf of Mexico. This sea was flanked on the west by the tectonically active Cordillera which supplied huge amounts of sediment to the sea. Eastward from the present Rocky Mountain front, the Upper Cretaceous succession forms a progressively thinning wedge of sediment extending 300 to 450 kilometres eastward and decreasing in thickness from a maximum of about 6000 metres near the western extremity to zero at the eastern erosional edge.

The deposits within this wedge record a remarkably consistent pattern of sediment throughout the Grassland Natural Region. In general, the sedmients consist of nonmarine deposits on the west bordering the mountains, predominately marine deposits in the east, and between, a complex intertonguing of marine and nonmarine sediments (Fig. 4).

During Tertiary time, large amounts of quartzite and chert gravels poured from the rising cordillera on to the Interior Plains to form a series of alluvial fans ending along the mountain front and protruding to the eastern boundary of the Grassland Natural Region. During the Oligocene Epoch of the Tertiary Period, the influx of sediment from the Cordillera was at its maximum, and alluvial fans of sand and gravel were spread across the Grassland Natural Region. The gravels which cap the Cypress Hill (Cypress Hills Formation) were fromed at this time.

After the Oligocene, the rivers coming from the Cordillera cut into the older alluvial fans leaving remnants to form uplands such as the Cypress Hills (Fig. 5a). As these streams continued to downcut, lower upland remnants were left capped with gravel which was deposited when the stream

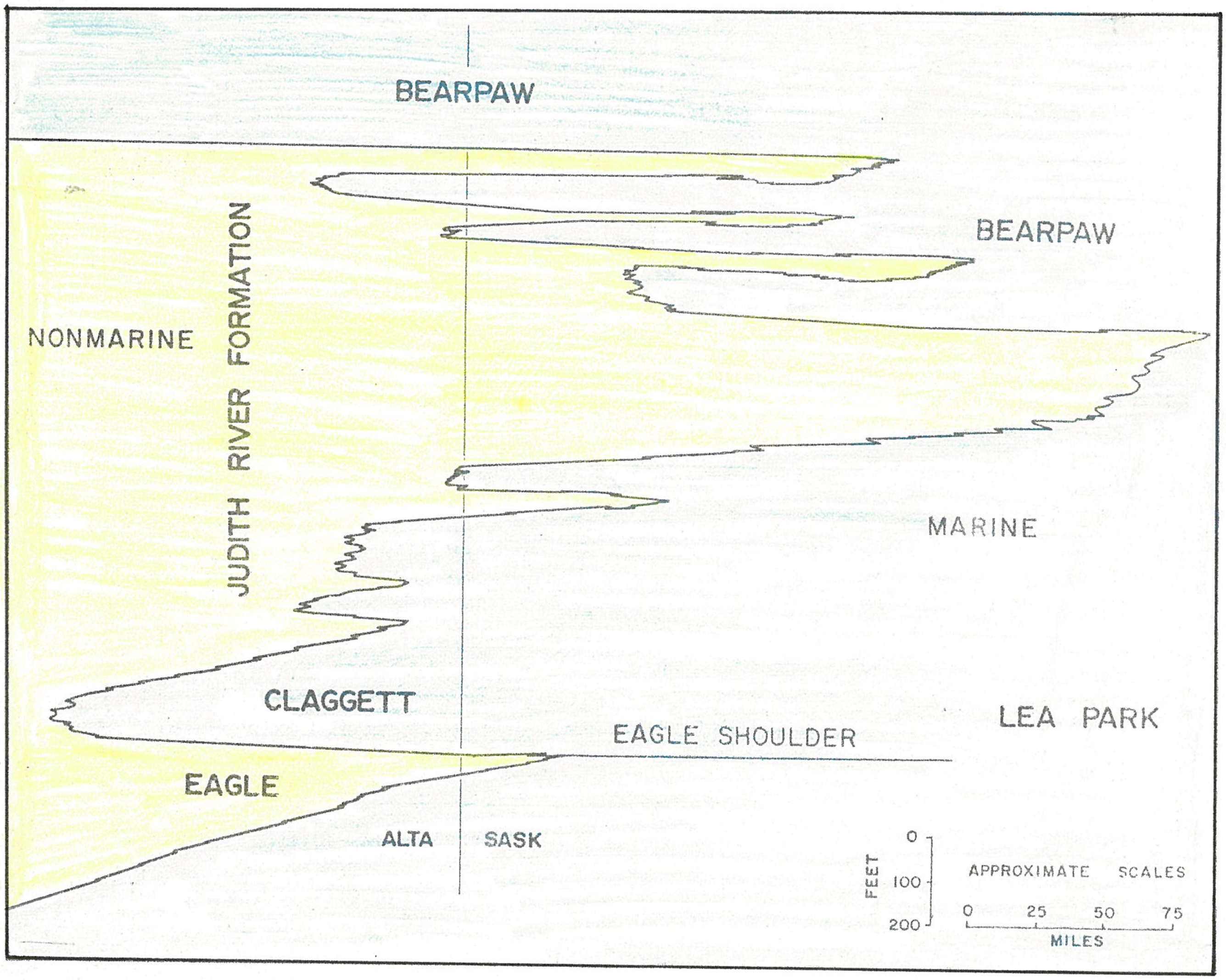

Figure 4. Schematic cross section across the Grassland Natural Region. From McLean (1971).

