QUATERNARY STRATIGRAPHY AND SURFICIAL GEOLOGY
PEACE RIVER - WINAGAMI REGION, ALBERTA
YEAR TWO REPORT FOR THE END FISCAL YEAR 1994-95

MDA PROJECT M93-04-035

Alberta Geological Survey Open File Report 1995-09

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EXECUTIVE SUMMARY

The surficial geology and glacial stratigraphy of the Peace River region (NTS 84C/ w half) indicate the area was affected by one major ice advance. The surficial morainal deposits, flutes, and morainal ridges which are generally situated in the uplands of the Clear and Whitemud Hills, are evidence of an unobstructed southerly flowing Laurentide Ice Sheet. Deglaciation is marked in the uplands by deposition from stagnant ice and erosion by meltwater channels flowing down slope. In the lowlands, deglaciation caused the formation of glacial lakes which inundated the Peace River valley including the towns of Manning and Peace River. Glacial stratigraphy in the study area is recorded by one glacial till. The composition and texture of this unit are both laterally and vertically variable due to deposition that took place from basal, englacial, and supraglacial positions within the glacier. Terrace formation along the major rivers followed deglaciation. Processes active at present include slumping of surficial and bedrock material as the rivers cut laterally, and the accumulation of organic sediments in bogs, swamps and other areas of poor drainage.

The Quaternary geology and stratigraphy of the Winagami region (NTS 83 N/w half) are consistent with at least one glaciation. Distribution of the surface units and ice directional landforms suggest two major ice movement directions, a strong south to southwest movement, and a weaker, topographically controlled southeasterly one. Most surficial deposits are associated with either ice stagnation and deglaciation, or post-glacial processes. Glaciofluvial, glaciolacustrine, aeolian and organic deposits are areally extensive. Colluvium and alluvium exist along the flank of and infill most drainage valleys. Stratigraphic correlation of the upper Quaternary units between boreholes and large well exposed sections, supports a single glaciation event. The lowermost diamict is a dark grey, massive, silty-clay, englacial to basal till of

Laurentide origin. Upper diamicts represent facies changes in the one major till. The thickness of the Quaternary deposits vary, ranging from a few metres near Reno to over 75 m in the buried paloechannels. Bedrock topography is irregular, due to several large paleochannels and their tributaries.

1.0 INTRODUCTION

1.1 OBJECTIVES

This project, partially funded under the Canada-Alberta Partnership Agreement on Mineral Development, was designed to provide reconnaissance level information on the Quaternary geology (stratigraphic and surficial) in the Peace River-Winagami region.

Specific objectives include:

1) To complete a reconnaissance scale study (1:250,000 scale) of the Quaternary geology in portions of two map areas (Peace River, NTS 84C/w half and Winagami, NTS 83N/w half).

2) To provide information on the distribution and composition of the surficial sediments, Quaternary stratigraphy, and the Quaternary geological history of the two map areas, with particular emphasis on glacial flow directions and implications for dispersal of diamond indicator minerals and geochemical elements of potential interests for mineral exploration.

1.2 STUDY AREA

The study area (Figure 1.1) is located in the western half of both the 1:250,000 scale Winagami and Peace River map areas (National Topographic System 83N and 84C, respectively). Manning, Peace River, Grimshaw, Fahler and Valleyview are the largest towns in the region (Figures 1.2 and 1.3). Smaller communities and hamlets are located near highways. Several highways, numerous secondary roads and seismic trails provide access to most of the region.

1.2.1 Physiography and drainage

The study area lies in the Interior Plains of Canada, within the Alberta Plateau and Peace River Lowland physiographic zones (Klassen, 1989). This region is characterized by rolling uplands, undulating river basins and deeply entrenched river valleys. Elevation varies from 326 m (bottom of the Peace River valley) to a maximum of 902 m (Puskwaskau hills).

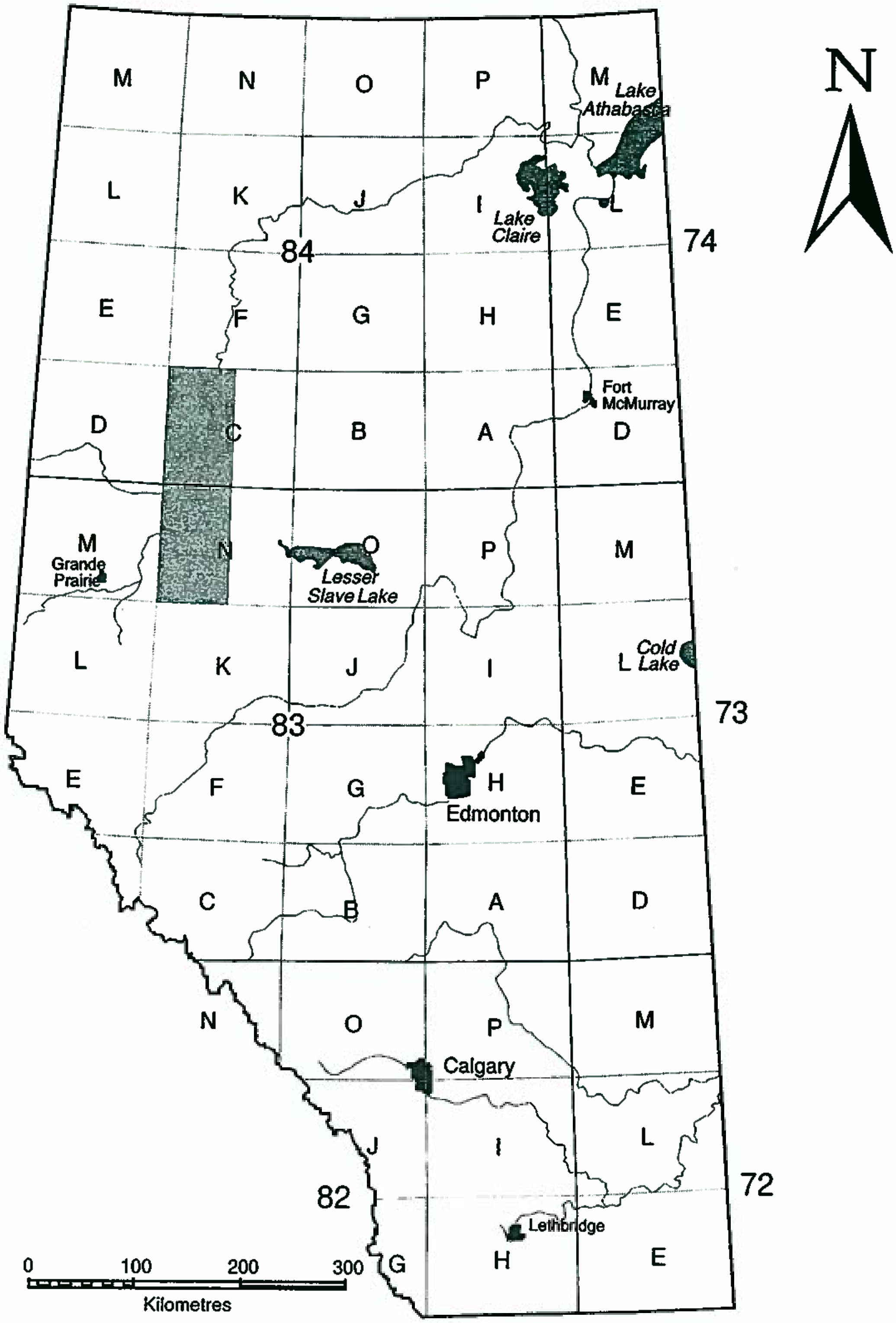


Figure 1.1 - Location map of study area

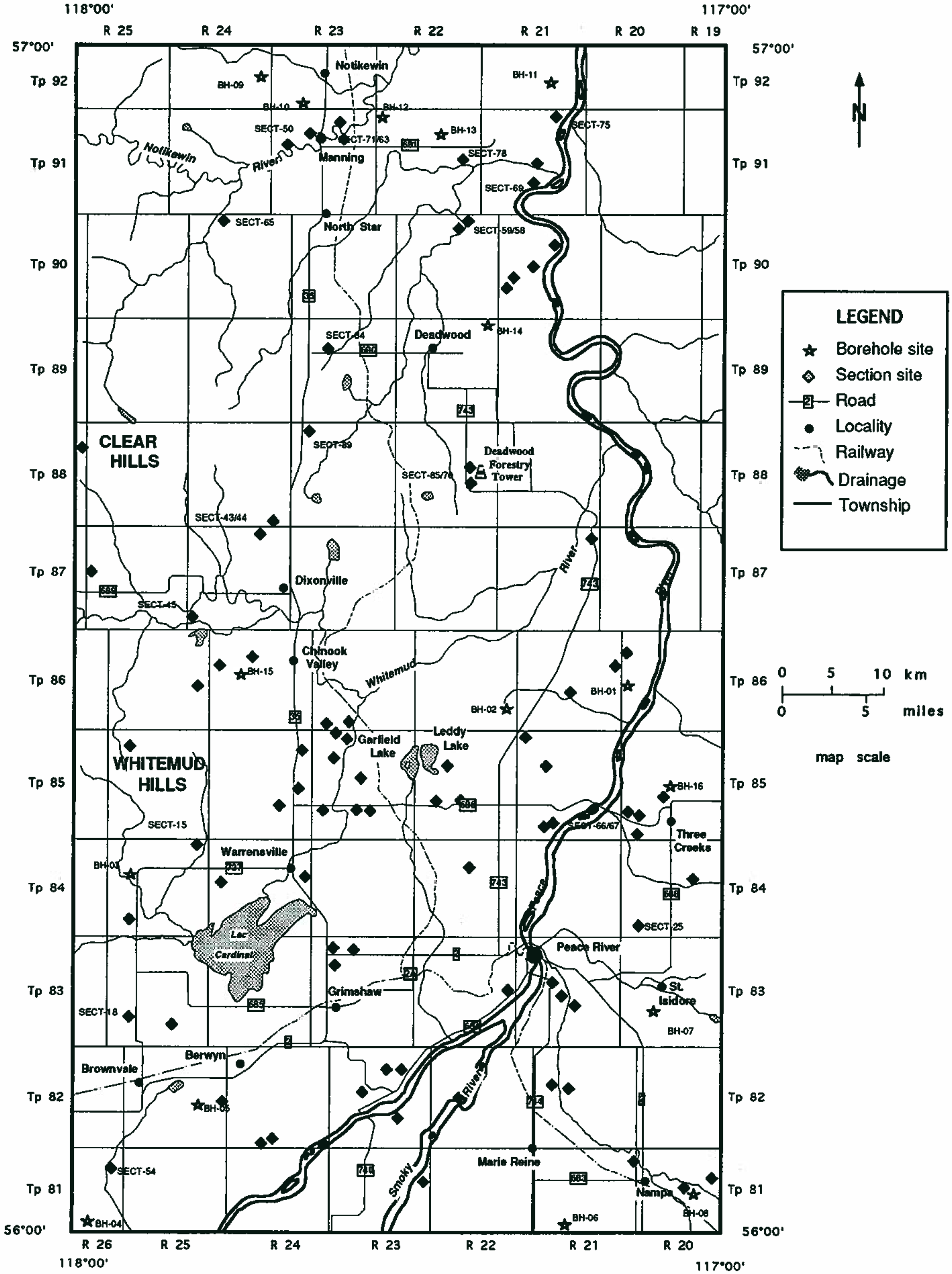


Figure 1.2. Location of sections and boreholes, Peace River sheet (84C/W1/2)

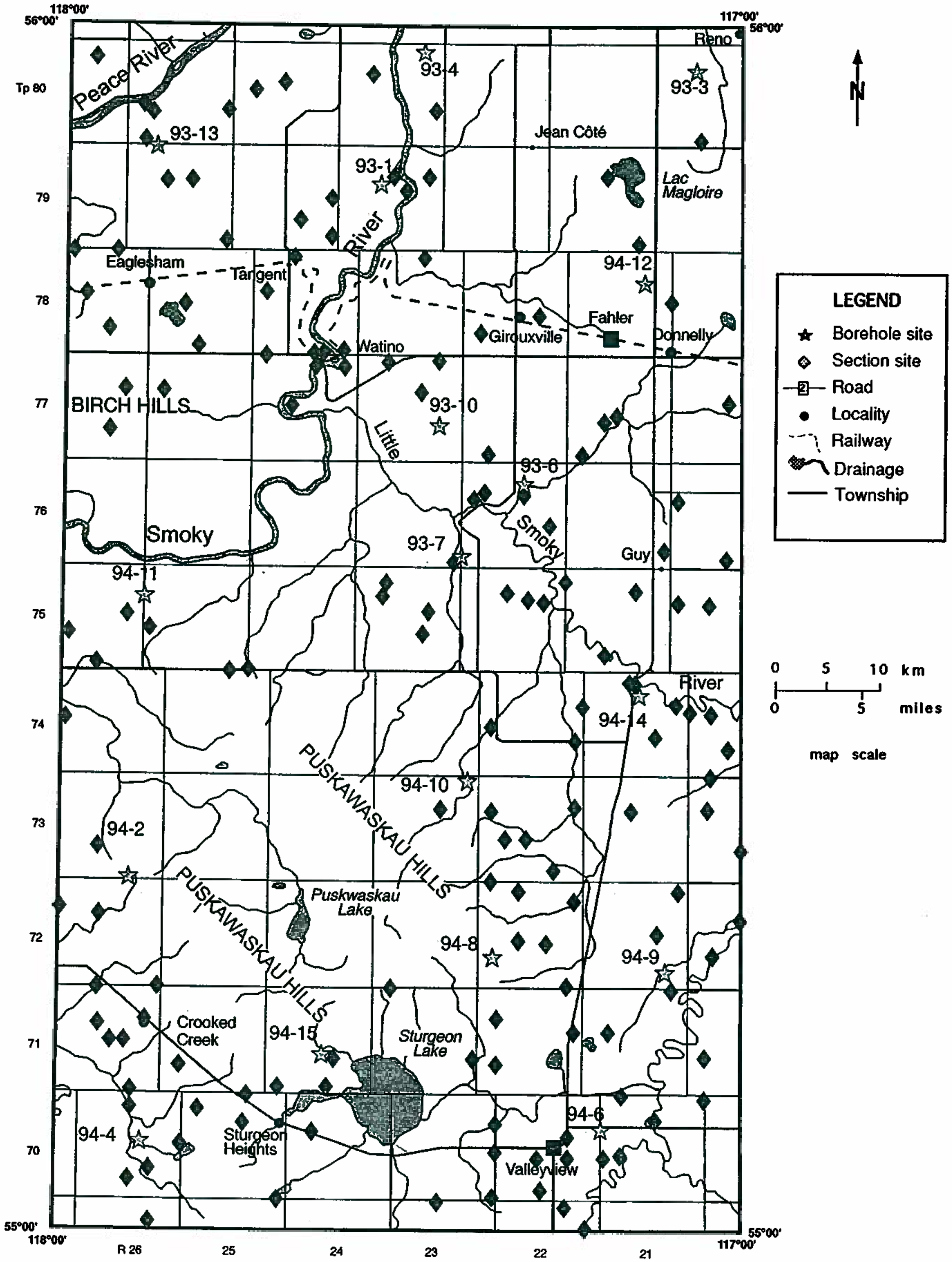


Figure 1.3. Location of sections and boreholes, Winagami sheet (83N/W1/2).

Peace River area consist of the eastern flank of the Clear Hills (838 m), the Whitemud Hills (823 m), and a small hill (640 m) in the vicinity of the Deadwood Forestry Tower. Combined, they form an east-west trending upland, with the highest elevation on the western edge of the map area, which slopes gently eastward down towards the Peace River. The central portion of the study area is flat, except for a small rise in elevation southeast of Fahler (60 m), steep west–facing slopes, and the Birch Hills (90 m). The Birch Hills form the eastern remnant edge of a north-facing cuesta. South of Smoky River, elevation rises over 305 m to form the Puskwaskau Hills, a series of two parallel ridges trending northwestward. Relief in this region is relatively high, ranging from small hummocks less than 2 m high, to ridges and hills over 90 m. Valleyview is situated on one of these hills.

Four major river valleys drain the area: the Peace, Smoky, Little Smoky and Notikewin. The largest river is the Peace, which crosses the northwestern corner of the Winagami map area, flows northeasterly through Peace River townsite and meanders north along the eastern edge of the study area. Valley sides exceed 420 m in depth. The Smoky River and its tributary the Little Smoky, form valleys that decrease in depth southwards. The Smoky's valley decreases from 210 m near its confluence with the Peace, to approximately 180 m as it enters the Grande Prairie map area. At its confluence with the Smoky, the Little Smoky valley is about 150 m deep. Southeast of Valleyview, the valley is less than 30 m deep. The Notikewin River is the smallest of the four, flowing along the northern edge of the region through the town of Manning. Extensive slumping characterizes all river, creek and stream banks. Paired and unpaired terraces are common.

There are four major lakes in the region: Lac Cardinal, Sturgeon Lake, Puskwaskau Lake and Lac Magloire. Lac Cardinal is shallow (~3 m), approximately 100 km^2 in areal extent, and is fed by streams flowing out of the Whitemud Hills. The lake drains north through Cardinal Creek into the Whitemud River. Sturgeon Lake (100 km^2 in size) drains the region south of the Puskwaskau Hills. Puskwaskau Lake (10 km^2 in areal extent) is shallow and inaccessible. Lac Magloire is one of several ephemeral lakes/swamps. Similar in size to Puskwaskau Lake, it is extremely shallow, with a maximum depth of 2 m. Smaller lakes of note are Garfield and Leddy lakes, which are situated approximately 15 km northeast of Lac Cardinal.

Many creeks and streams, often intermittent, cover the area. Ponding is variable, forming extensive swamps, bogs, sedge marshes and muskegs.

1.2.2 Bedrock geology

The study area is underlain by the eastern limb of the Alberta syncline which dips at a low angle towards the south (Rutherford, 1930). Cretaceous formations (Figure 1.4) include the Peace River, Shaftesbury, Dunvegan, Kaskapau, Bad Heart, Puskwaskau and Wapiti (Green, 1972). These formations form continuous horizontal units that dip gently towards the northeast (Borneuf, 1980). Bedrock exposures are restricted primarily to river and stream cuts, and occasionally along road cuts.

The Fort St. John Group includes the Shaftesbury and the Peace River formations. The lowermost unit in the area is the Peace River Formation (Figure 1.4), Lower Cretaceous in age, which includes sandstones (Paddy and Cadotte members) underlain by shale (Harmon Member). The Paddy Member is a lithic, calcareous, continental greywacke with thin coal seams. Some marine fossils may occur. This unit is restricted to the southwestern corner of the Peace River map area. Thickness varies from 0 (Twp 71) to 40 m (south of Clear Hills). The Cadotte Member is a marine, clean, coarse to fine grained, massively bedded sandstone which ranges in thickness from 12 to 52 m. Alternating bands of thinly bedded sands and shales, and concretions 3 to 5 m in diameter are common. Notable fossils include *Gastroplites*, *Inoceramus cadottensis*, starfish and arenaceous foraminifera. The Paddy Member and portions of the upper part of the Cadotte Member are exposed in vertical cliffs (up to 30 m in height) at the townsite of Peace River and downstream for about 10 km. The lowermost unit, Harmon Member, consists of soft, fissile, non-calcareous, dark grey shale which ranges in thickness from 10 to 34 m. Thin beds of bentonite and siltstone are present in some places. The same fossils found in the Cadotte are present in the upper portions of the Harmon. Exposure of the Harmon Member is restricted to river level of the Peace River within and north of Twp 90 and in Buchanan Creek at its confluence with the Peace River.

The Shaftesbury Formation of Upper and Lower Cretaceous age, is the lowermost unit present in the Winagami map area (NTS 83N). It contains fish-scale bearing, friable, dark marine shale, with many nodules and thin beds of concretionary ironstone (Green, 1972). Bentonite partings ate locally present. The lower portion of this unit contains thin silty and sandy intervals and abruptly overlies the Peace River Formation. The Shaftesbury is characterized by endemic ammonites, *Neogastroplites, Irenicoceras,* and *Beattonoceras*, *Posidonia nahwisi*, and *Holcolepis* (Glass, 1990). The fish-scale zone of the Shaftesbury Formation is a significant geophysical marker horizon. The Shaftesbury Formation is exposed along the Peace River, its confluences with the Smoky and Whitemud rivers, and along Buchanan Creek (Figure 1.2). Roadside exposures include one south of Whitemud River along Highway 743 (LEL-Section-86).

The Dunvegan Formation of Upper Cretaceous age, is a grey, fine-grained, feldspathic sandstone with thin beds of shale, shelly limestone and coal. Origin ranges from deltaic to marine. The Dunvegan is overlain conformably (transitionally) by the Kaskapau, except for an apparent hiatus near Watino. Its lower contact is conformable with the Shaftesbury Formation. Fossils include a rich assemblage of shallow fauna, as well as numerous conifers, cycads and ferns. This unit is exposed in river cuts

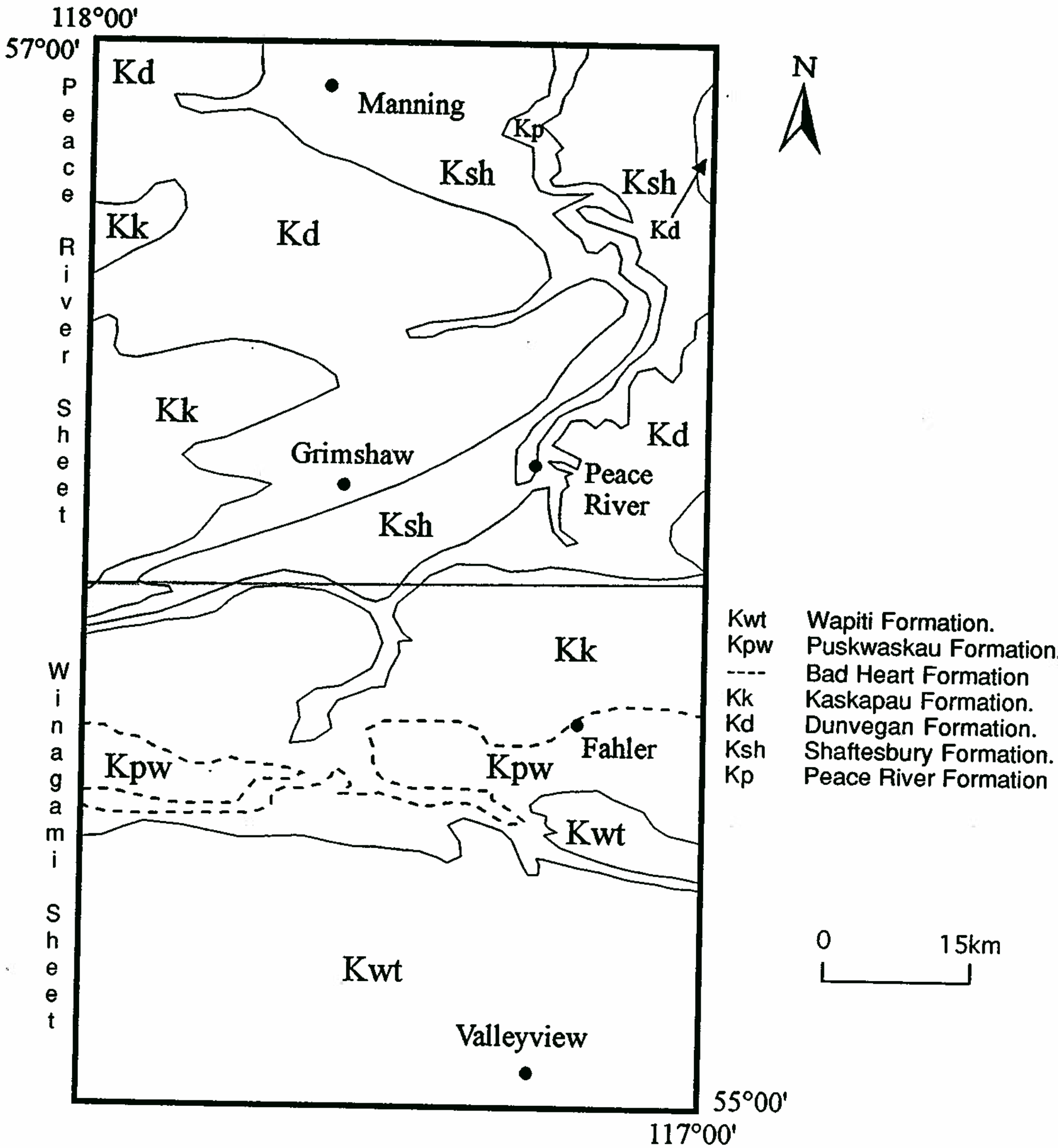


Figure 1.4. Bedrock map of the Peace River and Winagami study areas. (Adapted from Borneuf, 1980 and 1981).

along the Peace River, the northern part of the Smoky River (Figure 1.2), and along the Whitemud River east of Chinook Valley. Smaller outcrops occur along Highway 743 near the Deadwood Forestry Tower (LEL-Section-85).

The Smoky Group, marine in origin and Upper Cretaceous in age, contains the Kaskapau, the Bad Heart and the Puskwaskau formations (Figure 1.2). The lowermost formation, the Kaskapau, contains dark grey, fissile, carbonaceous shale with thin concretionary ironstone beds. The lower portion of this formation is interbedded with fine-grained, quartzose sandstone and thin beds of ferruginous oolitic mudstone. Its lower contact is transitional with the Dunvegan Formation, except near Watino, where it abruptly overlies the Shaftesbury Formation. Fossil assemblages in the formation include: *Inoceramus, Inoceramus (Mytiloides) labiatus, Dunveganoceras, Watinoceras, Scaphites s.l.* (Glass, 1990). This formation underlies the northern half of the region, and caps both the Whitemud Hills and the southeastern flank of the Clear Hills below 760 m elevation (Figure 1.2). The thickness varies from about 160 m along the Smoky River, to about 170 m in the Sturgeon Lake area. The Kaskapau is exposed in two small road cuts along Highway 35, a few kilometres north of Chinook Valley.

The Bad Heart Formation contains medium to coarse grained marine, quartzose and ferruginous oolitic sandstones and mudstones. Numerous marine fossils, including *Scaphites, Inoceramus stantoni* and *Pinna* (Glass, 1990), and bands of chert pebbles are present. The Bad Heart Formation forms a thin line south of Watino, extending through Fahler (Figure 1.2). Tokarsky (1967) noted that this formation is present in the Whitemud Hills at the 760 m elevation. It is conformable with both the Puskwaskau and the underlying Kaskapau formations, pinching out towards the east. Its thickness varies from 1.5 to 8 m.

The Puskwaskau, a dark grey fossiliferous shale, is the youngest formation of the Smoky Group. The Puskwaskau Formation is composed of thinly bedded, dark marine shales with some speckled shale in the mid-portion. It forms an east-west trending belt south of Watino. Tokarsky (1967) suggested that the Puskwaskau caps the Clear and Whitemud Hills above 760 m elevation. Exposure is restricted to the Smoky and the Little Smoky river valleys. Recessive in outcrop, it varies in thickness up to 123 m in the Smoky River area. The Puskwaskau Formation is conformably overlain by the Wapiti Formation. Notable fossil assemblages, in the Puskwaskau, include: *Inoceramus, Scaphites s.l.,* and *Baculites* (Glass, 1990).

The Wapiti Formation is the youngest of the bedrock units. It forms a wide belt that covers the southern portion of the study area south of the confluence of the Smoky and Little Smoky Rivers (Figure 1.2). Thinly bedded to massive, medium to coarse–grained, calcareous, feldspathic, clayey, fresh-water sandstone comprises most of this unit. Bentonitic mudstone and bentonite, with scattered clay beds and coal seams are present (Glass, 1990).

The surface of the bedrock in the study area is irregular. There are many buried channels, likely of Late Tertiary age. The largest of these channels is located north of the Smoky River (an unnamed, Henderson, 1959) and along the Peace River (the Shaftesbury channel, Tokarsky, 1967). Smaller channels include the Manning (Marciniuk and Kerr, 1971), Berwyn (Tokarsky, 1967) and several unnamed ones near Dixonville, Valleyview and Crooked Creek.

1.3 PREVIOUS WORK

1.3.1 Peace River

Some of the earliest work on the Quaternary geology in the Peace River area was completed by Rutherford (1930). It was not until the late 1960's and into the 1970's that the area was extensively studied by the Alberta government, in particular, the Alberta Research Council and Alberta Energy. As a result, there are several soil surveys (e.g. Scheelar and Odynsky, 1968) and hydrogeology (Jones, 1966; Tokarsky, 1967, 1971; Borneuf, 1981; and Ozoray, 1982) reports on the Peace River area.

Some surficial geology maps have been presented in reports (Jones, 1966; Scheelar and Odynsky, 1968; Tokarsky, 1967; Borneuf, 1981; and Fox et al., 1987). However the focus of these studies was principally on the soils, hydrogeology, or aggregate. The maps therefore provide only limited and generalized information of glacial landforms and morphology. Tokarsky (1967) described surficial sediments and glacial landforms for the area around Grimshaw-Lac Cardinal. There has been no work completed on the glacial stratigraphy of the Peace River area.

1.3.2 Winagami

Previous work in the Winagami region has focussed on soil surveys (Wyatt, 1935; Odynsky and Newton, 1950; Odynsky, Wynnyk and Newton, 1956; Pawluk and Bayrock, 1969), oil and gas exploration, hydrogeological and landfill studies (Borneuf, 1980; Groundwater Protection Branch, 1992), and bedrock mapping (McLearn, 1918).

The only report on surficial geology in the Winagami region was by Henderson (1959). This report contained a surficial map, a generalized stratigraphy, and a proposed glacial history. Henderson (1959) interpreted a minimum of three invasions of Laurentide Ice into the region based on the degree of leaching of three "unique tills".

Detailed Quaternary research has focussed on the Watino section, located along the Smoky River (Lowden and Blake, 1970; Westgate et al., 1971, 1972; Lichti-Federovich, 1975; Fenton, 1984; Klassen, 1989; Liverman et al., 1989). This section contains one of the few time marker horizons in the region, the Watino Nonglacial Interval, which has been dated at 43 ka to 22 ka in age (Fenton, 1984; Klassen, 1989).

1.3.3 Regional

Much of the research on the glacial history of northern Alberta has focussed on the Laurentide Ice Sheet and it's interactions with Cordilleran Ice during the last glaciation (Westgate et al., 1972; Fenton, 1984; Liverman et al., 1989). Investigations west of the area indicate that Cordilleran Ice did not extend into the study region (Liverman, 1989). The deglaciation history of northwestern and central Alberta has been documented by Taylor (1960), St-Onge (1972) and Mathews (1980). These authors provide a sequence of formation for the extensive glacial lakes were created when meltwater was dammed by the melting Laurentide Ice Sheet.

1.4 METHODOLOGY

Several techniques were employed to determine the surficial geology and glacial history of the region including: preliminary research; field mapping, drilling and sampling; and laboratory analyses.

1.4.1 Research techniques

This category includes preliminary work such as airphoto, water-well and petroleum log interpretation. Airphotos (scale 1:63,360) were interpreted before field work. Units based on morphology, tone and drainage were refined and verified during the field seasons. Water-well and petroleum logs are used to determine lateral continuity of subsurface units, their stratigraphy, and bedrock topography.

1.4.2 Field techniques

The study area was mapped, drilled and sampled during the 1993 and 1994 field seasons (Figures 1.2, 1.3; Appendices A1-A6); a total of 253 (163 from 83N, 90 from 84C) stratigraphic sections and 33 (17 from 83N, 16 from 84C) cored boreholes were described. Field work was restricted to reasonably accessible areas due to time and manpower constraints. Access in the region was accomplished by truck, canoe and foot traverse.

Section samples were taken in the C-horizon and lower; minimum sampling depth was 0.5 m. Thirty-three hollow-stem auger cores (Figures 1.2, 1.3) were drilled by

Canadian Geological Drilling Limited. Maximum core length was 45 m, with a diameter of 7.5 cm. A total of 596 (341 from 83N, 255 from 84C) samples were collected; 402 (244 from 83N, 158 from 84C) from stratigraphic sections and 194 (97 from both 83N and 84C) from 17 (8 from 83N, 9 from 84C) borehole cores.

The majority of samples were from tills, gravels and waterlain diamicts (Appendices

A4, A5 and A6). Samples representing bedrock, glaciolacustrine, glaciofluvial and aeolian deposits were obtained for comparison. Larger samples, about 3 to 5 kg, were collected for lithological, granulometric and geochemical analyses. Multiple samples were taken from larger sections to obtain information on lateral and vertical variations of individual units. Three sites (93-SB-67, 94-SB-27, 94-LL-62) were sampled for organic material (wood and shells), which will be analyzed and dated later this year.

Auger cores were described in detail in the field. Seventeen of the cores (LEL-BH-01, LEL-BH-03, LEL-BH-04, LEL-BH-08, LEL-BH-10, LEL-BH-11, LEL-BH-14, LEL-BH-15, LEL-BH-16, 93-SAB-06, 93-SAB-13, 94-SAB-02, 94-SAB-08, 94-SAB-09, 94-SAB-10, 94-SAB-11, and 94-SAB-15) were sampled for laboratory analyses. Each unit was represented by a minimum of one sample. Thick till units were sampled at minimum intervals of 1.5 m (Appendices A4, A5 and A6).

1.4.3 Laboratory techniques

Samples from stratigraphic sections and cores are being analyzed by various methods to determine their granulometric, lithologic and geochemical characteristics. Granulometry and lithology analyses are currently underway at the University of Alberta. Complete data charts will be presented later.

The <0.063 mm fraction of 360 (195 from 83N, 165 from 84C) surficial and core samples was recovered for geochemical analyses. These samples, which represent the till, waterlain diamict, glaciolacustrine, and bedrock units, were sent out for Atomic Absorption and Induced Neutron Activation analyses.

Five 26 kg till samples from four cores (93-SAB-06, 93-SAB-13, LEL-BH-01, LEL-BH-04) and eleven from sections (93-SB-38, 93-SB-39, 93-SB-52, 94-SB-14, 94-SB-35, 94-SB-76, 94-LL-27, 94-LL-34, 94-LL-35, 94-LL-40, 94-LL-42) were taken for mineralogical studies. Heavy minerals in the sand-sized fraction were processed by the Saskatchewan Research Council (SRC) for diamond indicator mineral grains. Suitable grains were then hand picked for microprobe analysis.

1.4.3.1 Granulometry

Samples, fifty grams in weight, were prepared and analyzed using combined hydrometer and sieving techniques according to modified American Society for Testing and Materials methods (ASTM, 19647; Balzer, 1992; Broster, 1982). The results are being analyzed for several granulometric parameters (Folk, 1974): sand/silt/clay percentages, mean grain size, sorting, kurtosis and skewness. These results will be plotted areally, and stratigraphically, to determine dispersion patterns and to characterize the surficial units, particularly, the tills.

1.4.3.2 Lithology

Lithologic analyses are underway at the University of Alberta. Lithological identification of the coarse sand to pebble fractions of the samples is being determined visually using binocular microscopy. The results are being compiled and will be analyzed for trends.

2.0 SURFICIAL GEOLOGY

The surficial geology of the western half of the Peace River and Winagami map areas comprises eight units based on composition, thickness, morphology and drainage characteristics (Figures 2.1 to 2.5): organics (1); alluvium (2); colluvium (3); aeolian (4a, 4b); glaciolacustrine (5a, 5b, 5c); glaciofluvial (6a, 6b); morainal deposits (7a, 7b, 7c); and bedrock (8). Unit boundaries are transitional and should be viewed as approximate. Areas where more than one unit is dominant are indicated by a slash (for example: 6a/7a).

2.1 ORGANIC DEPOSITS (UNIT 1)

Organic deposits, swamps, fens and peat bogs of variable extent, occur in shallow basins and poorly drained areas (Figures 2.2 to 2.5). These deposits are extensive, often covering several square kilometres, particularly near Garfield and Leddy lakes, the Clear, Whitemud and Puskwaskau Hills and southeast of Valleyview. Organic deposits infill many of the relict meltwater channels in the Peace River area. Sampling is difficult due to high water tables.