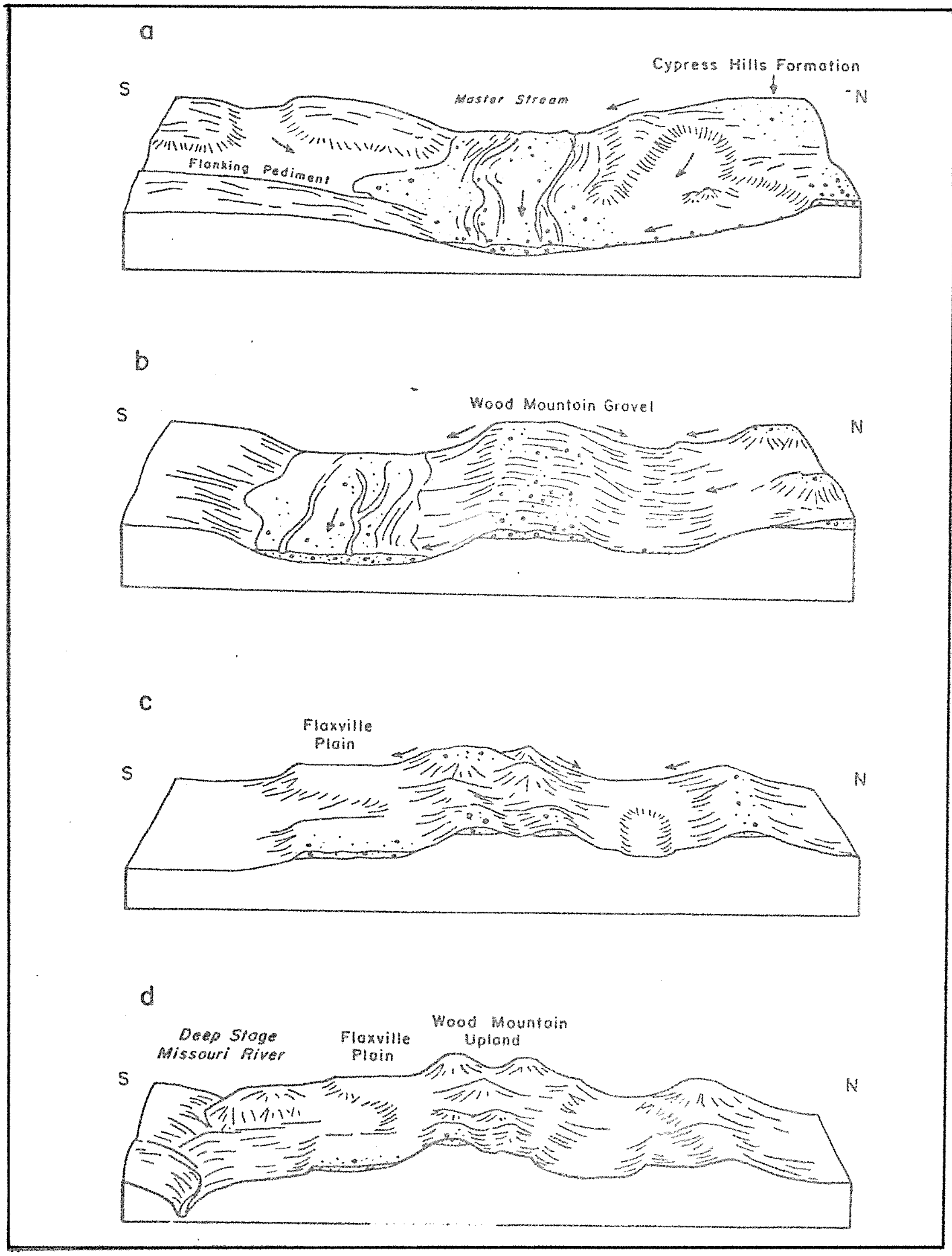

Figure 5. Schematic diagram showing the origin of Tertiary gravels in the Grassland Natural Region. From Parizek (1964).

was at a higher level (Fig. 5 b,c,d). During the final stage of down-cutting, which was terminated by glaciation, "preglacial valleys" were formed (Figs. 5d, 6). These valleys were either filled with glacial deposits or were removed in part or completely by glacial erosion.

Finally, during continental glaciation, the Grassland Natural Region was glaciated several times during which glacial till was deposited directly by the glaciers and silts, clays,sands, and gravels by glacial meltwater. The Swift Current area was glaciated at least three times, whereas the Cypress Hills,above about 1300 metres,apparently escaped glaciation completely.

Recent studies suggest the last glaciation was at its maximum extent about 17,000 years ago and had retreated north of the Grassland Natural Region about 11,500 years ago.

4.0 GEOLOGY ALONG HIGHWAY 1 BETWEEN ERNFOLD AND GULL LAKE

4.1 Introduction

During the geological field workshop on June 29 and 30, 1978, eight sites along the Trans Canada Highway were examined (Fig. 7). They include: (1) Reed Lake, (2) Rush Lake, (3) Leinan Moraine, (4) Aikins Moraine, (5) Swift Current, (6) Prairie Wildlife Centre, (7) Seward Sand Hills, and (8) the ice-marginal position south of Antelope and Webb. During the workshop, the Braddock and Neidpath Channels east of Swift Current and the classical landslides and geologic exposure of Quaternary deposits east of Stewart Valley were also examined. The Quaternary geology of this region is described by Christiansen (1959) and David (1964).

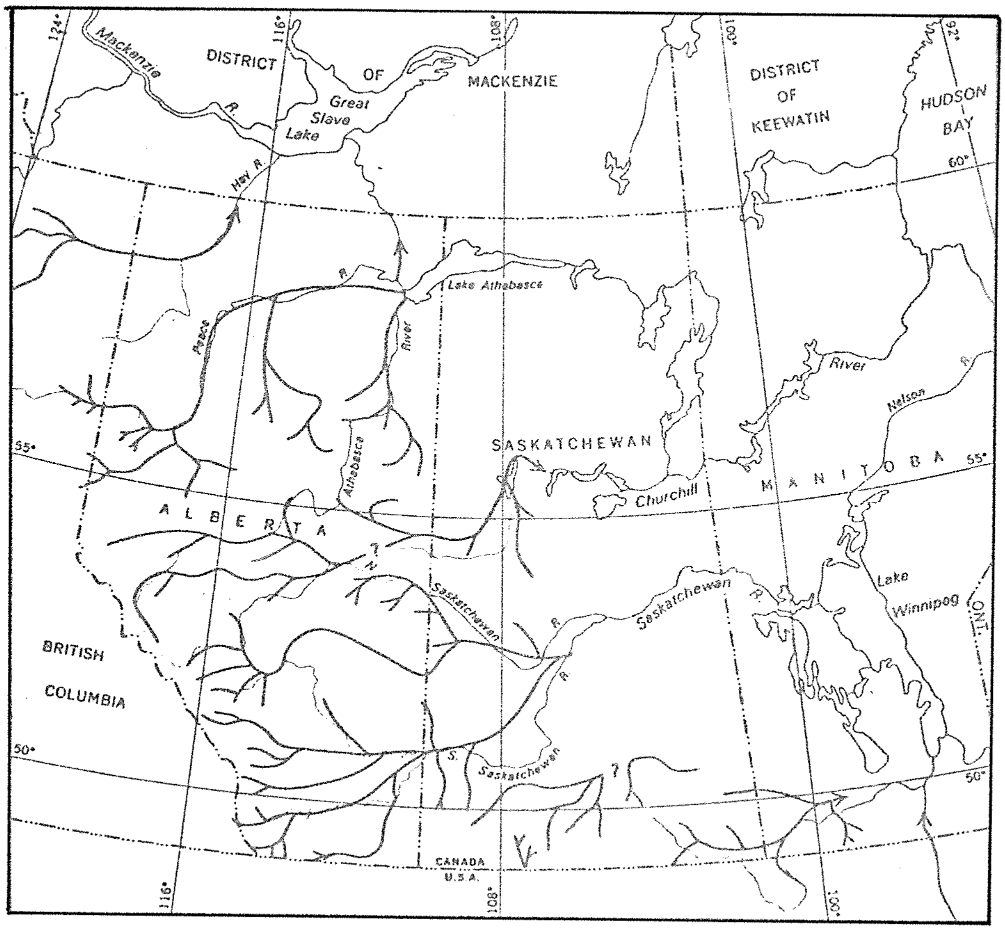

Figure 6. Preglacial valleys in the Prairie Provinces. Modified from Prest (1972).

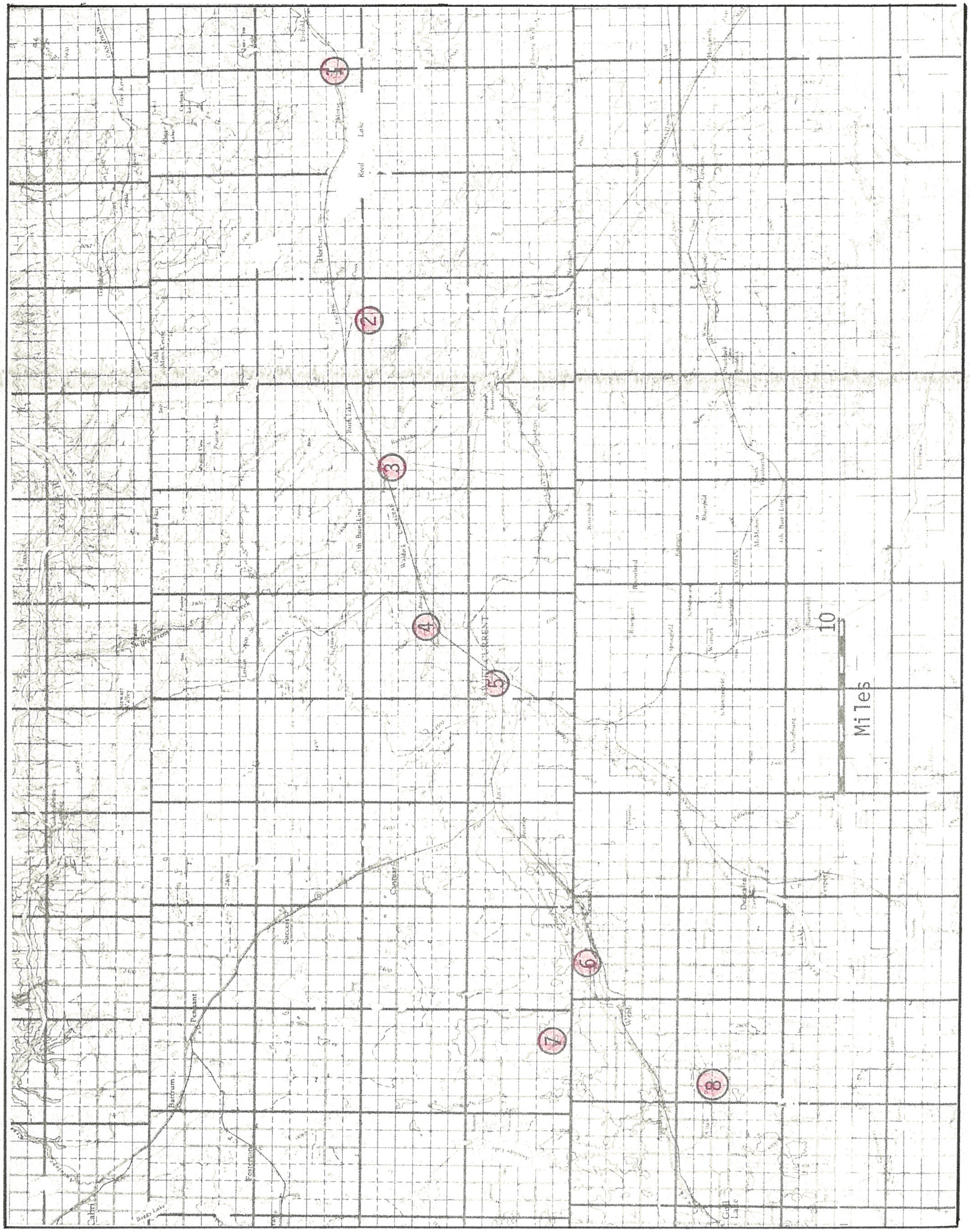

Figure 7. Geologic sites along Trans Canada Highway between Ernfold and Gull Lake.

4.2 Reed Lake

A testhole drilled at the intersection of Highways 1 and 19 two km east of Reed Lake, shows a great thickness of stratified drift in this area. Christiansen and Whitaker (1976) have shown great thicknesses of stratified sediments occur in ice-thrust depressions (Fig.8). It is believed that Reed Lake lies in such a depression formed by a glacier or glaciers advancing southward.

4.3 Rush Lake

Rush Lake, which was drained by the C.P.R., was a remnant of a larger glacial lake in the region. Well-developed wave-cut cliffs up to 15 m high surround this lake discontinuously, and can be seen from the Trans Canada Highway. Between the wave-cut cliffs and the lacustrine clays, which occur in the central part of the drained lake basin, is a strip of till covered with boulders representing a lag deposit formed by wave-erosion.