2.2 ALLUVIAL DEPOSITS (UNIT 2)

Alluvial deposits contain moderately sorted sand, gravel, silt and clay. Reworked material from slump faces is common. Material is deposited as channel fill, bars, floodplains and terraces (Figures 2.2 to 2.5). Up to six generations of terraces (paired and unpaired) appear along the Notikewin, Peace, Smoky and Little Smoky rivers. Most of this material is restricted to the present day river valleys, but remnant floodplains have been noted along the upper flanks of valley walls. Many old terraces are major aggregate sources for the region. Multiple active gravel pits line the Peace and Smoky rivers, particularly at Peace River townsite and Watino.

2.3 COLLUVIAL DEPOSITS (UNIT 3)

Colluvium is comprised of a variety of slumped material, including till, clay, silt, sand, gravel, organics and bedrock. These slumps form the gently undulating slopes along many of the major rivers. In areas of active slumping (the Heart, Notikewin, Peace and Smoky rivers), valley sides are flanked by large scalloped hummocks and ridges. Some sections along these rivers contain sediment gravity flow structures, such as

LEGEND

1 ORGANIC DEPOSITS:Swamps, fens, sedge marshes and peat bogs deposited in shallow depressions and poorly drained areas.

2 ALLUVIAL DEPOSITS: Predominantly moderately sorted sand, silt and gravel deposited as channel fill, bars and floodplains along present river level; terraces, paired and unpaired may be present; includes reworked material from slump faces.

3 COLLUVIAL DEPOSITS: Silt, clay, sand, gravel, till and bedrock deposited along steep valley flanks as slumps, gently undulating, scalloped hummocks and ridges.

4 AEOLIAN DEPOSITS: Moderately to well-sorted sand, minor silt; form parabolic to irregular dune fields and hummocks; variable in thickness from <2m to >10m.

- **4a** Forested dune fields with abundant organics; parabolic to irregular in shape; relief up to 7.5m.
- **4b** Primarily fine sand and silt; irregular dunes and modified ice-contact stagnation ridges and hummocks; kettled, relief up to 3m.

5 GLACIOLACUSTRINE DEPOSITS: Massive to laminated silt and clay, minor sand; occasional dropstones; generally flat, fluted, ridged or hummocky; relief up to 2.5m.

- **5a** Flat plains with flutes and ridges; relief generally <2m; poorly drained; numerous ponds.
- **5b** Varies between flat, fluted, ridged to hummocky; relief up to 2m; poorly drained; many ponds.
- **5c** Hummocky; relief up to 2m; ponding in depressions.

6 GLACIOFLUVIAL DEPOSITS: Sand, gravel and silt; minor clay and till; deposited at the margin of, within or under glacial ice; kames, streamlined ridges, hummocks, eskers and outwash plains; variable in thickness.

- **6a** Outwash and meltwater channels; moderately sorted sand, minor clay and silt; relief generally flat; moderately to well drained; thickness may exceed 30m.
- **6b** Ice-contact landforms; eskers, kames, streamlined ridges and hummocks; relief up to 5m; thickness variable.

7 MORAINAL DEPOSITS: Predominantly ablation with some basal till; local pockets of glaciolacustrine, aeolian, alluvial and organic deposits; subdued to ridged and hummocky; relief up to 10m; thickness varies from <2.5m to >43m; moderate to poor drainage; ponding common.

- **7a** Ranges from flat to ridged to hummocky; mixed basal, englacial and ablation till; relief up to 10m.
- **7b** Hummocky to kettled; predominantly ablation till, some basal; relief up to 10m; ponding common.
- **7c** Prairie mounds/doughnuts; relief up to 10m; predominantly ablation, some englacial till; ponding around and in centers of mounds.

8 BEDROCK: Exposed in river cuts and as thrusted slabs. Lithology dependent upon location.

SYMBOLS

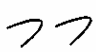
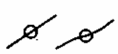
	Geological boundary (defined, assumed)
	Dunes
	Drumlinoids
	Flutes, ridges, elongated hummocks
	Meltwater channel

Figure 2.1 Legend for the surficial geology map shown in figures 2.2 to 2.5.

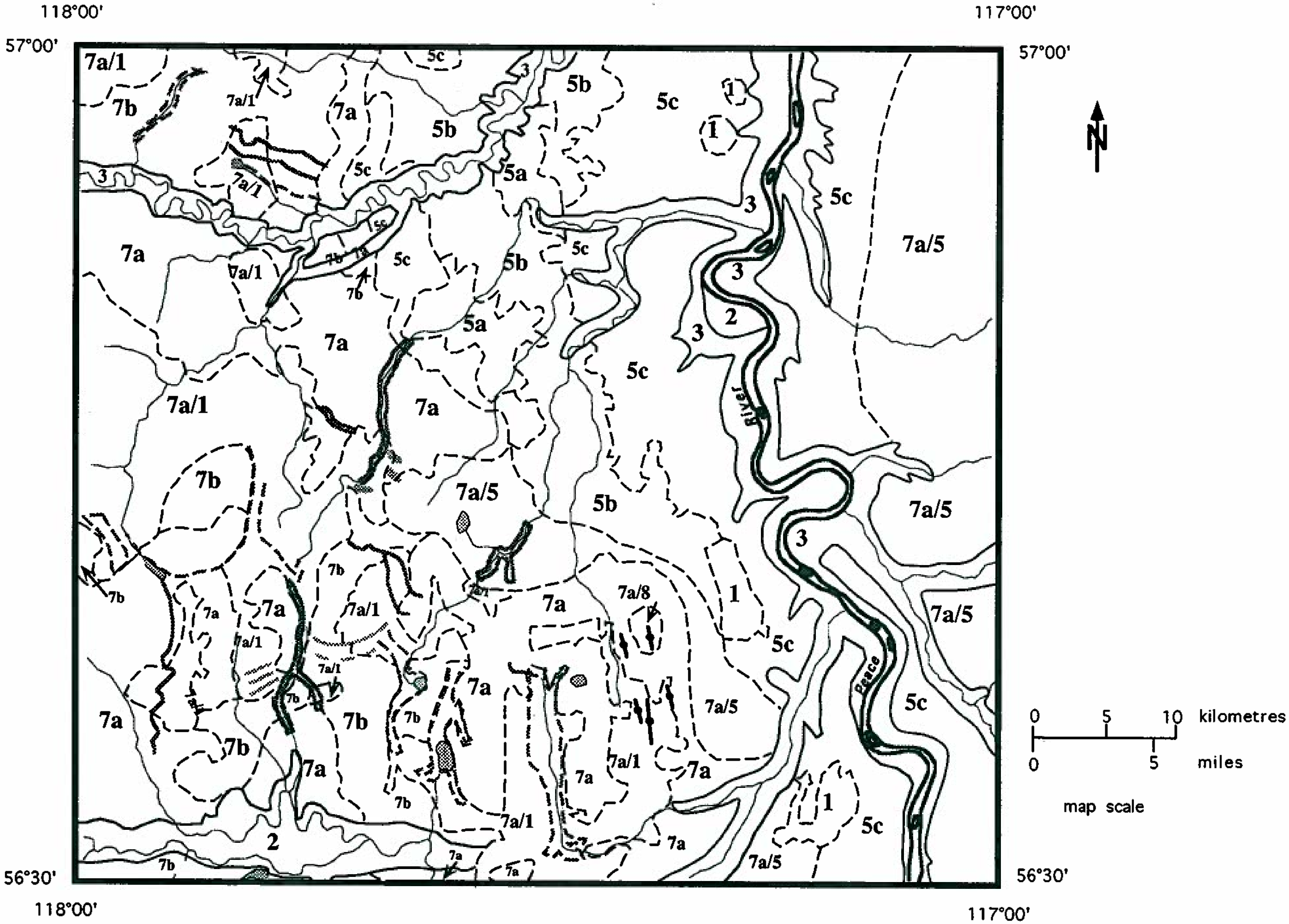


Figure 2.2. Surficial geology Peace River sheet, NW1/4.

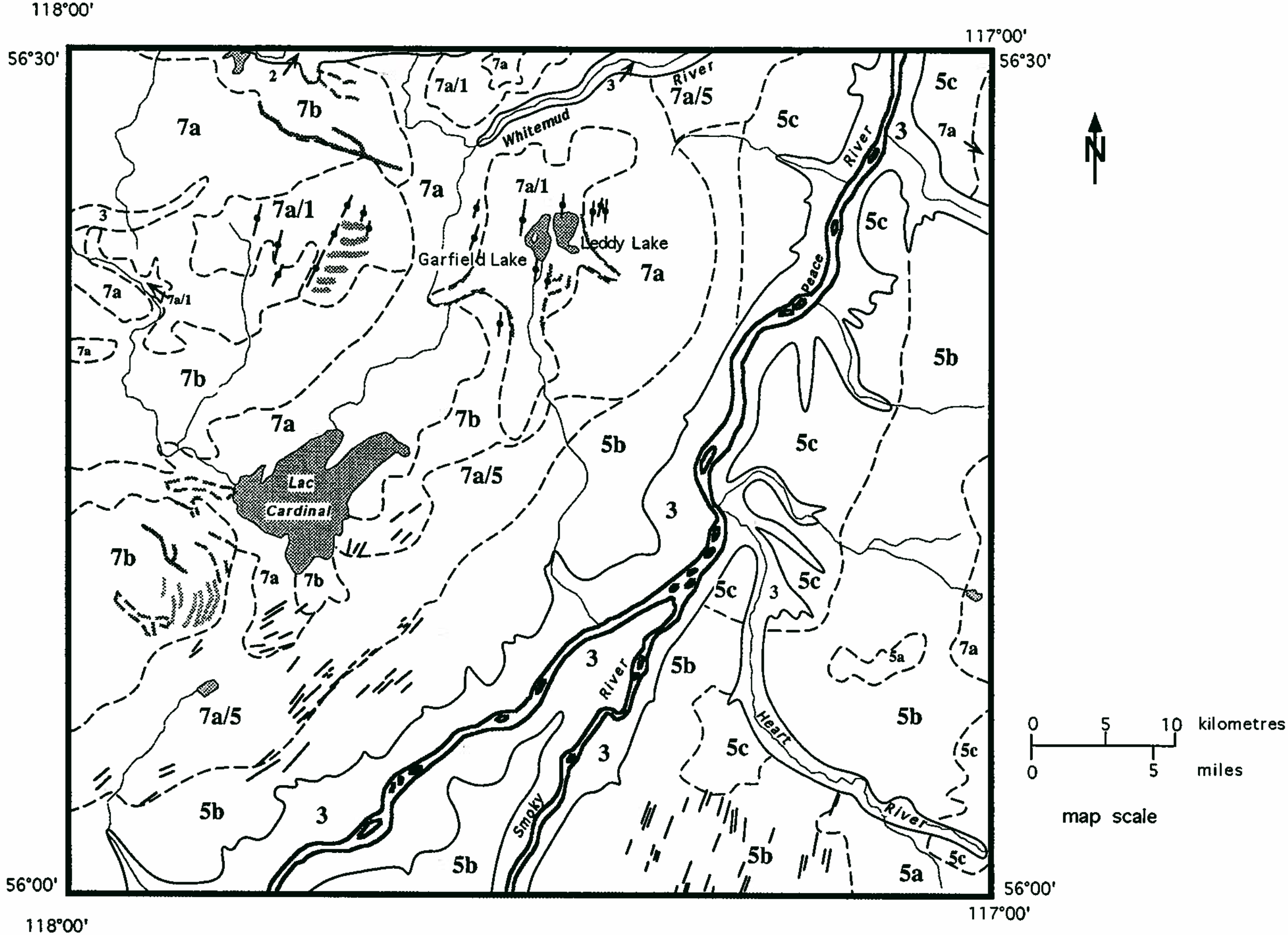


Figure 2.3. Surficial geology Peace River sheet, SW1/4.

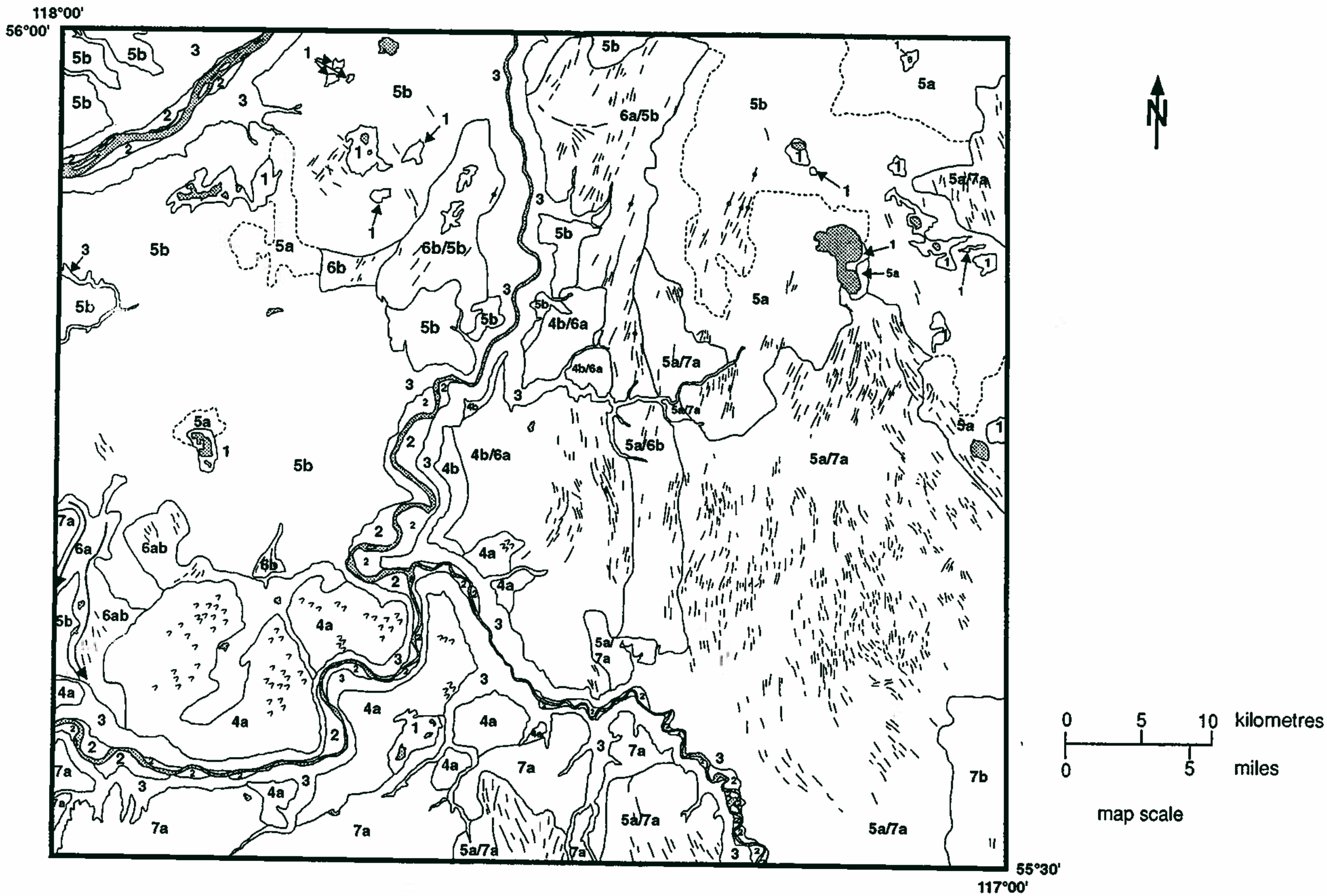


Figure 2.4 - Surficial geology of Winagami sheet, NW¼. Unlabelled polygons contain organics (Unit 1).

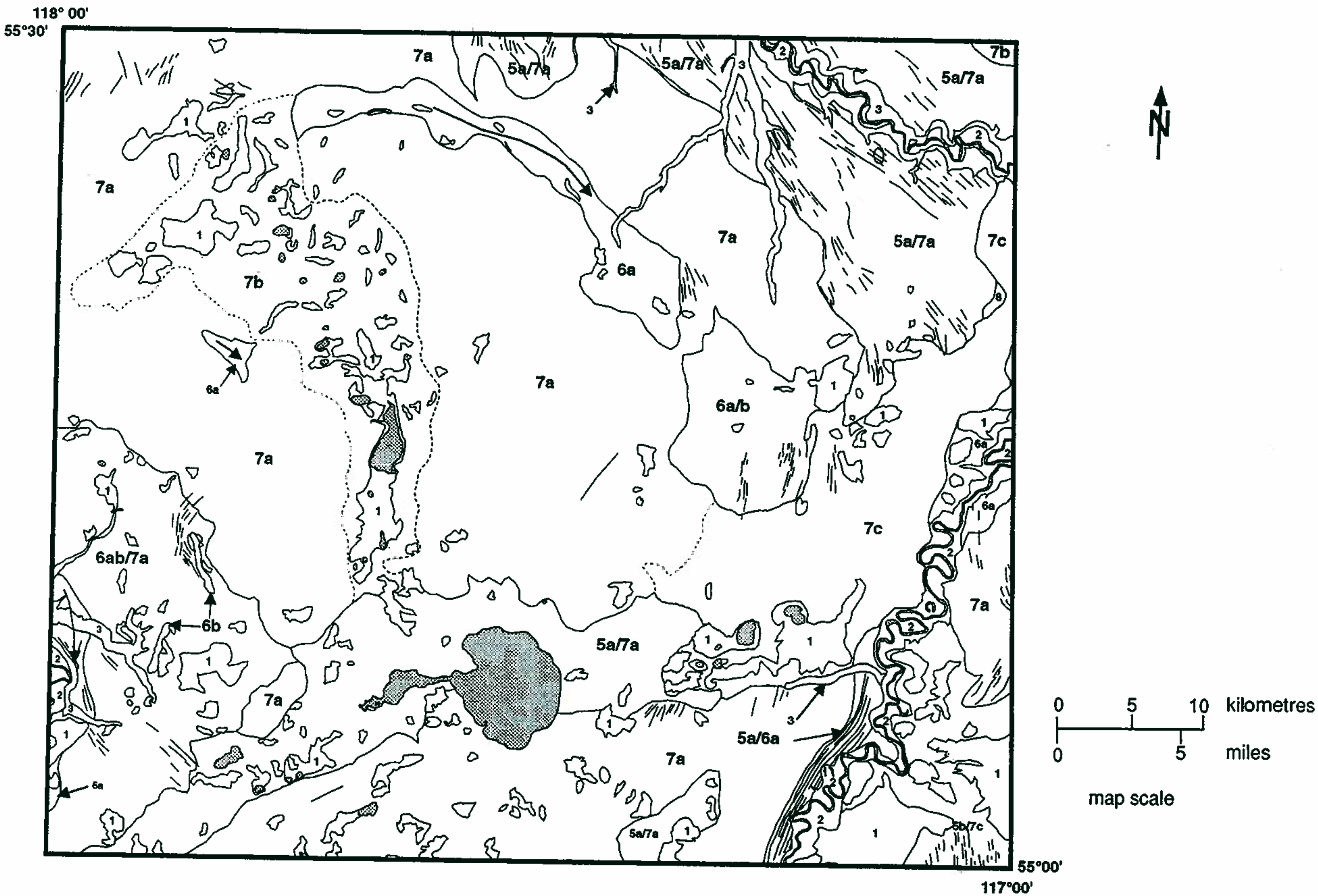


Figure 2.5 - Surficial geology of Winagami sheet, SW¼. Unlabelled polygons contain organics (Unit 1).

flow noses, convoluted laminae and slickensided detachment surfaces. Blocks of material contain normal faulting resulting from loss-of-support (93-SB-67, 94-SB-01). Reverse faulting has been noted, suggesting that some material may have experienced compression prior to slumping.