4.4 Leinan Moraine

The Leinan Moraine was formed as an end moraine when the glacier stood at the position shown in Figure 9. The broad valley, in which Rush Lake and Waldeck occur, is almost completely plugged at Fauna to form this Leinan Moraine. When the glacier stood at this position, meltwater flowed southeastward through the Neidpath Channel (Fig. 9).

4.5 Aikins Moraine

The Aikins Moraine was formed as an end moraine when the glacier stood at

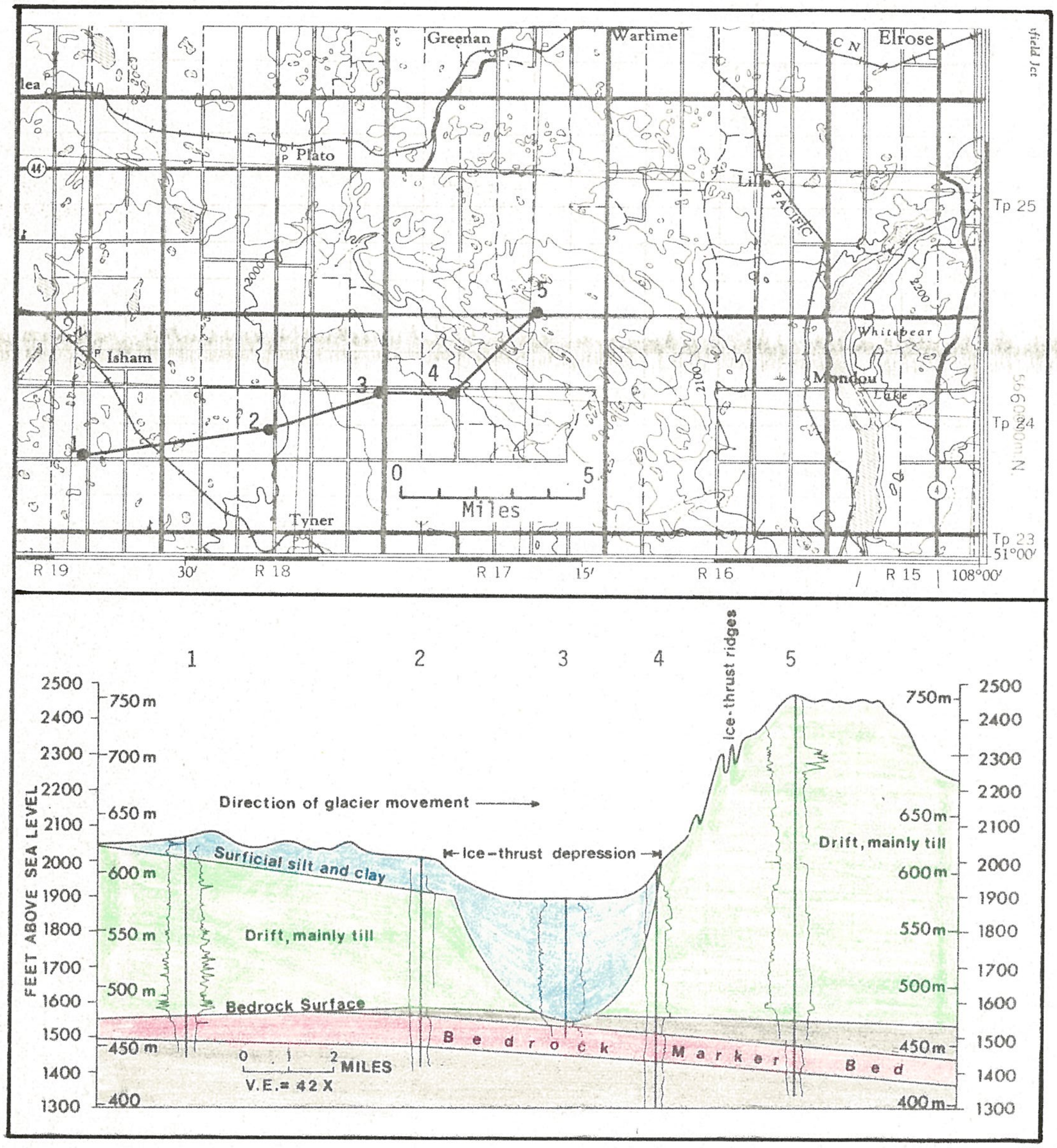

Figure 8. Omission of beds and thick glacial lake deposits in an ice-thrust depression east of Tyner Saskatchewan. From Christiansen and Whitaker (1976).

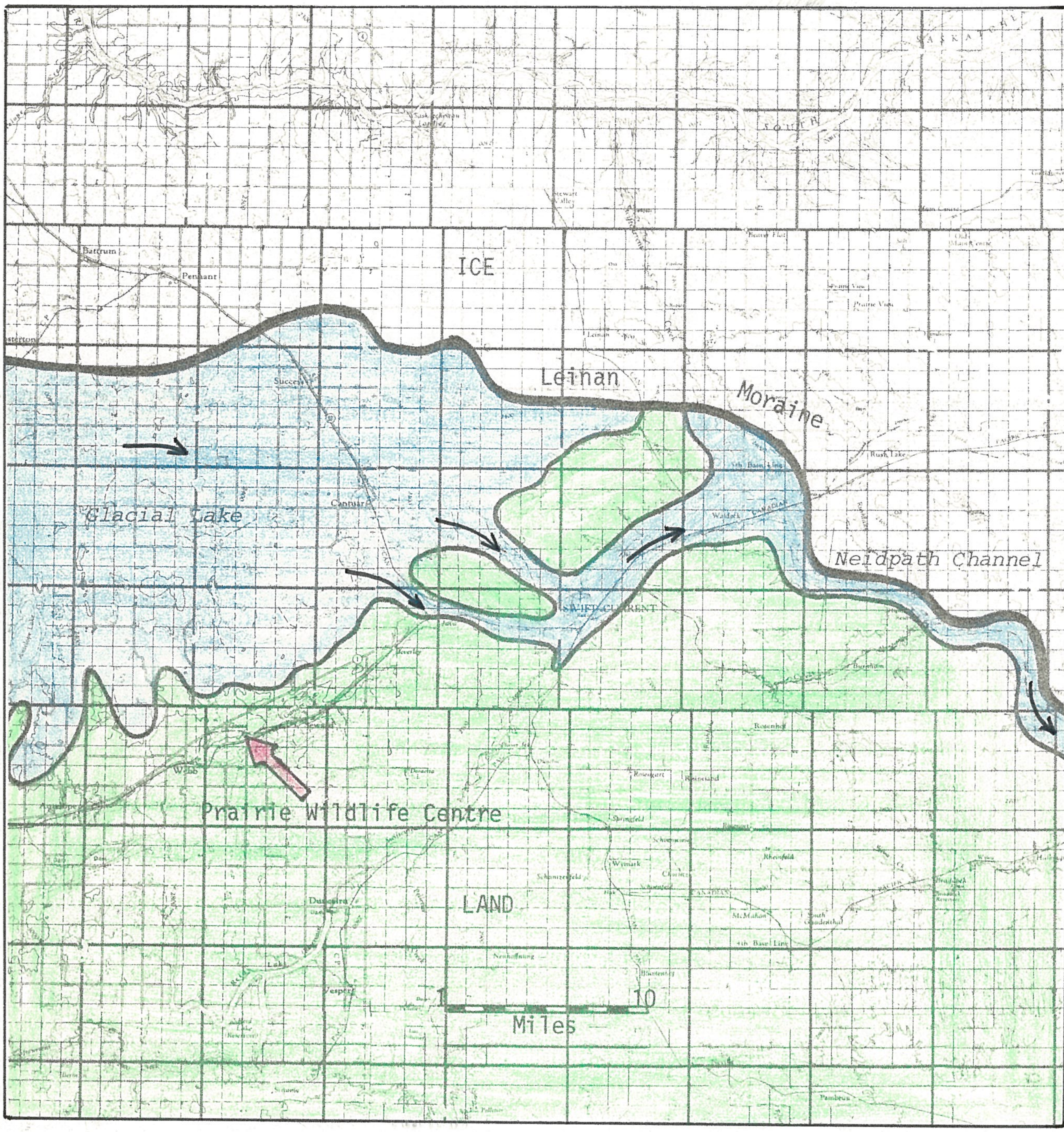

Figure 9. Neidpath Channel phase of the history of deglaciation.

the position shown in Figure 10. Near Aikins, hummocky moraine was draped over the preglacial Swift Current Valley to form the Aikins Moraine. Meltwater drained southeastward through the Braddock Channel during this phase.

4.6 Swift Current

The city of Swift Current lies in the western side of the preglacial Swift Current Valley near its confluence of two other ancient valleys to the west and northwest. The Swift Current Valley was 370 feet deeper in preglacial time than it is now (Fig. 11). This valley contains the deposits of at least three glaciations, whereas the uplands are covered with only a few feet of till deposited during the last glaciation.

The bedrock upland surrounding Swift Current is composed of Bearpaw silts and clays capped with Tertiary chert and quartzite gravels. The former can be seen in the campsite area along the Trans Canada Highway. The bedrock, in turn, is covered with a few feet of till and up to two feet of wind blown silt (loess) derived from the sand dune areas to the west. Much of the till in this upland area is in the form of ridges believed to have been deposited in crevasses in the melting glacier.

4.7 Prairie Wildlife Centre

This subject will be discussed in the next chapter.

4.8 Seward Sand Hills

The Seward Sand Hills are described in Appendix 1.