Colluvium is actively deposited along all rivers and streams due to surface runoff and poor drainage (Figures 2.2 to 2.5). In many regions, particularly the Peace River Townsite, slumping has required extensive preventive engineering of valley walls, highways and bridges.

2.4 AEOLIAN DEPOSITS (UNIT 4)

Aeolian deposits are composed primarily of moderately- to well-sorted sand and silt. They form parabolic, irregular and linear dunes, hummocks and ridges. These deposits are covered by forest vegetation and grasses. The thickness of unit 4 ranges from a veneer (<2 m) in the southeast to a thick blanket (>10 m) in the west.

Forested, large scale (up to 10 m) parabolic and irregular dunes and hummocks (4a) form areally extensive fields south of the Smoky River (Figure 2.4). The sands become interbedded with and overlie silts and clays southeast of Watino.

A transitional zone of dunes and glaciolacustrine/stagnation deposits lies east of unit 4a. Similar in composition to unit 4a, this area contains large–scale ridges and hummocks up to 3 m in height and 1 km in length (Figure 2.4). Loss of support features, such as normal micro-faulting, are preserved in ridge cross-sections.

2.5 GLACIOLACUSTRINE DEPOSITS (UNIT 5)

Deposits of glaciolacustrine origin are composed of laminated to massive units of silt and clay, with minor amounts of sand and diamict, and the occasional dropstone. Thickness varies from less than 2 m to over 10 m.

Low relief hummocks, ridges, flutes and slump scars typify the surface morphology. Relief is generally less than 2 m, but may locally reach 5 m. Glaciolacustrine deposits are divided into three subunits (Figures 2.2 to 2.5) based primarily on morphology and drainage: subdued, flat to fluted (5a); variable, flat to hummocky (5b); and, hummocky (5c).

Unit 5a is predominantly flat, however in places ridges and flutes, up to 3 m in height, and grooves are common. Massive to laminated silts and clays dominate this unit, but patches of organics are widespread. Drainage mimics the fluting/ridged and groove patterns, and indicates general ice flow directions.

Unit 5b contains surficial variations in morphology and drainage that are too localized to differentiate on a map scale of 1:100,000. This unit ranges from low–relief, flat areas to ridges, to large (>3 m high) hummocks. Compositionally, the unit is dominated by silts and clays with minor fine sand and diamict. The unit is usually massive to laminated, but convoluted beds exist in a few places. Well to poorly-drained areas with local ponding and organics, which are underlain by unit 5b, occur throughout the region.

Unit 5c is dominated by hummocks that are up to and occasionally exceed 5 m in height. Massive to laminated silts, clays and minor fine sand comprise the hummocks. Ponding, almost kettled in appearance, occurs in most depressions. Distribution of this unit appears confined to areas near the Peace River, with only minor patches elsewhere within the Peace River map area. Organic sediments are widespread in these depressional regions.

2.6 GLACIOFLUVIAL DEPOSITS (UNIT 6)

Glaciofluvial deposits are divided into two distinct map units (Figures 2.2 to 2.5): outwash and meltwater channels (6a); and, ice contact landforms (6b). Unit 6a consists of moderately sorted glaciofluvial deposits, composed of sand, silt and minor amounts of clay which infill the channels. Thickness is variable, for example exceeding 30 m in the Puskwaskau channel. Most channels are broad and shallow with poorly preserved sides. Two distinct channels occur in the southern regions of the study area (Figure 2.5). The first is east of Valleyview, and parallels the Little Smoky River. The second is along the northeastern edge of the Puskwaskau Hills.

Ice-contact deposits are composed primarily of gravel or sand and silt, with minor amounts of clay and till (6b). Streamlined ridges, hummocks, kames, eskers and ridges of variable relief and morphology typify these regions (Figures 2.4, 2.5). Cobbles and boulders on the surface are frequent. Unit thickness is variable, usually exceeding 2 m. These sediments have been deposited at the margin of, within or under glacial ice. Most of the deposits appear to have been reworked by glaciofluvial processes. Several of the ridges and eskers are used as local sources of aggregate.

2.7 MORAINAL DEPOSITS (UNIT 7)

Ablation, englacial and basal till (7) underlie most of the area, although outcrops are restricted primarily to the southern half of the Winagami map area (Figures 2.4 and 2.5) and in the northern half of the Peace River map area (Figures 2.2 and 2.3). The thickness of Unit 7 ranges from less than 3 m to greater than 43 m. Morainal deposits can be subdivided into three units based on morphology, drainage and texture: mixed flat to hummocky (7a), hummocky and kettled (7b), and prairie mounds (7c). All subunits may include small pockets of glaciolacustrine, aeolian, alluvial and organic deposits.

Subunit 7a contains ridges, hummocks, kettles and plains. Relief for ridges and hummocks can exceed 5 m. Drainage is irregular. Compositionally, the unit contains brownish-grey to brown, ablation to englacial till, silty to clayey in texture, with a clast content of 15% or less. Fine sand lenses and laminae may be present. The clasts are sub-rounded, highly weathered and very friable. Lithologically, they are dominated by a mixture of local (shales, sandstones) and Canadian Shield (granites, carbonates, mafics, volcanics) material.

Subunit 7b contains a typical hummocky and kettled terrain associated with ice stagnation. Hummocks are irregular in shape and form "a basket of eggs" topography. Depressional areas are kettled and commonly contain water during the spring and summer. Relief can exceed 10 m in height. Lower relief regions are used for crops, whereas the higher relief areas are restricted to grazing or forestry. This unit contains ablation and englacial till similar in composition, texture, colour and lithology to subunit 7a.

The last subunit, 7c, is similar to 7b, but the shape of the hummocks is very distinctive. Prairie mounds look like doughnuts on airphotos and miniature volcanoes on the ground. Roughly circular, the mounds have relatively steep sides and circular depressions on the top. These depressions are often filled with water or vegetation. These mounds can exceed 10 m in height and 500 m in diameter. Subunit 7c contains ablation and englacial till similar to subunits 7a and 7b, however, the clasts are less weathered. Finer sediments, primarily laminated to massive silts and clays overlie the mounds and thicken towards the central depression. These finer sediments are also found in the depressional and poorly drained regions around the mounds. Although crops are planted in this region, many hummocks are better suited for cattle grazing.

2.7.1 Undifferentiated deposits (Units 7a/1, 7a/5, & 7a/8)

Morainal deposits coupled with organic deposits distributed over large areas have been designated as subunit 7a/1. Usually the organic deposits are too small and abundant to map individually. They are found in the Clear and Whitemud Hills and the Garfield and Leddy Lakes area (Figures 2.3 and 2.4). Their morphology and composition are as described above for Units 7 and 1.

Subunit 7a/5 is a transitional map unit between Units 5 and 7 associated with ice stagnation and periodic ponding of meltwater. Both types are combined into one unit since, individually, they are too small to map and are not easily distinguishable on airphotos. The low relief hummocks, ridges and irregular forms are composed of a brown, oxidized, ablation till similar to subunit 7a. Interspersed with these are flat areas of interlaminated silts, clays and minor sand and diamict similar to subunit 5a. This unit is found south of Lac Cardinal and southeast of Manning.

Subunit 7a/8 consists of a discontinuous cover of morainal material over bedrock. This unit is confined to a small area situated around the Deadwood Forestry Tower (Twp 88, R 22). At that site bedrock is exposed along portions of the surfaces of a few large flutes with morainal deposits in the lee and in the depressions between the flutes.

2.8 BEDROCK (UNIT 8)

The only bedrock exposure large enough to qualify as a separate surficial map unit is a small hill located north of Valleyview (Figure 2.5). A road cut through the exposure reveals bedding planes inconsistent with the local bedrock pattern; beds have an apparent dip of approximately 9 degrees to the east. Faults, curved bedding and strike/dip measurements (280/21) indicate possible ice thrusting from a northwestern direction. Material in the hill is similar to exposures of the Kaskapau Formation along the Little Smoky River.

Bedrock is exposed primarily in river and stream cuts. Local roadside exposures of bedrock are found along Highway 35 approximately 20 km north of Grimshaw and just south of where the Secondary Highway 743 crosses the Whitemud River. The exposures along Highway 35 cuts through morainal ridges showing deformed shale, probably of the Kaskapau Formation, thrust upon till.

2.9 ICE DIRECTIONAL INDICATORS

There are few good indicators of ice flow direction in the study area. Interpretation is based on flute/drumlinoid and groove orientations and areal distribution of the deposits. The areal distribution of flutes, drumlinoid ridges and grooves, reveals there were two major ice-flow directions: south-southwesterly and southeasterly (Figures 2.2 to 2.5). The south to southwestward direction is the stronger, more erosive flow movement that originated north to northeast of the Peace River map area. Low relief ridges, grooves and flutes south of Lac Cardinal and in the Winagami map area support this flow direction. Large flutes which formed in the vicinity of the Deadwood Tower and other forms crossing over the upland areas indicate that this advance does not appear to have initially been influenced by local topography.

A second, weaker ice-flow to the southeast moved around local topographic features and may have been channelled by them (Figures 2.4 and 2.5). This second flow pattern appears to have originated northwest or west of the study region. This latter direction may be a possible effect of ice streaming or diversion.

Transverse ridges are present along the flanks of the uplands in the Peace River map area, particularly in the Clear and Whitemud Hills. Their orientation indicates they were formed by the stronger, more erosive south-southwesterly ice-flow. Other arcuate-shaped moraine ridges are found in the Clear Hills and southwest of Lac

Cardinal. They indicate a southeast flow direction probably associated with minor ice fluctuations that occurred during the initial waning stages of deglaciation. During this interval the flow may originated from that portion of the ice lying to the west and northwest of the Peace River map area.

3.0 QUATERNARY STRATIGRAPHY

3.1 UNIT DESCRIPTION AND INTERPRETATION

A total of six major stratigraphic units, including bedrock, have been recognized. Many of the units can be correlated between a number of sections. Some of these units are equivalent to those described in the segments on surficial and bedrock geology.

3.1.1 Bedrock

The lowermost unit in all cross-sections is bedrock. Due to the variability of the bedrock (as discussed in sections 1.2.2 and 2.8), this unit was not designated a letter code. The bedrock type, at any particular section, is dependant on the formation that subcrops at that particular site (Figure 1.4).

3.1.2 Unit A

The characteristics of unit A are based primarily on the Watino section in Winagami map area, gravel pits in the Peace River area (the Grimshaw Gravels of Tokarsky 1967), and two exposures east of Manning (LL-Sections-78 and 69).

Unit A is composed of preglacial, moderately sorted gravel (granule to boulder sized) and poor to moderately sorted fine to coarse sand. A distinctive orange oxidization stains the gravel. The clasts are sub- to well-rounded. Lithologies are dominantly Cordilleran in origin, consisting primarily of quartzites, sandstones, and carbonates. Large–scale trough cross-bedding show a weak paleocurrent towards 010° at the Watino section, a north to northeast one in the Peace River area, and 090° and 360° ones in the Manning area. Thickness is variable; at the Watino section it averages 15 m and abruptly overlies ironstone and shales of the Shaftesbury Formation. Its upper contact varies from conformable to abrupt. In the Peace River area, exposures of Unit A are 30 m (Grimshaw Gravels) to over 100 m (LL-Section-69) thick and are overlain by unit C. Unit A contains three subunits: A-1, gravels; A-2; and A-3.

Subunit A-1 is composed primarily of gravel. It is restricted to paleochannels cut into the underlying bedrock, with the exception of the Grimshaw Gravels which have been interpreted as upper terrace deposits. This subunit is thought to be the northern equivalent of the Saskatchewan sands and gravels (Tokarsky, 1967). The age of the sediments is questionable, due to a lack of dating control. Sediments at the Watino section have been interpreted as Tertiary or Sangamon in age. The unit is a major source of aggregate in the Peace River/Grimshaw and the Watino areas. Subunit A–1 is believed to have originated as channel fill in old river beds and as terrace deposits.

The characteristics of subunit A-2 are based on the Watino exposure in the Winagami map area (Figure 1.3). Subunit A-2 contains finely–laminated, very fine sand and silt. The lower portion contains climbing A-type ripples that gradually become planar stratified towards the middle sections. The upper sections are more massive and contain large (up to 50 cm) water release structures. Overlying the sands is a unit approximately 2 m thick of planar–laminated, dark grey, silty clay, brown silt and grey-brown, silty sand. Laminae thickness varies from 1 mm to 19 cm. The sandier portions are cross-laminated to wavy, with climbing B-type ripples. At Watino, the lower contact with subunit A-1 is conformable, although abrupt.

The age of subunit A-2 is questionable. It is preglacial due to a lack of Shield material, and is older than 50 ka. Subunit A-2 also appears to be restricted to the paleochannels. Sedimentary features, such as laminations and ripples, support a fluvial origin for subunit A-2. These sediments were likely deposited as sand bars or floodplains.

Subunit A-3 contains fluvial sediments similar to subunit A-2. The lowermost unit contains well–sorted, very fine sand with black laminae of organics and coal. The unit progresses upwards from A to B-type ripples to climbing A-ripples to sinuous wavy lamination to planar lamination. The middle portions contain a massive to finely laminated, dark grey, silty clay. The laminae are commonly deformed and show distinct detachment surfaces with slickenslides. Above the silty clay is another thick unit (>5 m) of moderately to well–sorted fine to medium sand. The sand is trough cross-bedded with gravel at the base, becoming more horizontally laminated further upwards and eventually massive at the top. Several dates have been obtained from subunit A-3 at the Watino site (Westgate et al., 1972; Liverman et al., 1989). The dates range from 27 to >40 ka, giving the sediments a Mid-Wisconsin age. The lack of glacially derived material has lead to the interpretation of this unit as fluvial sediments deposited during the Watino Non-glacial. Subunit A-3 is probably exposed in two other localities (LEL-BH-15 and LL-Section-69) based on their stratigraphic position, but dates are not available to confirm this.

3.1.3 Unit B

Unit B contains a mixture of sediments, including fine to coarse sand, gravel, diamict and massive to laminated silt and clay. Unit B is conformably overlain by unit C, except at Watino where Unit B is overlain by colluvium.

The gravels and sands contain material of Canadian Shield origin and are therefore attributed to meltwater from advancing Laurentide Ice. This portion of unit B is well exposed at Watino, showing trough cross-bedding and ripples. Much of this material has been removed by local aggregate companies.

The lithological composition of the silts and clays have not been determined. Based upon their stratigraphic position, below the basal till, they are correlated with the advancing Laurentide Ice deposits. They are the result of ponding due to ice-damming of previous drainage patterns. Clays and silts occur in smaller pockets/depressions in regions further south, particularly in the Puskwaskau Hills region. Their existence is known mainly through drilling for geological (for example core hole 94-SAB-08), landfill and hydrological studies.

The characteristics of Unit B differ in the Peace River map area where the unit commonly includes thick diamicton beds. Exposures south of Grimshaw, in gullies along the Peace River (LL-Sections-36,42, and 47) and along a cut bank of Buchanan Creek (LL-Section-78), have tabular diamicton interbeds (2-4 m thick). These occur within predominantly horizontally–stratified to massive units of sand with lesser amounts of gravel and silt; interpreted to be glaciofluvial and debris flows generated near the ice front. Unit B at these localities is present within a paleochannel, conformably overlain by Unit C.

3.1.4 Unit C

Unit C is a glacial package containing three subunits: C-1, a dark grey till; C-2, a brown-grey to brown till; and C-3, glaciofluvial sediments. Subunit C-1 is a dark grey, massive, silty-clay till. The till varies from englacial to basal/deformational depending upon location and depth. Clasts (pebbles and granules) comprise approximately 8 to 12% of the unit. The clasts are generally subangular to angular, and very fresh in appearance. Dominant lithologies include local bedrock (shales, sandstones, ironstone) and material from the northeast/shield regions (granites, volcanics, pink-purple quartzites, carbonates, schists). The percentage of local material increases substantially downwards. Subunit C-1 is very compact and laterally extensive. Englacial portions of the unit may contain lenses or laminae of silt, clay and/or fine to coarse sand. Lenses range from 6 to 32 cm thick. In several boreholes (LEL-BH-01,-04,-12,-13,-14, and -16), minor amounts of pea gravel are common in the lower parts of subunit C-1. The lower contact varies from abrupt/sharp to gradational and/or deformational with the underlying bedrock. The upper contact may be gradational or sharp with units C-2, C–3 and D, and is abrupt with alluvial sediments of Unit E. Unit thickness is highly variable, ranging from less than 3 m near the Winagami-Peace River map area boundary to well over 40 m south of the Little Smoky River and in the Manning area.