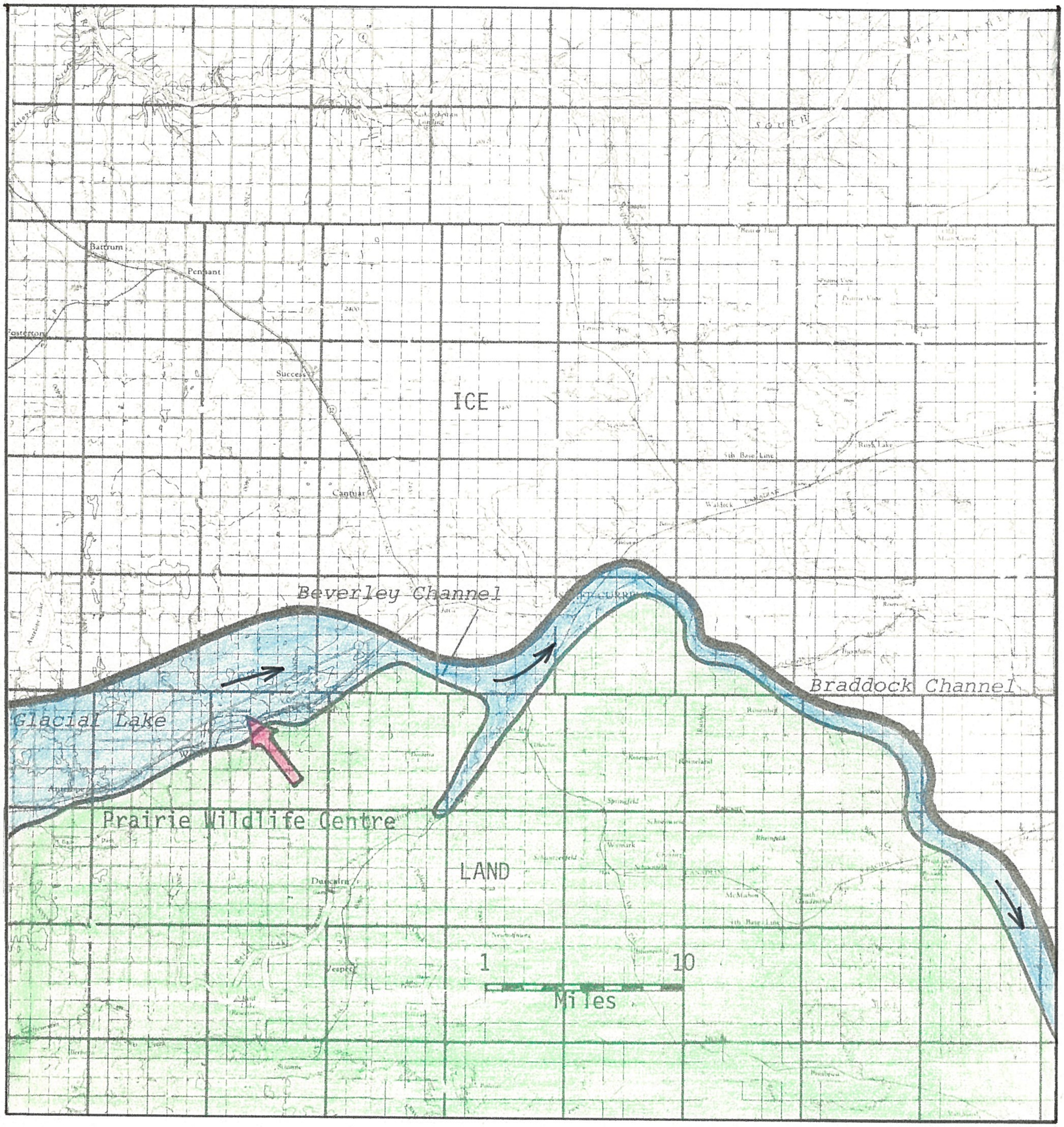

Figure 10. Braddock Channel phase of the history of deglaciation.

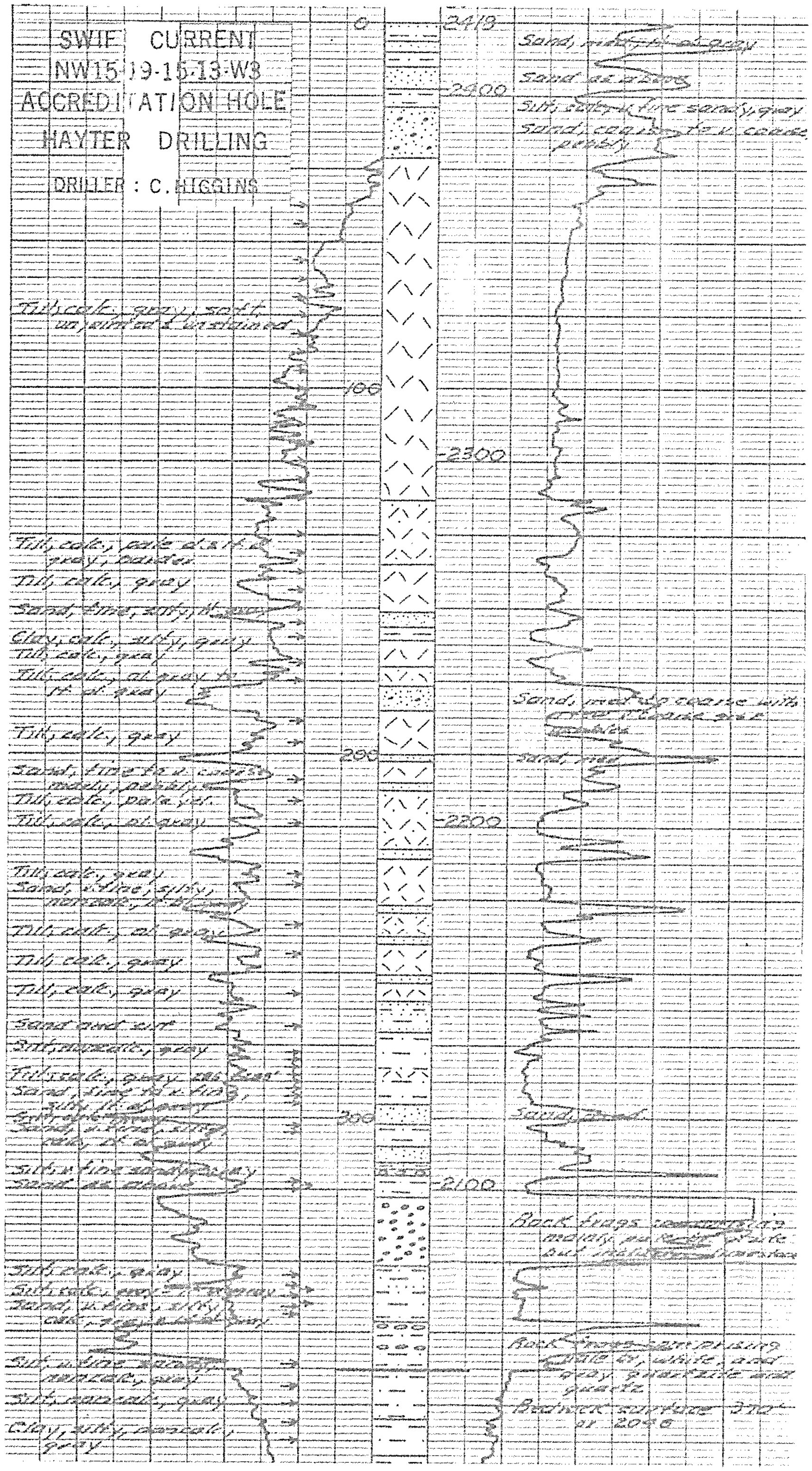

Figure 11. Swift Current testhole in the preglacial Swift Current Valley.

4.9 Ice-marginal Position South of Antelope and Webb

Side-hill, ice-marginal channels occur south of Antelope and Webb (Fig. 12) and are correlative with the Pelletier Channel phase of Christiansen(1959). These channels drained meltwater from the glacial lake north of the Cypress Hills.

5.0 PRAIRIE WILDLIFE CENTRE

5.1 Introduction

The Prairie Wildlife Centre is in a broad valley trending northeast-south west along the foot of the escarpment along the northern margin of the Swift Current Plateau. The Centre is near Goose Lake between Webb and Seward about 2 km from the Trans Canada Highway.

5.2 Bedrock Geology

South of the Prairie Wildlife Centre on the Swift Current Plateau, the area is underlain by gravels of the Cypress Hills Formation (David and Whitaker, 1973). To the north of this upland, the Bearpaw Formation forms the bedrock.