Subunit C-2 is a greyish–brown to brown, weathered till. Compositionally, the till contains silty-clay, but local areas may contain more clay–, silt– or sand–rich facies. Sandier facies are common at higher elevations, particularly in the Puskwaskau Hills region. Till structure varies from massive to stratified (LEL-BH-03,-04,-10, and -12).

Clasts comprise approximately 15% of the unit and are often weathered, soft, friable and sub- to well-rounded. Lithologically, the clasts contain local and abundant Shield material. Some places in the southern half of the Winagami map area the clasts from subunit C-2 include some Cordilleran type lithologies (carbonates, quartzites, cherts). Thicker laminae and lenses of silt and occasionally sand are common. The till is predominantly ablation in origin, but thicker sequences contain englacial and glaciofluvial material. Large vertical, oxidized fractures are common and occur at depths of up to 22 m. The fractures are usually orange–brown to brown in colour and contain gypsum crystals up to 4 cm in length.

Subunit C-2 conformably overlies the dark grey till of subunit C-1 in most regions. The lower contact is usually gradational or inter-laminated (to interbedded with 10 to 30 cm beds), but may be abrupt. The upper contact varies from gradational to abrupt, but appears to be conformable. This subunit varies in thickness from 1.5 m to over 16.5 m (LEL-BH-04). Alteration by groundwater, meteoric water and soil forming processes is visible in exposed sections. C-2 is interpreted as the upper ablation/englacial facies of subunit C-1 and is attributed to the same ice depositional event.

Subunit C-3 contains glaciofluvial sands and/or gravels. The unit is generally thin (<2 m) and sporadic in occurrence. A lack of geometric control on this unit makes it difficult to describe properly. Subunit C-3 may occur as lenses or distinct beds/laminae of variable thickness and extent (for example sites. 93-SAB-03, 94-SAB-10, 94-SAB-04, 94-SAB-06, 94-SAB-11, LEL-BH-16). When present, it overlies subunit C-2 or C-1 and is in turn overlain by the silts and clays of unit D. Meltwater that flowed beneath, within, atop and proximal to the ice all contributed to subunit C-3 as braidplain sediments, lenses and laminae.

3.1.5 Unit D

Unit D contains waterlain sediments, and can be subdivided into two subunits: D-1, diamict; and, D-2, massive to laminated silts and clays. Subunit D-1 is a laminated to massive silty-clay diamict that is greyish-brown in colour. Abundant granules of calcareous concretions and local dropstones comprise approximately 2 to 3% of the unit. The lower and upper contacts are abrupt to gradational with unit C and unit E, respectively. Subunit D-1 is very local in extent and is found primarily in the Peavine Creek area of the Winagami map area. Thickness varies from approximately 1 to 4 m. This unit appears to have been deposited as ice-rafted debris or as debris flows from proximal Laurentide ice.

Subunit D-2 contains massive to laminated silts and clays. Laminae are 1 to 30 mm thick and may be convoluted. Dropstones (variable lithologies) and carbonate concretions comprise less than 1% of the unit. Thicker silt bands are commonly water-saturated. The lower contact is conformable, but abrupt with unit C and gradational with subunit D-1. The upper contact is conformable with the present soil horizons or is abrupt with the alluvial and aeolian sediments of unit E. Subunit D-2 varies in thickness from 2 to 30 m (for example borehole LEL-BH-07). The thickest portions are found near St. Isidore, south of the Peace and Smoky Rivers confluence and north of the Puskwaskau Hills region. Subunit D-2 is interpreted as glaciolacustrine deposits due to it's massive to rhythmically laminated structure, and to the presence of dropstones. These sediments were likely laid down during later stages of deglaciation by ice damming of drainage systems.

3.1.6 Unit E

Unit E contains sediments of post-glacial to recent age (surficial units 1 to 4). Detailed descriptions of these units are contained in the surficial segment of this report (sections 2.1 to 2.4). The lower contact of these units is variable, ranging from abrupt, yet conformable to erosional (alluvial). The aeolian sediments of unit E conformably overlie unit D in the west-central portion of the area. Alluvial sediments may overlie any unit, depending upon location. Unit E is restricted to regions adjacent to present day rivers and creeks, forming the floodplain and channel deposits associated with the incision of the rivers and creeks.

3.2 CROSS–SECTION CORRELATIONS

This segment of the report presents only generalized stratigraphic summaries and cross-sections for both the Peace River (84C) and the Winagami (83N) areas. Detailed stratigrapic interpretations are difficult because there are numerous and widespread facies changes in the Quaternary sediments that prohibit detailed correlation between boreholes and sections. Also, the underlying bedrock contains numerous paleochannels and tributaries that are poorly documented in the current literature and which had not been more precisely defined by this study at the time this report was written.

3.2.1 Peace River

Three cross–sections have been chosen to represent a generalized glacial stratigraphy of the Peace River (84C/w 1/2) map area (Figures 3.1, 3.2 and 3.3). Two north-south cross–sections (A-A' and B-B') are on the western and eastern halves of the map area, and a third (C-C') is an east-west cross–section, passing through Manning in the norther portion of the area (Figure 3.1). There is little control on the bedrock topography and consequently this surfaces shown in the cross-sections is only approximate. Bedrock depths can be confirmed where observed in sections and boreholes, but information from water well logs in some instances can be unreliable or uncertain.

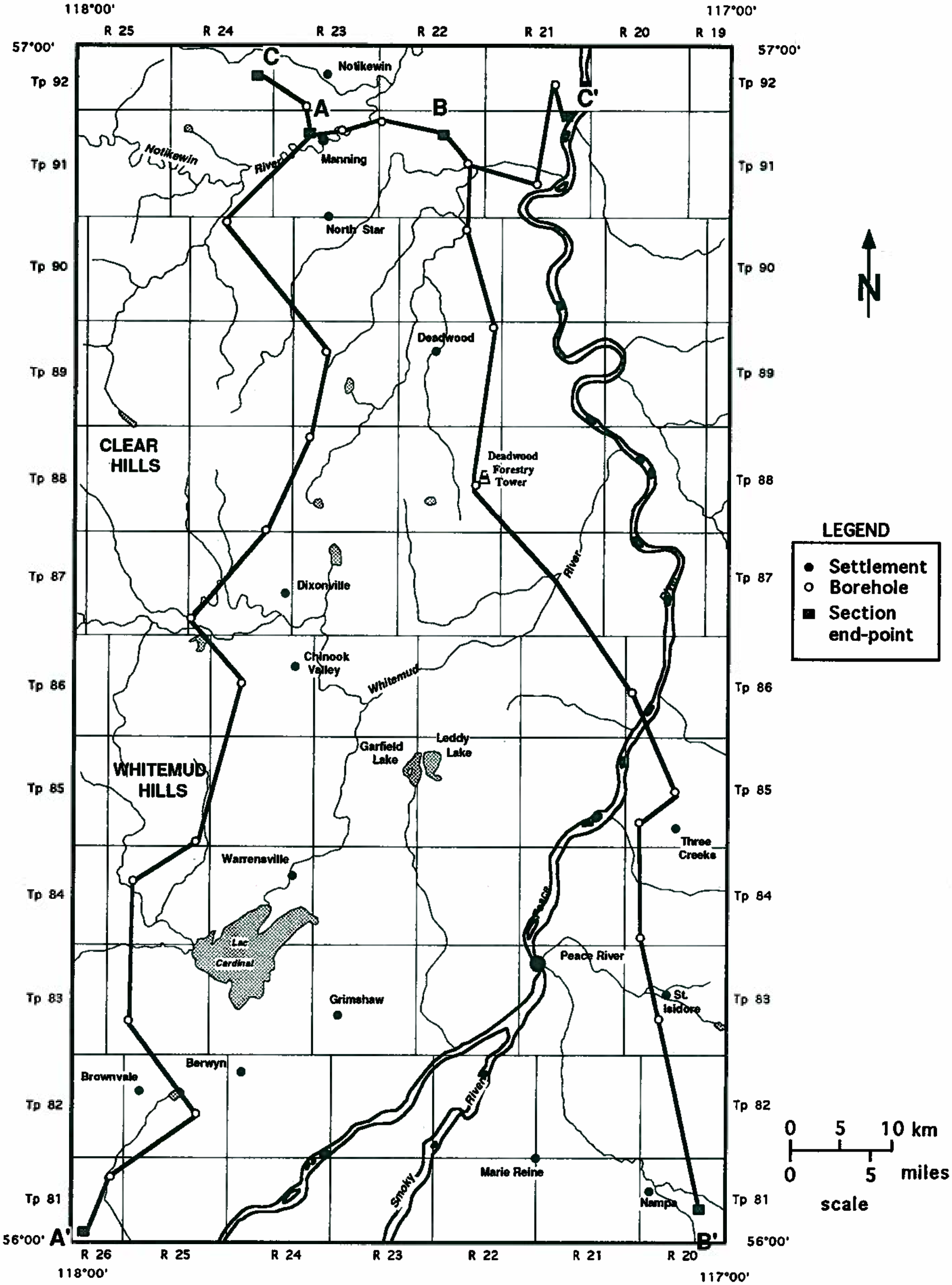


Figure 3.1. Cross-section location map, Peace River sheet.

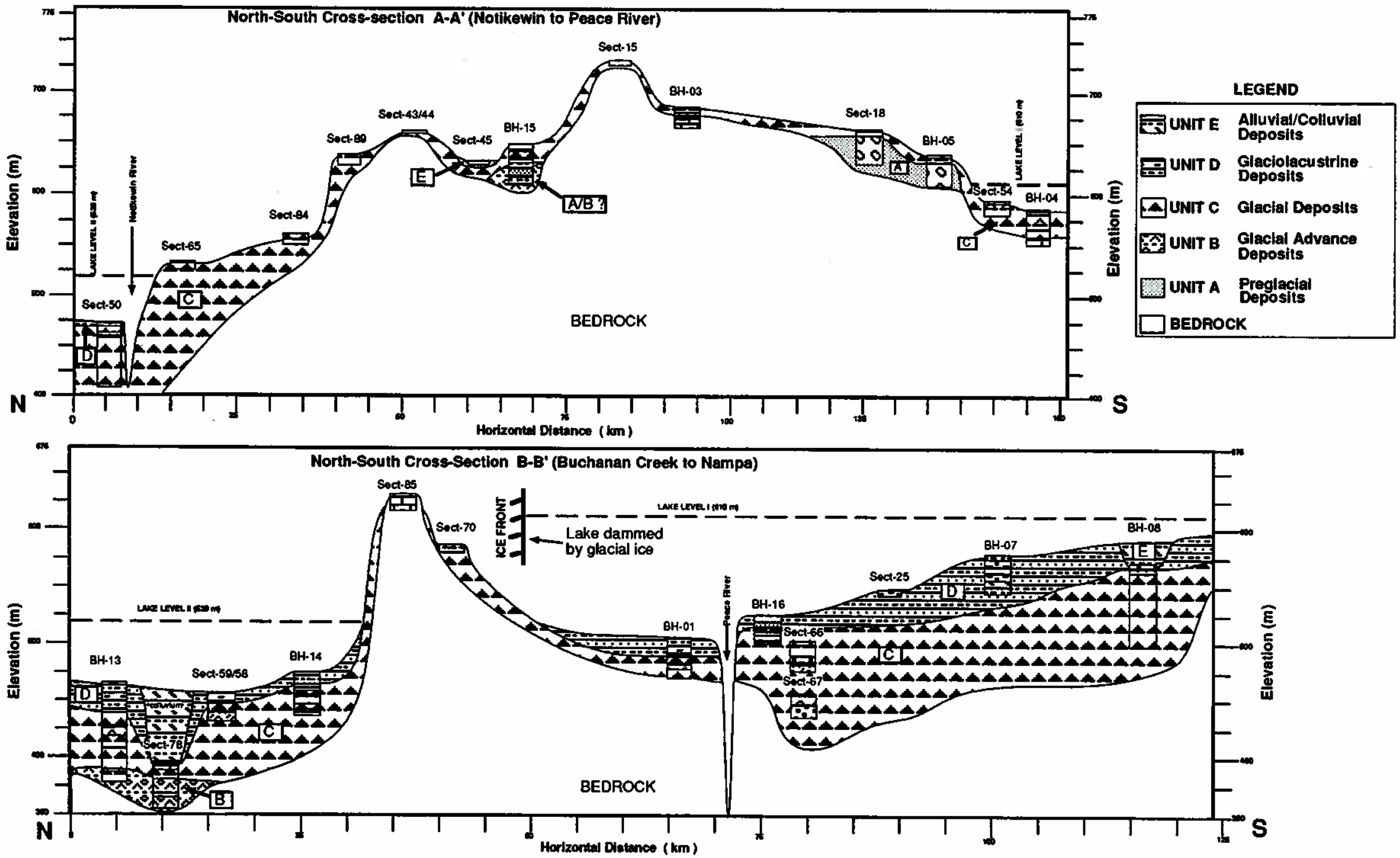


Figure 3.2. Peace River cross-sections A-A' and B-B'.

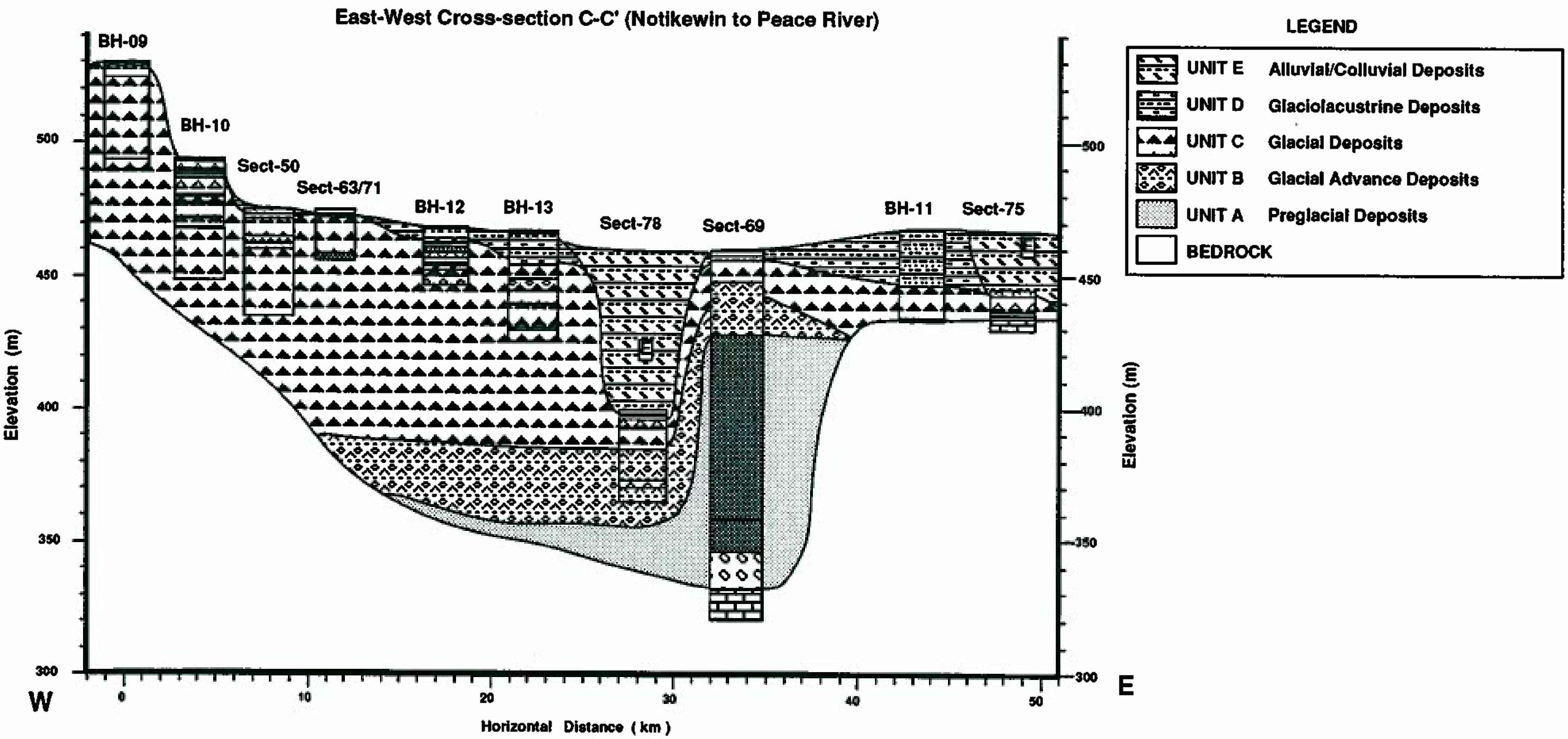


Figure 3.3. Peace River cross-section C-C'

3.2.1.1 Cross–section A-A'

Cross–section A-A' (Figure 3.2) begins at an exposure along the Notikewin River in the town of Manning (LL-Section-50), extends south crossing the upland areas of the Clear and Whitemud Hills, and ends at a borehole site (LEL-BH-04) on the plateau just north of the Peace River. In this cross–section the lowland areas contain thick sequences of drift; generally more than 30 m.

The Grimshaw Gravels, included in Unit A, are present near the south end of the cross–section, directly overlying bedrock of the Dunvegan Formation. Unit B which was intersected in corehole LEL-BH-15, consists of finely bedded, fine to medium sand, silt, clay, and black horizons. These sediments have a strong sulphurous odour that may be attributed either to a weathering product of the local shale bedrock which contains sulphur beds, or organic sediments. The presence of organic sediments indicate a preglacial or interglacial origin, thus this unit could be reinterpreted as Unit A. These units will be examined in more detail later. In addition, small shell fragments (sample LL-94-62) were collected from these sediments and will be submitted for radiocarbon dating.

Unit C is present throughout the entire cross–section and overlies either Unit A, Unit B, or bedrock. The thickness of Unit C is quite variable. It is thickest in the paleochannels (for example.about 25 m in corehole LEL-BH-04 drilled near the south end of the cross–section), less than 4 m thick overlying Unit A and perhaps no more than 8 m in the uplands of the Whitemud and Clear Hills. The thickness of this unit is unknown around Manning, but interpreted to be generally greater than 30 m. The preglacial topography is a controlling factor for till accumulations; the deeper the channel the thicker the till, and the till is thinnest away from the channels.

Glaciolacustrine sediments of Unit D conformably overlie Unit C at elevations below approximately 610 m near the Peace River and 520 m in the Manning area. The thicknesses of Unit D ranges from 4 to 8 m, which is thin in comparison to the eastern side of the map where cross–section B-B' is situated. As well, the sediments of Unit D in cross section A-A' are generally more thinly bedded to interlaminated, and coarser than this unit in cross–section B-B'. Unit E is only present along this cross–section as floodplain sediments (LL-Section-45) of the Whitemud River.

3.2.1.2 Cross–section B-B'

Cross–section B-B' extends north-south along the eastern side of the map area. It crosses the uplands near the Deadwood Forestry Tower, intersects the Peace River mid-way, and ends at borehole LEL-BH-08 near the village of Nampa. Unit A is not exposed in this cross–section. The fluvial sands and gravel with minor diamicton beds are of Unit B. They are interpreted as sediments deposited in front of the ice by meltwater as the Laurentide Ice advanced into the area from the north. This interpretation is supported by the presence of Canadian Shield clast lithologies and diamicton beds within the fluvial sediments. As in cross–section A-A', Unit C extends across the entire B-B' cross–section. It overlies either bedrock or Unit B. Unit D can be more than 30 m thick (LEL-BH-06) and is thickest at both ends of the cross–section.

3.2.1.3 Cross–section C-C'

This cross–section begins just west of the hamlet of Notikewin and extends east to a gully section (LL-Section-75) above the Peace River (Figure 3.3). In this short cross–section all stratigraphic units are well represented. The large paleochannel exposed in LL-Section-69, at the east end of the cross–section, contains a very thick sequence (>100 m) of Unit A sediments. These sediments are exposed in steep-sided gullies of loosely consolidated sands and gravels, making detailed observation and sampling of the sediments very difficult. Two determining factors for assigning these sediments to Unit A were that a) they overlie bedrock, and b) no Canadian Shield clast lithologies were observed in the cobble gravels. The assigned contact between Unit A and B in this exposure is arbitrary because the contact is situated beneath a covered portion of the slope. However, Unit B sediments, which directly underlie Unit C, are distinguishable based upon a different composition from Unit A sediments which outcrop at the lower end of the exposure. Unit B is composed predominantly of medium to coarse sand, with minor gravel, diamicton, and silt. Unit B, in LL-Section-78, is a coarser sequence with thicker diamicton beds. At the west end of this cross–section, Unit C is of unknown thickness (>30 m) and at the east end it is only 13 m thick where it directly overlies bedrock. Unit D covers the surface below an elevation of approximately 520 m and is not exposed in LEL-BH-09. It is thickest in LEL-BH-11, where it is 20 m thick. But, in general, these units are thinner than Unit C in the southeastern portion of the Peace River map area. Unit E is composed of colluvial material.

3.2.2 Winagami

Three north-south cross–sections (Figures 3.4) through the Winagami map area are presented in Figures 3.5 to 3.7. The cross–sections have been simplified to better show the changes in the major units from A to E, and the underlying bedrock topography. Bedrock topography was estimated from Henderson (1959), Borneuf (1980) and descriptions from water wells, landfills, boreholes, and geological mapping.

3.2.2.1 Cross–section D-D'

Cross–section D-D' extends along the western side of the Winagami area, crossing over the Peace and Smoky Rivers, and the westernmost Puskwaskau Ridge

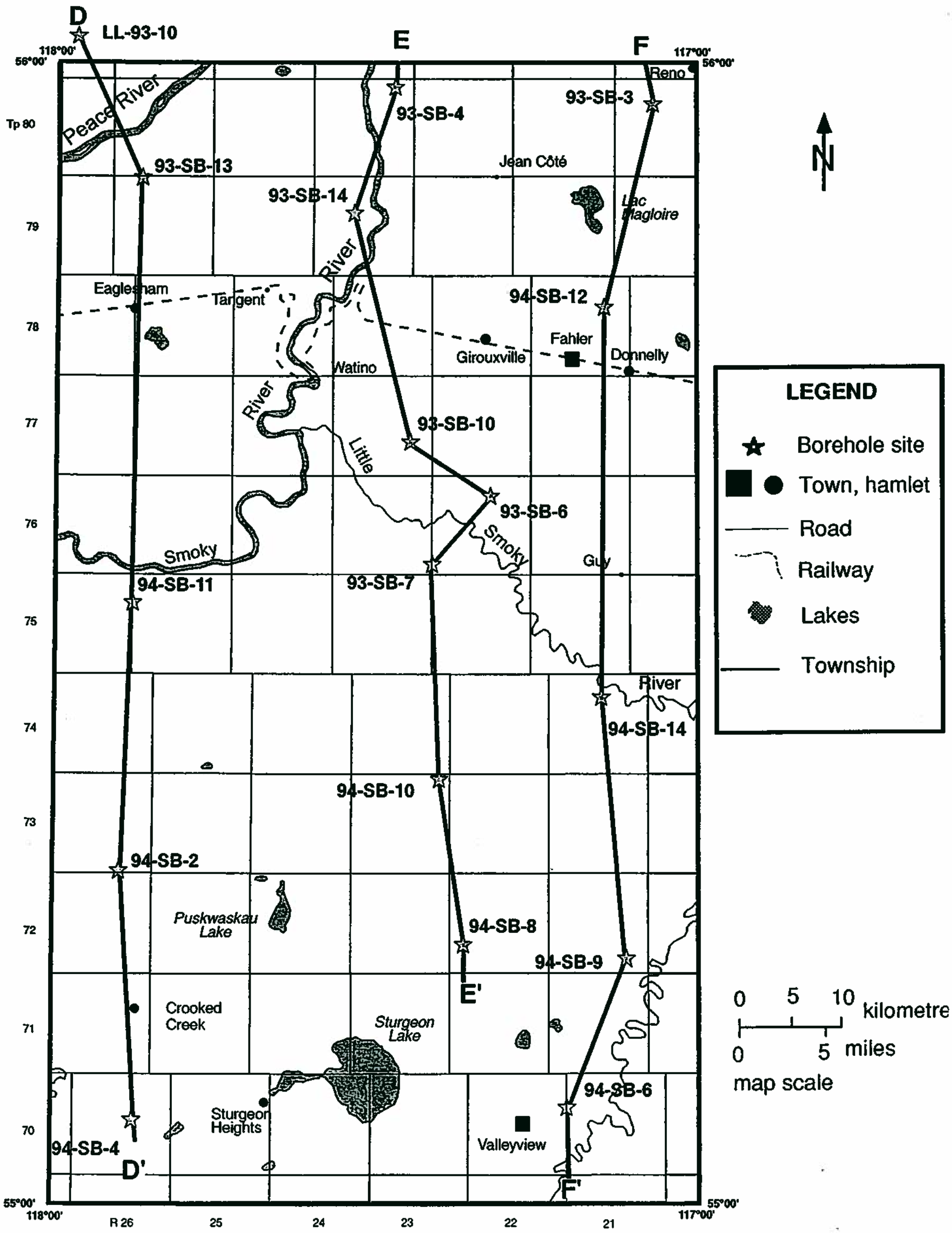
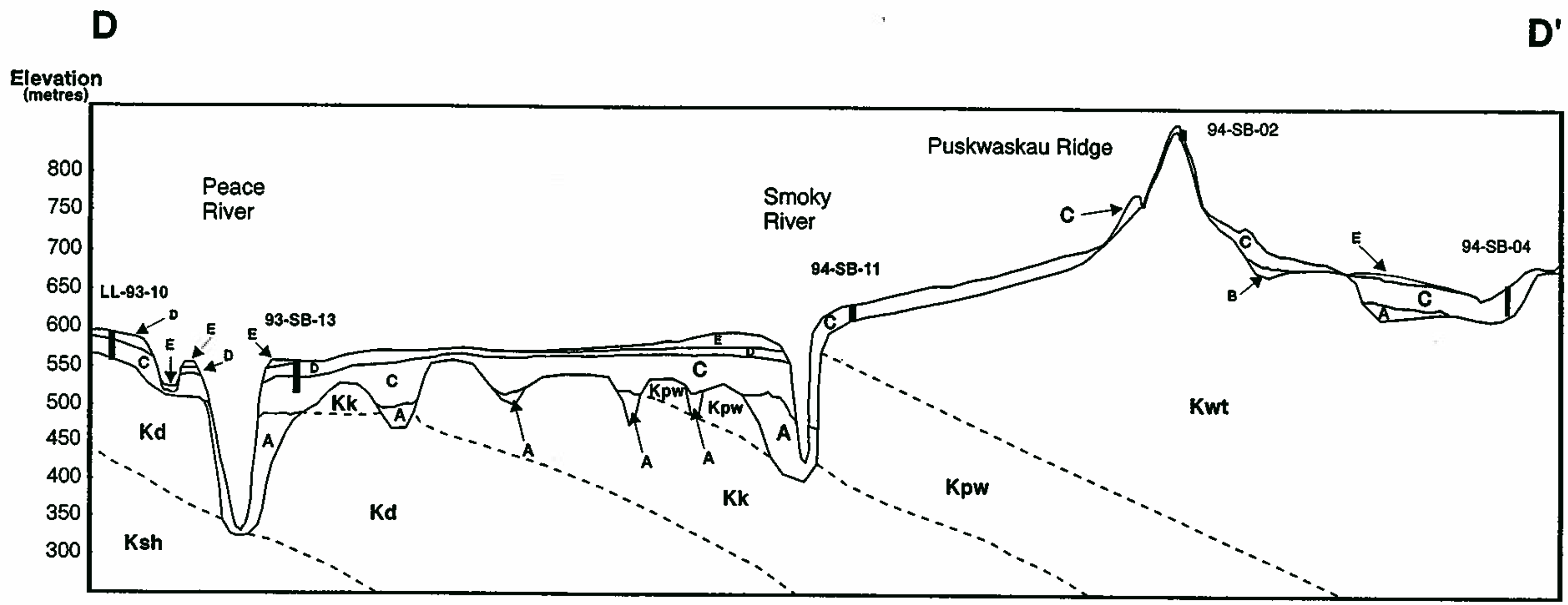


Figure 3.4 - Location of cross-sections, Winagami sheet (83N/W½).



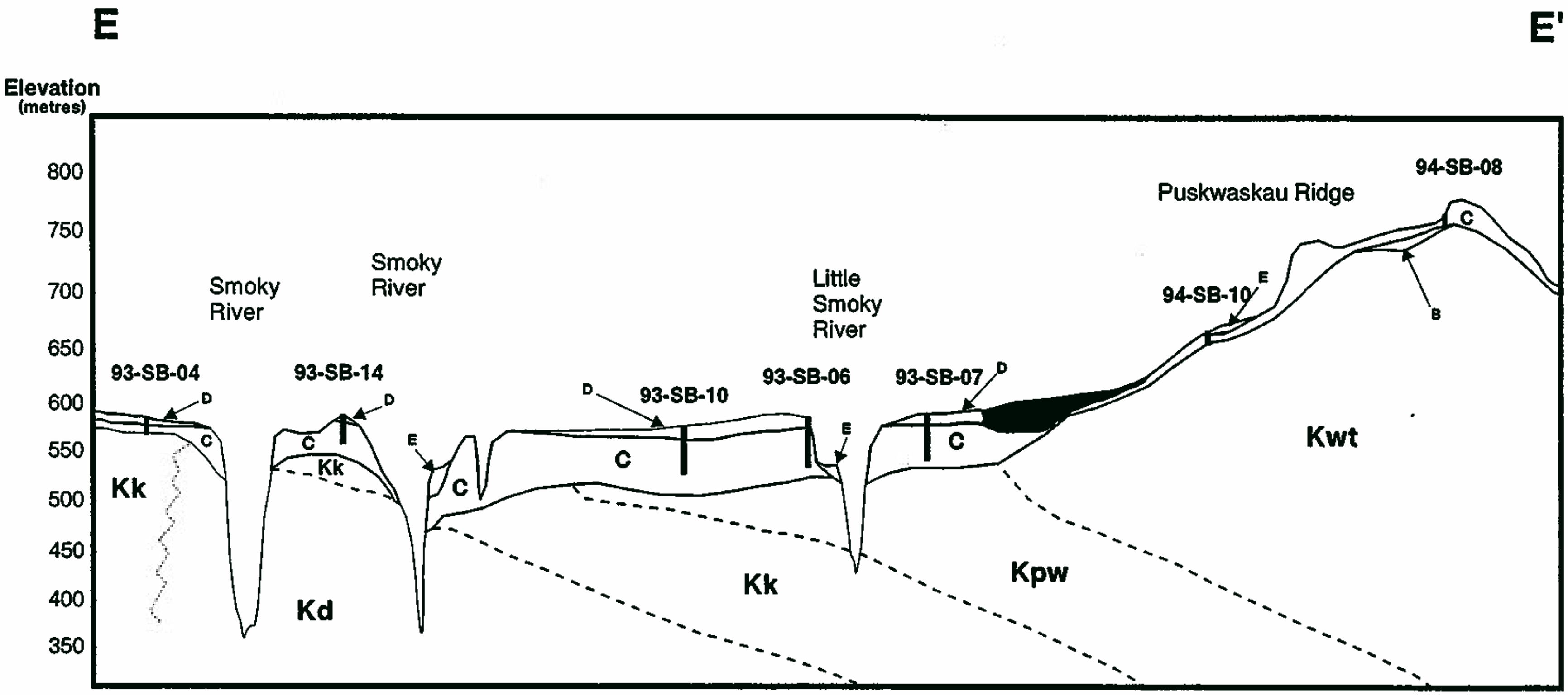
LEGEND

Ksh = Shaftesbury Fm.
Kd = Dunvegan Fm.
Kk = Kaskapau Fm.
Kpw = Puskwaskau Fm.
Kwt = Wapiti Fm.

A = unit A
B = unit B
C = units C-1 to C-3
D = unit D
E = unit E

Bedrock surface based on Borneuf (1980) and Henderson (1959).
Dashed lines represent approximate contacts for individual units. See text for descriptions.

Figure 3.5 - Winagami cross-section D-D' (north - south). Horizontal axis is not drawn to scale.



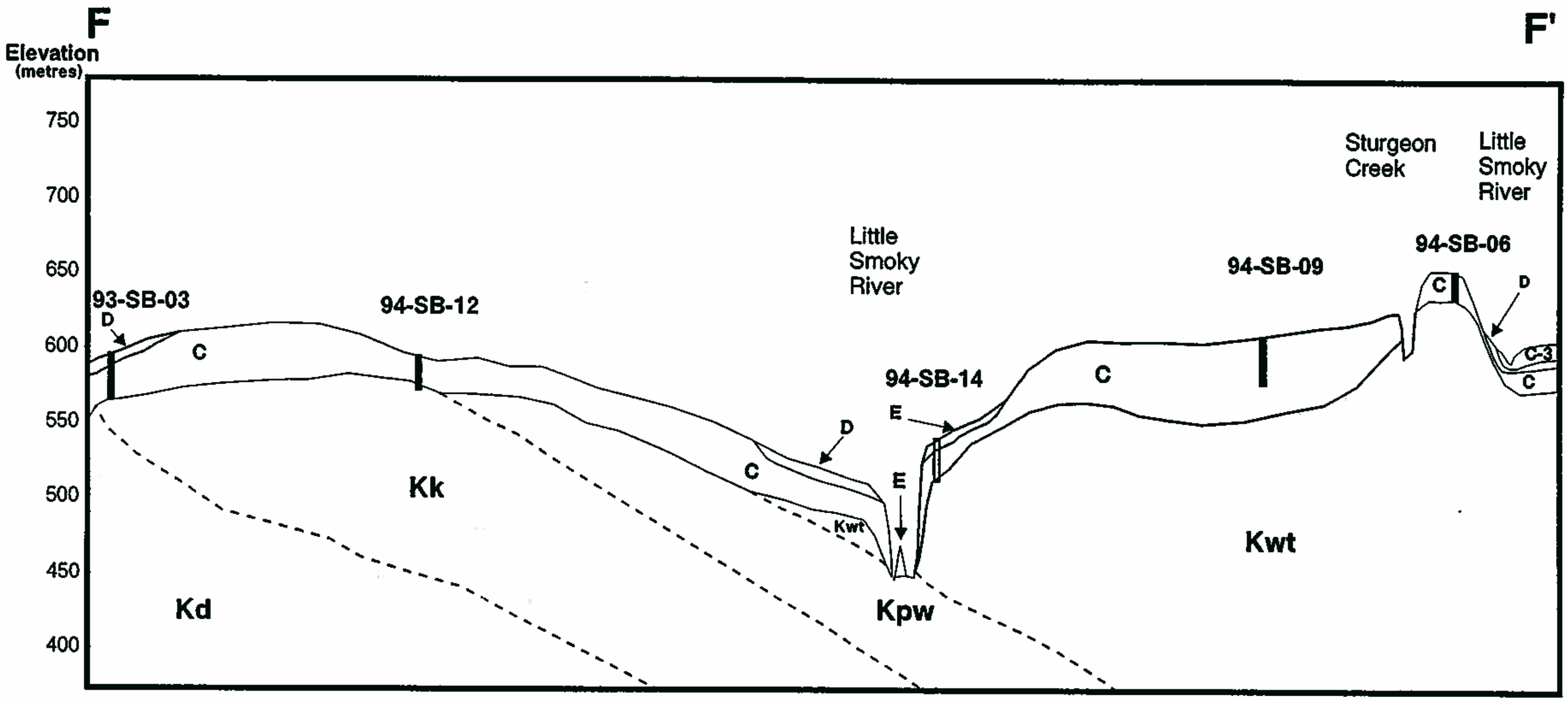
LEGEND

Ksh = Shaftesbury Fm.	A = unit A
Kd = Dunvegan Fm.	B = unit B
Kk = Kaskapau Fm.	C = units C-1 to C-3
Kpw = Puskwaskau Fm.	D = unit D
Kwt = Wapiti Fm.	E = unit E

Bedrock surface based on Borneuf (1980) and Henderson (1959).