5.3 Quaternary Geology

The broad valley that trends northeast-southwest under Goose, Gosling, and Gander Lakes is believed to have formed by glacial erosion as the ice advanced over the Swift Current Plateau escarpment. Such ice-thrust depressions have been recorded elsewhere in Saskatchewan (Fig. 8). To determine whether this hypothesis for the origin of the Goose - Gosling -

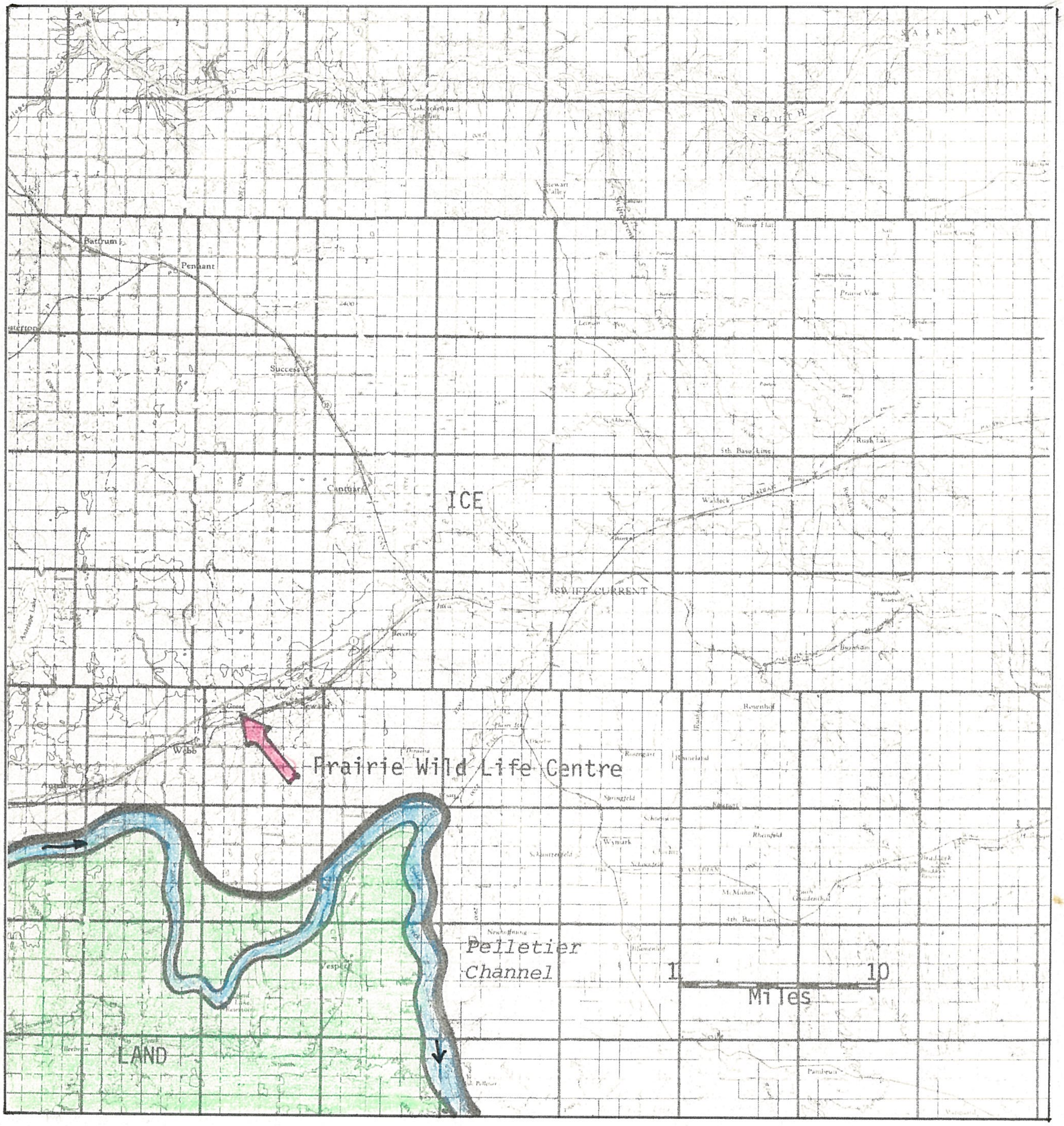

Figure 12. Pelletier Channel phase of the history of deglaciation.

Gander Lakes depression is correct, a testhole in this depression and one to the south and north would be required.

Three phases dominate the history of deglaciation of the Prairie Wildlife Centre area (Figs. 9,10,12). During the Pelletier Channel Phase (Fig. 12), the glacier stood at the north side of the ice-marginal channel south of Antelope, and meltwater from the glacial lake to the west drained southward through the Pelletier Channel.

When the glacier stood immediately north of the Seward Sand Hills, a glacial lake was formed between the retreating glacier and the Swift Current Plateau escarpment south of the Prairie Wildlife Centre. This glacial lake drained southeastward through the Beverley and Braddock Channels (Fig. 10). If glacial lake deposits occur in the Goose Lake area, they were deposited during this phase. During this phase, the glacial lake was about 30 m deep over what is now Goose Lake.

When the glacier stood at the Leinan Moraine (Fig. 9), the glacial lake dropped 30 m, leaving Gander and Goose Lakes as remnants of the large glacial lake. Since this time, these lakes have been receiving sediments from the adjacent uplands; thus recording the postglacial history of the area.

During a brief reconnaissance of the surficial geology it, was discoverd that the major landforms in the Prairie Wildlife Centre area is moraine with a thin cover of massive silt and fine sand, probably derived from wind action in the dune areas to the north and west of the Centre. Glacial lake deposits were not identified during this brief investigation, but they are expected to occur in the area.

During a traverse along the shoreline of Goose Lake, raised beaches were identified, the upper one of which is marked by a wave-cut cliff and associated lake ramparts of material pushed up by lake-ice. The more recent abandoned water planes are marked by bands of different vegetation paralleling the present shoreline. Lakeward from the wave-cut cliff is a zone of boulders which represents a lag concentrate from the erosion of till by wave-action. At the mouth of an intermitten stream that enters Goose Lake from the east is a delta-like feature. The deposit in this feature is sand and gravel which may represent a delta with the sand and gravel being derived from the erosion in the stream valley.

For a credible presentation of the surficial geology, the deposits must be investigated in more detail. Such and investigation should include test drilling as mentioned above and shallow augering of the Prairie Wildlife Centre property including the sediments under Goose Lake.

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July 7, 1978

Date

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Appendix 1

SEWARD SAND HILLS

Location: The dune area is located ca. 10 miles west of Swift Current. The Trans-Canada Highway passes about two miles south of the sand hills more or less parallel with it.
Lat.: 50° 15' N; Long.: 108° 14' W. NTS: 72 K, Prelate.
Ownership: part of the area lies within the former Seward Forest Reserve which is indicated only on the Maple Creek Sectional Sheet No. 67 of the Topographical Survey of Canada Map Series (1925, 1:190,080).
Surface area: 42 mi^2.