Dashed lines represent approximate contacts for individual units. See text for descriptions.

Figure 3.6 Winagami cross-section E-E' (north - south). Horizontal axis is not drawn to scale.



LEGEND

Ksh = Shaftesbury Fm.
Kd = Dunvegan Fm.
Kk = Kaskapau Fm.
Kpw = Puskwaskau Fm.
Kwt = Wapiti Fm.

A = unit A
B = unit B
C = units C-1 to C-3
D = unit D
E = unit E

Bedrock surface based on Borneuf (1980) and Henderson (1959).
Dashed lines represent approximate contacts for individual units. See text for descriptions.

Figure 3.7 - Winagami cross-section F-F' (north - south). Horizontal axis is not drawn to scale.

(Figure 3.5). Many paleochannels in the northern half of the cross–section are infilled by largely unknown sediment types. However, based on the Watino section, they may contain unit A and possibly B as channel fill. Unit C extends across the entire cross–section, infilling channels and capping bedrock highs. North of borehole 94-SB-02 (Figure 3.5), unit C contains primarily subunits C-1 (grey till) overlain by C-2 (grey-brown till), although sandy lenses or laminae of C-3 may occur. A higher proportion of sand is present in cores overlying the Wapiti Formation (94-SB-11, 94-SB-02). South of borehole 94-SB-02, subunit C-3 overlies and is interbedded with C-1 and C-2.

Glaciolacustrine sediments (unit D) overlie the tills on the northern side of the Smoky River (Figure 3.6). Thickness varies from about 3 to 17 m, with the thickest portion between the Peace and Smoky rivers. Unit E, along the banks of the Peace River, contains alluvium (sands and gravels) from the incision of the river. Unit E along the north side of the Smoky River contains aeolian sediments (mainly sand and silt) with a minor amount of glaciofluvial material from unit C-3.

3.2.2.2 Cross–section E-E'

Cross–section E-E' extends from northeast of the Smoky River (93-SB-04), to the southeastern portions of the Puskwaskau main ridge (Figure 3.4 and 3.6), crossing the Smoky River three times. The underlying bedrock topography is poorly constrained. The oldest known Quaternary unit is unit B (laminated silts and clays), and is found at higher elevations in the Puskwaskau Hills. In the Hills, unit B infills shallow depressions and is known only through boreholes.

Unit C (C-1 and C-2 combined) generally overlies bedrock and varies in thickness from 3 m to more than 38 m. Unit D conformably overlies unit C and extends until just south of borehole 93-SB-07 (Figure 3.6) where it abuts against unit C-3 (broad meltwater channel). Just north of Smoky River, around boreholes 93-SB-10 and 93-SB-06, unit D contains subunit D-2 (waterlain diamict), which conformably overlies the tills of unit C.

Unit E contains alluvial deposits formed during incision of the Smoky River and some smaller streams (e.g. borehole 94-SB-10). This unit contains mainly fine sand and silt, with variable amounts of gravel and coarser sand from remnant floodplains and terraces (Figure 3.6).

3.2.2.3 Cross–section F-F'

Cross–section F-F' is the simplest, stratigraphically, of the cross–sections. It extends along the eastern side of the Winagami map area, which is topographically flatter, crossing over the Little Smoky River and ending just south of Valleyview (Figure 3.4 and 3.7). The underlying bedrock topography is poorly known in this region.

In general, the thickness of the Quaternary sediments has remained relatively consistent compared to the other cross–sections. Along the F-F' cross–section, the lowermost unit may be C (includes C-1, C-2 and C-3). Subunit C-3 is restricted to lenses and laminae interlaminated between C-2 and C-1. Unit C is relatively uniform throughout the cross–section and directly overlies the local bedrock. Thickness varies from 21 m to greater than 42 m; thinner segments overlie bedrock highs.

Unit D is found in localized regions, primarily around Reno (93-SB-03, Figure 3.4) and southeast of Valleyview (94-SB-06). In both regions, unit D is quite thin, generally less than 2 m. Near Valleyview, glaciolacustrine silts and clays (unit D) show distinct rhythmic lamination and infill part of the local meltwater channel. This channel is occupied by the Little Smoky River, which has deposited recent alluvium (unit E) over the glaciofluvial and glaciolacustrine sediments previously deposited in the channel (Figure 3.7). Unit E also occurs in the Little Smoky River as floodplain and terrace deposits of sands, silts and gravels. Thicker deposits of unit E (>2 m) are present on the southern flank of the Little Smoky River at borehole 94-SB-14 (Figure 3.7). Composed of sand and gravel, this part of unit E formed an old terrace or floodplain of the river during its initial incision.

4.0 QUATERNARY HISTORY

The Quaternary history of the region is complex and not easily related to the underlying bedrock. A lack of sediment control and dates between the end of the Cretaceous (65 Ma) and the latest datable material (ca. 50 ka) leaves a significant chronological gap. However, based on the information available, generalized summaries of the glacial history follow.

4.1 PEACE RIVER

It is difficult to imagine what the topography was before being glaciated. There probably was an older Peace River originating from the Rockies, along with other smaller rivers from the Clear and Whitemud Hills, converging and flowing northward similar to present day. However, there is clear evidence that they flowed along different paths in the past as evidenced by the many buried channels in the area. The Shaftesbury Channel (Tokarsky, 1967) flowed along the north side of the Peace River at the western edge of the map area, but beyond where it crosses the river just north of the Peace River townsite, its path is uncertain. The Manning Channel (Marciniuk and Kerr, 1971) has been identified from water well sites, but it too has not been well mapped. It would take an intensive study, utilizing drilling, and surface geophysics, to map the paleochannels of the area, a task beyond the scope of this project. The presence of deeply buried paleochannels and areas of drift extending below 40 m where the depth to bedrock is unknown, indicate that the paleotopography contained broader and deeper valleys than are present today. This is particularly evident in the area surrounding Manning and east to the Peace River, and from the town of Peace River south to the Nampa area.

Based on the relatively shallow stratigraphic data (maximum coring depth was only 42 m) that indicate only one till and subglacial dates from the Watino section, the region was glaciated by one major advance, presumably of Late Wisconsinan age, which completely covered the Peace River area. The east-west trending uplands comprising the Clear and Whitemud Hills and the upland where the Deadwood Forestry Tower is situated, were not a barrier to the advancing ice, but they most likely acted to slow its advance. Large flutes, including those near the Deadwood Forestry Tower, Leddy Lake and Whitemud Hills, and grooves in the Nampa area, indicate an erosive glacial advance which flowed generally from the north. The transverse ridges which are cored by thrusted bedrock (LL-Section 80), provide more evidence of active ice.

During the initial waning of Laurentide glaciation, ice in the uplands was probably separated or acted independently to some extent from the ice in the lowlands surrounding the town of Peace River. As a result, minor fluctuations were produced, this marking the beginning of Stage I of deglaciation. In the lowlands, flutes and grooves oriented to the southwest were formed in and around Grimshaw. In the uplands, arcuate–shaped moraine ridges and some meltwater channels were formed on the south slope of the Whitemud Hills. An arcuate moraine ridge west of Brownvale, is the only flow indicator to suggest minor ice movement from the northwest. Ice in the lowlands melted rapidly as the result of being separated from Laurentide Ice Sheet to the north. A glacial lake formed in the lowlands surrounding Peace River due to melting ice and meltwater from the west and upland ice to the north. The shoreline of this glacial lake reached a maximum elevation of approximately 610 m (2000 ft) and persisted long enough to deposit over 30 m of glaciolacustrine sediments in the St. Isidore area (LL-BH-06).

Deglaciation progressed to a stage where the glacial lake drained to the southeast (outside of the map area) through an outlet and then north along the Peace River into the Manning Lowland; thus, marking the beginning of Stage II. A new glacial lake in the Manning area lowland developed to an elevation of approximately 520 m (1700 ft). The thickest glaciolacustrine sediments, which are situated alongside the Peace River (LEL-BH-11), are only about 20 m thick. It is important to note that the thickness is both the function of the amount of sediment supplied to the lake and the duration of the lake. Therefore, if the sediment supply was about the same in both Stages I and II, the glacial lake in the Peace River area may have been longer lived. Thus indicating that deglaciation occurred in pulses, controlled to some extent by the capability of the lake to drain through an outlet.

Eventually ice withdrew far enough north to drain the glacial lake in the Manning area, thus ending deposition of glacial sediments. Since this time, the Peace River and other rivers and streams began to cut down. Slumping took place and terraces were built at times of stable river levels. The exposed glaciolacustrine sediments remained poorly drained and water saturated for some time, not allowing for any reworking by wind. Today, active slumping of glacial sediments and bedrock continues in most of the major rivers.

5.2 WINAGAMI

During the Tertiary or perhaps later, the original Peace, Smoky and other rivers and streams drained the Winagami region. Topography and relief before the onset of glaciation was similar to the present. Rivers and their tributaries cut deeply through the region, forming broad paleochannels. These rivers deposited sediments as channel fill, bars and floodplains (stratigraphic unit A). Infilling and incision of the valleys by non-glacial agents continued until ca. 23 ka; thus depositing the uppermost portion of unit A, during what is called the Watino Non-glacial Interval (Fenton, 1984). No evidence of prior glaciations has been documented in the exposed portions of the paleochannels.

Soon after the deposition of the Watino Non-glacial sediments, glacial sediments were deposited. The Laurentide Ice Sheet advanced from the north and northeast, including covering the entire region from the Peace River area to Grand Prairie and south of the Winagami area. Pre-advance glaciofluvial and "glacio"-lacustrine material (Unit B) were deposited in localized depressions and channels as the drainage of the area was obstructed by advancing ice. The initial advance of the Laurentide was extensive and thick, easily covering the highest elevations (e.g. 825 m at the crest of the Puskwaskau Hills). Topography in the region did not affect the massive Laurentide Ice Sheet. Drumlinoids, flutes and ridges produced beneath the actively flowing ice showed that there was a strong ice-flow direction towards the south and southwest. Highly compact basal, lodgement and deformational tills (stratigraphic unit C-1) were deposited on bedrock highs and in depressions.

Possibly in the middle or near the end the Late Wisconsinan, the Laurentide Ice Sheet thinned and weakened. The ice was influenced by the local topography. West of the Winagami Area, the Laurentide Ice Sheet was diverted by some larger obstacle, perhaps Cordilleran ice. Smaller lobes at the margin of the Laurentide, diverted towards the southeast, were active enough to allow ice-thrusting of bedrock. Ridges and flutes in the Winagami region provide evidence for this later southeasterly ice-flow movement.

Ablation and downwasting of the ice sheet and its marginal lobes allowed the deposition of most of the englacial and ablation till that covers the study region (stratigraphic unit C-2 and C-3). Deglaciation appears to have been rapid. Typical deglaciation features such as eskers, kames, and end moraines are scarce to non-existent considering to the size of the ice sheet that was formerly present in the region. Several large glacial lakes formed during the initial stages of deglaciation (e.g.

Lake Fahler and Lake Valleyview (Henderson, 1959)). Massive to rhythmically laminated silts and clays were deposited in these lakes. Debris flows and iceberg debris were laid down in regions proximal to the ice margin. As the Laurentide ice continued to melt back, old drainage routes reopened and the lakes drained rapidly via large, broad meltwater channels.

Continuing deglaciation allowed the stabilization of drainage patterns for the region. Rivers incised new channels into the underlying glacial sediments. Occasionally, these rivers followed pre-existing meltwater channels (eg. Little Smoky River near Valleyview), others cut new channels subparallel to the preglacial river valleys. Conditions were still arid enough during the latter stages of deglaciation to allow the formation of large-scale dune fields west of Watino. Aeolian processes, primarily deflation, reworked pre-existing material to form the dune fields and to modify the ice-contact stagnation deposits east of Watino. Glaciolacustrine deposits produced the major source of the fine sands and silts for dune formation. These dunes required extensive amounts of material and stronger winds from the southwest than are currently evident. Amplification of these winds was likely a result of the proximal position of the Laurentide Ice Sheet to the region.

The date of complete deglaciation in the Winagami area is uncertain. However, organic deposits near the study region, such as peat, yield basal dates of ca. 4 to 8 ka (Halsey, pers. comm. 1994). Organic, alluvial and aeolian deposition continue to the present. Colluvial deposits likely started with river incision. Slumping is still a major depositional process along present river valleys.

5.0 CONCLUSIONS

The currently available data allow several preliminary conclusions to be made about the Quaternary and surficial geology of the Peace River and Winagami study area.

5.1 PEACE RIVER

The surficial geology, consisting of both the glacial landforms, and primarily glaciolacustrine and morainal deposits, indicates that the Peace River area was affected by only one major glacial advance. Morainal deposits, flutes and moraine ridges, which are present in the uplands of the Clear and Whitemud Hills show an unobstructed southerly ice flow direction. Deglaciation is marked in the uplands by stagnant ice deposition and erosion by meltwater channels that generally flowed down slope, and in the lowlands by the formation of glacial lakes that formerly existed about the towns of Manning and Peace River.

The glacial stratigraphy also supports one major glacial advance. This glacial event, represented by one till (Unit C), is subdivided into subunits C-1, C-2 and C-3. Subunit

C-1, a dark grey massive silty clay till, was deposited at the base of the glacier by lodgement and basal melt out processes. This unit is enriched in local bedrock lithologies, with the greatest concentration present at and near the basal contact and decreasing upwards. Subunit C-2 is sediment deposited from an englacial to supraglacial position in the ice, which resulted in material the high variability in texture, structure and composition including mixed lithologies (ie. both local and far travelled). The thickness of Unit C is variable, depending on the topographic setting, with thicker deposits in the lowlands and infilling paleochannels.

The absence of any cross-cutting relationships and multiple tills are strong, but not conclusive, evidence for a single glaciation. The timing of the one documented event is assumed to have been in the Late Wisconsin based on the subglacial dates obtained at the Watino section.

The evidence from this study does not preclude multiple glaciations. This is because the study utilized only relatively shallow stratigraphic data (maximum coring depth was only 42 m): the drift in the deeper portion of the preglacial or possibly interglacial channels, was inaccessible. The glacial stratigraphy in the lowland area of Manning, for example, is incomplete since bedrock was not observed. This is an extensive area of thick drift (>30 m) where presumably the chances of preserving deposits from previous glaciation(s) are quite high. Consequently, until the stratigraphy down to bedrock is studied in this area, there still remains uncertainty as to the glacial history.

5.2 WINAGAMI

Overall, the surficial geology and Quaternary stratigraphy geology of the region is consistent with at least one glaciation. Two directions of glacial advance: (1) a strong, south to southwest movement, and (2) a weaker, topographically controlled southeasterly one, are indicated by belts of stagnation moraine, flute and drumlinoid orientation, and ice-thrusted bedrock. The lack of strong cross-cutting and overlapping stratigraphic relationships between the two ice-flow patterns and their deposits, indicates that both advances were from a single major Laurentide event. Ice flow to the southeast may be attributed to diversion of Laurentide Ice northwest of the study region.

Most of the surficial deposits in the Winagami area are associated with ice stagnation and deglaciation, or post-glacial processes. Widespread glaciolacustrine sediments cover the northern half, while ablation and englacial tills cover the southern regions. Glaciofluvial and reworked ice-contact material is restricted primarily to a region east of Watino's dune fields, and within broad, shallow meltwater channels. The widespread organic, aeolian and colluvial and alluvial sediments are primarily post-glacial in origin and are being deposited at present.

Stratigraphic correlation between drill cores and sections shows the variable thickness of glacial sediments and the irregularity of the underlying bedrock surface. In general, the Quaternary sediments are usually less than 75 m thick, except for the paleochannels. The lowermost till, accessible to this study, is englacial to basal in origin, dark grey, silty-clayey and extensive, covering virtually the entire study area. Diamicts overlying the grey till are not separate tills, but rather facies changes due to stratigraphic position in the ice during their formation, and to post-depositional changes.