Description: The Seward Sand Hills area comprises one principal and one secondary dune occurrences which are separated by a distance of a few hundred meters. Both areas are elongate in a general northeasterly direction. This elongation is due primarily to the distribution of the source deposits and secondarily to the direction of dune migration.

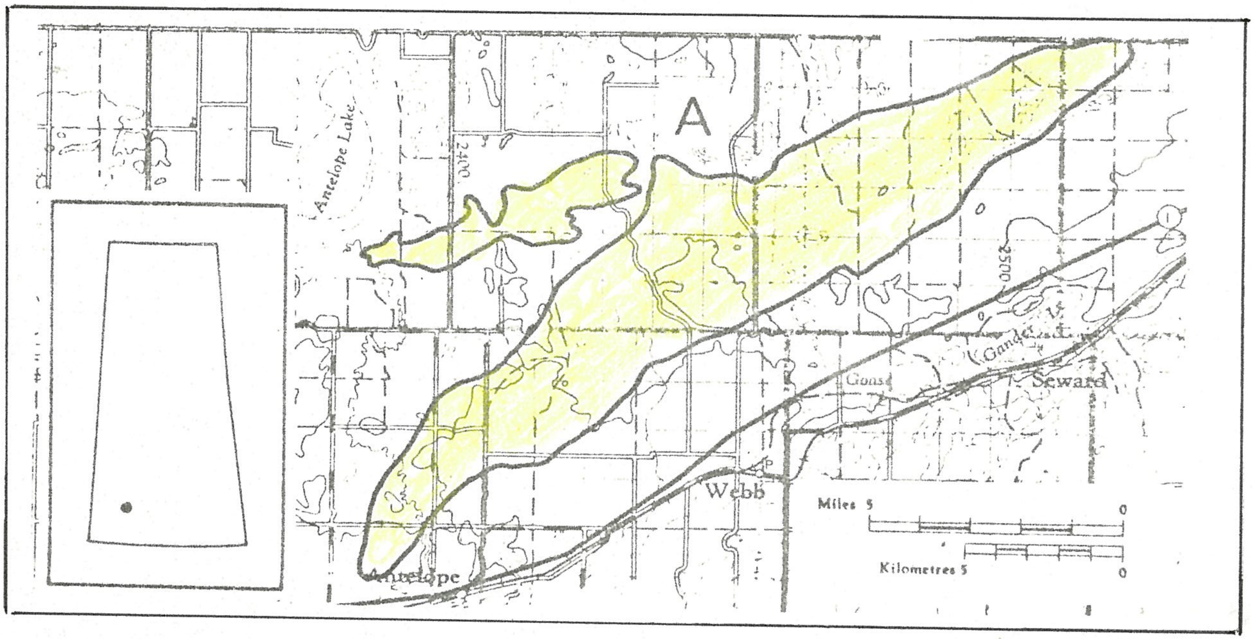
An unnamed intermittent creek arrives from the south to the dune area north-northwest of Webb where it disappears under the sand dunes. The same creek reappears again in the north and drains into a lake just outside of the sand hills. In the dune area only short segments of the creek are visible locally wherever it passes over silty sediments or wherever it has succeeded in breaching some of the dune ridges. It has been observed (David, unpub. data) that during those years when the quantity of total yearly precipitation is much greater than the annual average, water appears in the channel of the creek. At the same time, standing water appears within the dune area along the general course of the creek. Water appears both in the blowout hollows of dunes and over much of the interdune areas. During these more humid years the vegetation cover in the moist areas is luxurious and remains unusually green through successive summers.

The source deposits of the dune sands are shallow water glaciolacustrine deposits in the west and outwash deposits in the remaining parts of the area (David, 1964). The southern part of the Antelope esker (David, 1964) reaches into the area from the north.

The dunes in the area are mainly parabola types, mostly short, only a few elongate; some of both sorts are partially filled. A few of the parabola dunes are composite with a "superposed" arrangement. There are numerous V-shaped and a few circular dunes. Typically, all the dunes have symmetrical wings. Some dunes show complex development due to recent activity at the heads. The southwestern parts of the area are completely occupied by blowout hollows some of which are elongate to the southeast (!) (see Mollard, no date, Fig. 8.9c). There are numerous dune crevasses in the otherwise stablized dunes. The base line of most of the dunes is sharp. All the dunes in the area occur in a random disposition.

From David (1977).

There are several active dunes in the area. These active dunes are enigmatic features inasmuch as they are those dunes which occur in the more humid sections of the sand hills. Time-lapse photo series from 1945 to 1969 indicate that while most of the dunes that were active in 1945 became stabilized by 1956 except those which had extensive active surfaces. These latter dunes remained active up to date. Some of these dunes actually show an expansion of the active surface between 1956 and 1969. Furthermore, some of the dunes which were stabilized in 1945 and had only small dune crevasses on them, became active by 1956 and are still active today. These



dunes occur on higher and, consequently, drier terrain. In view of the large number of recently formed dune crevasses and the enigmatic presence of most of the active dunes, it is concluded that most if not all the present-day activity is due to man's disturbance of the protective vegetation cover and that it started since the settlement of the region.

The development of dune-track ridges is very well demonstrated in the central, humid section of the area. There, all the dunes have a series of very prominent though low dune-track ridges in their blowout depressions. These ridges which mark former positions of the "upwind" base-line of the head of a dune, developed due to stabilization of the sands by the periodically appearing luxurious vegetation mentioned above. When, subsequently to this partial stabilization of the dune, the dune moves "off" its stabilized base-line, the part which is left behind forms a ridge. If the periodicity of occurrence of high groundwater levels or inondation can be determined, the rate of migration of the dunes can be calculated.

Importance: The only important features are the enigmatic active dunes and the dune-track ridges.

Human impact: Recent activity of the dunes is attributed to human disruption. There are several roads and trails passing through the area. Recent exploration for oil and the installation of oil pumps destroyed the natural beauty of a good part of the sand hills. There are also pipe-lines across the area.