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Appendix A1. Section Locations, Peace River Map Area (84C/W)

LL SECTIONS		NTS	LSD (W of 5th)	UTM ZONE 11V		ELEVATION	
#	NAME	SHEET	LSD-SEC-TP-R	NORTHING	EASTING	(m)	(ft)
1	Weberville Sand Pit	84 C/6	09-34-84-22	6242500	476800	648	2125
2	Chinook Valley Section	84 C/5	03-32-85-23	6251500	462900	655	2150
3	Grimshaw Gravel Pit 1	84 C/4	13-29-83-23	6231800	462600	650	2135
4	Mullen Gravel Pit	84 C/4	04-32-83-23	6232400	462500	650	2135
5	Smithmill Site 1	84 C/5	01-23-86-25	6225800	449500	663	2175
6	Smithmill Site 2	84 C/5	12-29-85-25	6250800	443100	720	2360
7	Smithmill Site 3	84 C/5	14-19-86-24	6259700	451800	653	2140
8	Chinook Valley Site 1	84 C/5	01-34-86-24	6261200	457700	634	2080
9	Chinook Valley Site 2	84 C/5	12-07-86-23	6255500	461300	634	2080
10	Chinook Valley Site 3	84 C/5	06-07-86-23	6255400	461400	634	2080
11	Chinook Valley Site 4	84 C/5	70-09-86-23	6255400	465100	625	2050
12	Warrensville Site 1	84 C/5	01-21-86-23	6248200	465700	632	2075
13	Warrensville Site 2	84 C/5	13-33-85-23	6252800	464300	646	2120
14	Warrensville Site 3	84 C/5	16-19-84-24	6240000	452500	663	2175
15	Whitemud Hills Section	84 C/5	13-01-85-25	6245000	449400	732	2400
16	Figure Eight Lake Section	84 C/5	13-08-84-25	6237000	443000	678	2225
17	Brownvale Site 1	84 C/4	13-02-83-25	6225900	447500	663	2175
18	Brownvale Gravel Pit	84 C/4	09-08-83-25	6226900	444100	664	2180
19	Weberville Site 1	84 C/6	13-30-86-20	6260600	490100	511	1675
20	Weberville Site 2	84 C/6	13-24-86-21	6259400	488900	509	1670
21	Leddy Lake Gravel Pit	84 C/6	02-29-85-22	6249800	473700	663	2175
22	Weberville Site 3	84 C/6	04-15-86-21	6256200	485200	518	1700
23	Weberville Site 4	84 C/6	16-20-85-21	6249700	483400	549	1800
24	Wesley Creek Site 1	84 C/6	16-15-84-20	6238200	496500	572	1875
25	Wesley Creek Site 2	84 C/6	04-17-84-20	6236800	491800	549	1800
26	Three Creeks Site 1	84 C/6	09-16-85-20	6247400	494800	524	1720
27	Three Creeks Site 2	84 C/6	15-05-85-20	6244800	492700	526	1725
28	Nampa Site 1	84 C/2	13-24-81-20	6210700	500100	587	1925
29	Nampa Site 2	84 C/3	09-21-81-20	6210000	496660	572	1875
30	Wesley Gravel Pit	84 C/6	08-28-84-21	6240600	485100	503	1650
31A	Whitelaw Gravel Pit A	84 D/1	16-36-81-1*	6214400	436800	640	2100
31B	Whitelaw Gravel Pit B	84 D/1	16-36-81-1*	6214350	437200	640	2100
32	Berwyn Site 1	84 C/4	14-32-81-24	6214200	455000	564	1850
33	Berwyn Site 2	84 C/4	08-05-82-24	6214700	456000	564	1850
34	Nampa Section	84 C/3	12-30-81-20	6211800	491900	564	1850
35	Peace River Gravel Pit	84 C/3	16-13-83-22	6228100	479800	373	1225
36	Brick's Hill Section	84 C/4	14-20-82-23	6220500	464700	533	1750
37	"Pulpmill" Section	84 C/6	04-09-85-21	6245000	483800	503	1650
38	Warrensville Gravel Pit	84 C/5	14-24-84-24	6239900	459500	648	2125
39	Grimshaw Gravel Pit 2	84C/4	02-33-83-23	6232180	464900	653	2140

40	Judah Hill Section	84 C/3	08-20-83-21	6222900	483500	533	1750
41	Smoky River Section	84 C/3	16-25-81-23	6212400	472100	533	1750
42	McAllister Creek Section	84 C/4	01-33-82-23	6220500	464800	518	1700
43	Dixonville Site 1	84 C/12	14-36-87-24	6272300	457775	686	2250
44	Dixonville Site 2	84 C/12	16-34-87-24	6272200	455600	663	2175
45	Dixonville Site 3	84 C/12	09-06-87-24	6263600	450600	632	2075
46	Clear Hills Site 1	84 C/12	05-18-87-25	6266800	439300	678	2225
47	Saskatoon Berry Section	84 C/4	06-34-82-23	6222900	468200	533	1750
48	Shaftesbury Ferry Section	84 C/4	15-10-82-23	6217230	468500	381	1250
49	Heart River Site 3	84 C/3	05-10-83-21	6225900	485400	533	1750
50	Notikewin River Site 1	84 C/13	11-28-91-23	6308680	461020	472	1550
51	North Star Gravel Pit 1	84 C/14	05-27-90-21	6298860	483550	305	1000
52	North Star Gravel Pit 2	84 C/14	01-20-90-21	6299620	481770	450	1475
53	Berwyn Site 3	84 C/4	08-13-82-25	6217800	452800	617	2025
54	Griffin Creek Section	84 C/4	01-26-81-26	6211200	441300	594	1950
55	Weberville Site 5	84 C/6	14-31-85-21	6252800	481050	625	2050
56A	Heart River Site 1	84 C/3	04-29-82-21	6220400	483800	427	1400
56B	Heart River Site 1	84 C/3	03-29-82-21	6220500	484300	533	1750
57	Heart River Site 2	84 C/3	08-30-82-21	6221120	483400	533	1750
58	Rousseau Creek Site 1	84 C/14	12-27-90-22	6299320	474200	457	1500
59	Rousseau Creek Site 2	84 C/14	09-34-90-22	6300700	475100	457	1500
60	Deadwood Site 1	84 C/14	05-17-90-21	6295600	480320	472	1550
61	Deadwood Site 2	84 C/14	14-17-90-21	6296200	480900	465	1525
62	Notikewin River Site 2	84 C/13	02-30-91-23	6308000	458400	503	1650
63	Notikewin River Site 3	84 C/13	01-34-91-23	6309500	463500	472	1550
64	Slump Creek Section	84 C/6	02-08-85-21	6245000	483050	518	1700
65	Jim Creek Section	84 C/13	04-03-91-24	6301600	452300	533	1750
66	Pulpmill Road Site 1	84 C/6	16-07-85-20	6246200	491600	503	1650
67	Pulpmill Road Site 2	84 C/6	15-07-85-20	6246240	491200	457	1500
68	Heart River Site 4	84 C/3	12-22-81-20	6210100	496700	570	1870
69	Peace River Site 1	84 C/14	07-09-91-21	6303750	481100	457	1500
70	Deadwood Tower Site 1	84 C/11	05-14-88-22	6276000	475300	587	1925
71	Notikewin River Site 4	84 C/13	09-27-91-23	6309000	463450	457	1500
72	Smoky River Site 2	84 C/3	03-20-82-22	6218950	474800	518	1700
73	Highway 686 Site 1	84 C/6	02-15-85-22	6246700	476400	663	2175
74	Highway 686 Gravel Pit 2	84 C/6	01-17-85-22	6246550	473500	625	2050
75	Peace River Site 2	84 C/14	08-02-92-21	6311550	484700	442	1450
76	Jnct Hwy 35 & 686 Section	84 C/5	16-11-85-24	6246420	459000	671	2200
77	Highway 686 Site 2	84 C/5	13-08-85-23	6246420	462500	649	2130
78	Buchanan Creek Site 1	84 C/14	01-24-91-22	6306375	476700	396	1300
79	Clear Hills Site 2	84 C/12	01-25-88-26	6279175	439200	831	2725
80	Highway 686 Site 3	84 C/5	14-10-85-23	6246420	466200	654	2145

81	Highway 686 Site 4	84 C/5	15-09-85-23	6246420	465300	652	2140
82	Highway 35 Site 1	84 C/5	05-24-85-24	6248730	459200	693	2275
83	Highway 35 Site 2	84 C/5	03-36-85-24	6251500	459720	709	2325
84	Deadwood Site 3	84 C/12	02-28-89-23	6288520	463150	561	1840
85	Deadwood Tower Site 2	84 C/11	05-23-88-22	6277800	475300	632	2075
86	Whitemud River Site 1	84 C/11	06-01-88-21	6272700	487300	457	1500
87	Buchanan Creek Site 2	84 C/14	09-15-91-21	6305700	483050	381	1250
88	Heart River Site 5	84 C/3	02-16-83-21	6227120	484400	503	1650
89	Highway 35 Site 3	84 C/12	07-31-88-23	6280850	460100	640	2100
90	Notikewin River Site 5	84 C/13	12-26-91-23	6309000	464000	472	1550

Appendix 2. Borehole Locations, Peace River Map Area (84C/W)

LEL BOREHOLES		NTS	LSD (W OF 5TH)	UTM ZONE 11V		ELEVATION		TOTAL DEPTH		BOTTOMED
#	NAME	SHEET	LSD-SEC-TP-R	NORTHING	EASTING	(ft)	(m)	(ft)	(m)	IN
BH-01	Weberville Site 1	84 C/6	04-18-86-20	6256140	490180	1660	506	104	31.70	grey till
BH-02	Weberville Site 2	84 C/6	13-01-86-22	6254420	478780	2100	640	27.5	8.38	siltstone
BH-03	Figure Eight Lake	84 C/5	12-21-84-25	6239320	444530	2250	686	52.5	16.00	shale
BH-04	Peace River	84 C/4	04-14-81-26	6207780	439800	1925	587	107	32.61	siltstone
BH-05	Brownvale	84 C/4	13-11-82-25	6217540	449450	2100	640	62.5	19.05	gravel
BH-06	Nampa Site 1	84 C/3	02-17-81-21	6207100	470600	1940	591	22.5	6.86	shale
BH-07	St Isidore	84 C/3	01-08-83-20	6225310	493200	1900	579	100	30.48	silty clay
BH-08	Nampa Site 2	84 C/3	12-22-81-20	6210050	496750	1875	572	133	40.54	grey till
BH-09	Notikewin	84 C/13	03-13-92-24	6314500	456220	1740	530	135	41.15	grey till
BH-10	Manning Airport	84 C/13	12-04-92-23	6312000	460500	1611	491	138	42.06	grey till
BH-11	Buchanan Creek	84 C/14	12-15-92-21	6315100	481850	1525	465	112	34.14	siltstone
BH-12	Manning Site 1	84 C/13	12-08-92-22	6313430	469000	1525	465	68	20.73	grey till
BH-13	Manning Site 2	84 C/14	13-35-91-22	6311100	473580	1525	465	138	42.06	grey till
BH-14	Deadwood	84 C/14	13-36-89-22	6291620	477100	1560	475	118	35.97	sand
BH-15	Smithmill	84 C/5	13-21-86-24	6259500	454400	2130	650	123	37.49	sand
BH-16	Three Creeks	84 C/6	16-16-85-20	6247800	494730	1725	525	76	23.17	gravel

Appendix A3. Section and Borehole Locations Winagami Map Area.										
Site #	NTS	Lsd	Sec	Tp	R	W of	Zone	UTM (n)	UTM (e)	Elev (m)
SECTIONS										
93-SB-01	83 N/11	16	34	77	23	5	U11	6175075	470675	556
93-SB-02	83 N/12	10	32	77	23	5	U11	6174475	466800	564
93-SB-03	83 N/11	8	7	78	22	5	U11	6177400	475550	564
93-SB-04	83 N/14	16	34	78	23	5	U11	6184850	470750	556
93-SB-05	83 N/14	8	26	79	23	5	U11	6192125	470450	549
93-SB-06	83 N/14	13	11	78	22	5	U11	6178325	480575	572
93-SB-07	83 N/11	15	9	77	21	5	U11	6168600	488025	579
93-SB-08	83 N/11	3	16	77	21	5	U11	6168675	487500	579
93-SB-09	83 N/11	16	31	76	21	5	U11	6165375	484950	587
93-SB-10	83 N/11	14	12	76	22	5	U11	6158825	482475	556
93-SB-11A	83 N/11	12	27	76	22	5	U11	6162975	478800	564
93-SB-11B	83 N/11	12	27	76	22	5	U11	6162970	478800	564
93-SB-11C	83 N/11	12	27	76	22	5	U11	6162960	478800	562
93-SB-11D	83 N/11	12	27	76	22	5	U11	6162950	478800	561
93-SB-12	83 N/13	15	32	78	26	5	U11	6185150	437800	549
93-SB-13	83 N/13	13	35	78	26	5	U11	6185100	441800	564
93-SB-14	83 N/13	8	20	78	26	5	U11	6180825	438250	567
93-SB-15	83 N/13	1	15	78	26	5	U11	6178725	441325	567
93-SB-16	83 N/12	1	14	77	26	5	U11	6169000	442950	579
93-SB-17	83 N/12	4	25	77	26	5	U11	6172225	443375	573
93-SB-18	83 N/12	4	29	77	25	5	U11	6172150	446400	572
93-SB-19	83 N/12	14	31	77	24	5	U11	6175225	455225	564
93-SB-20	83 N/12	4	2	78	25	5	U11	6175375	451275	572
93-SB-21	83 N/13	16	17	78	25	5	U11	6180000	447975	565
93-SB-22	83 N/13	2	30	78	24	5	U11	6181775	455625	564
93-SB-23	83 N/13	13	33	78	24	5	U11	6184575	457850	549
93-SB-24	83 N/13	1	1	79	25	5	U11	6185075	452175	564
93-SB-25	83 N/13	8	18	80	25	5	U11	6198625	444250	396
93-SB-26	83 N/13	1	18	80	25	5	U11	6198375	444375	445
93-SB-27	83 N/13	5	5	80	25	5	U11	6195425	444450	564
93-SB-28	83 N/13	2	29	79	25	5	U11	6191650	445400	564
93-SB-29	83 N/13	16	22	79	25	5	U11	6191525	448950	564
93-SB-30	83 N/13	15	12	80	25	5	U11	6197950	451925	564
93-SB-31	83 N/13	8	19	80	24	5	U11	6200225	454225	564
93-SB-32	83 N/13	1	28	80	24	5	U11	6201250	457425	578
93-SB-33	83 N/13	1	15	79	24	5	U11	6188325	458725	552
93-SB-34	83 N/13	9	1	79	24	5	U11	6185825	462225	556
93-SB-35	83 N/13	16	13	79	24	5	U11	6189525	462275	567
93-SB-36	83 N/13	15	20	80	23	5	U11	6201050	465200	572
93-SB-37	83 N/13	10	22	79	23	5	U11	6190800	468425	465
93-SB-38	83 N/13	2	28	79	23	5	U11	6191475	466625	549
93-SB-39	83 N/5	5	3	75	26	5	U11	6146800	439500	640
93-SB-40	83 N/5	15	8	75	26	5	U11	6149575	437300	622
93-SB-41	83 N/12	8	23	75	26	5	U11	6151600	442775	619
93-SB-42	83 N/5	4	18	75	25	5	U11	6149850	444475	632
93-SB-43	83 N/5	14	34	74	25	5	U11	6146175	451800	658
93-SB-44	83 N/5	15	35	74	25	5	U11	6146100	454025	655

93-SB-45	83 N/12	12	29	75	23	5	U11	6153400	465700	573
93-SB-46	83 N/11	9	16	77	20	5	U11	6169700	498300	614
93-SB-47	83 N/11	4	30	76	20	5	U11	6162150	493575	620
93-SB-48	83 N/11	8	1	76	21	5	U11	6156400	493375	597
93-SB-49	83 N/11	1	4	76	20	5	U11	6155675	498075	646
93-SB-50	83 N/11	1	29	75	20	5	U11	6152425	496375	608
93-SB-51	83 N/11	13	19	75	20	5	U11	6152300	493725	588
93-SB-52	83 N/11	12	27	75	21	5	U11	6153225	488550	565
93-SB-53	83 N/11	8	36	75	22	5	U11	6154550	483300	518
93-SB-54	83 N/11	2	5	77	22	5	U11	6165475	476525	558
93-SB-55	83 N/14	12	19	78	20	5	U11	6180700	493525	611
93-SB-56	83 N/14	3	4	80	20	5	U11	6194550	495650	620
93-SB-57	83 N/14	4	27	79	21	5	U11	6191400	486900	602
93-SB-58	83 N/14	1	2	79	21	5	U11	6184825	489675	602
93-SB-59	83 N/14	1	13	80	23	5	U11	6197875	471800	567
93-SB-60	83 N/11	16	15	75	23	5	U11	6150575	470500	575
93-SB-61	83 N/11	13	23	75	23	5	U11	6152350	470600	570
93-SB-62	83 N/11	14	23	75	22	5	U11	6152325	481100	549
93-SB-63	83 N/11	1	27	75	22	5	U11	6152475	480325	565
93-SB-64	83 N/11	13	27	75	22	5	U11	6153750	478725	564
93-SB-65A	83 N/11	2	1	76	23	5	U11	6155675	473150	564
93-SB-65B	83 N/11	2	1	76	23	5	U11	6155750	473150	556
93-SB-65C	83 N/11	3	1	76	23	5	U11	6155700	473025	541
93-SB-65D	83 N/11	14	36	75	23	5	U11	6155600	472975	526
93-SB-65E1	83 N/11	3	1	76	23	5	U11	6156000	472875	511
93-SB-65E2	83 N/11	3	1	76	23	5	U11	6156000	472875	503
93-SB-66	83 N/11	4	27	77	23	5	U11	6172300	469100	564
93-SB-67A	83 N/12	11	34	77	24	5	U11	6174500	460075	411
93-SB-67B	83 N/12	11	34	77	24	5	U11	6174500	460075	389
93-SB-67C	83 N/12	11	34	77	24	5	U11	6174450	459950	419
93-SB-67D	83 N/12	11	34	77	24	5	U11	6174450	459975	419
93-SB-67E	83 N/12	6	34	77	24	5	U11	6174225	459850	381
93-SB-67F	83 N/12	5	34	77	24	5	U11	6174375	459750	396
93-SB-67G	83 N/12	5	34	77	24	5	U11	6174375	459775	396
93-SB-67H	83 N/12	5	34	77	24	5	U11	6174380	459775	407
93-SB-68	83 N/12	10	34	77	24	5	U11	6174800	460325	434
93-SB-69A	83 N/12	6	21	77	24	5	U11	6170900	458275	427
93-SB-69B	83 N/12	7	21	77	24	5	U11	6171050	458575	419
93-SB-70	83 N/12	16	34	77	24	5	U11	6175125	460650	396
93-SB-71	83 N/11	13	20	76	22	5	U11	6161775	475600	427
93-SB-72	83 N/11	16	19	76	22	5	U11	6161975	475475	419
94-SB-01	83 N/6	10	33	74	21	5	U11	6145300	489475	533
94-SB-02	83 N/4	11	3	71	24	5	U11	6108225	461475	683
94-SB-03	83 N/4	16	10	71	24	5	U11	6110475	462050	715
94-SB-04	83 N/4	7	6	71	24	5	U11	6108050	456925	719
94-SB-05	83 N/4	13	20	70	24	5	U11	6104050	459500	715
94-SB-06	83 N/6	5	33	72	22	5	U11	6125650	478875	707
94-SB-07	83 N/6	2	6	73	22	5	U11	6126675	476500	735
94-SB-08	83 N/3	12	16	72	22	5	U11	6121150	478875	727
94-SB-09	83 N/3	5	29	71	22	5	U11	6114150	477175	735
94-SB-10	83 N/3	14	20	71	21	5	U11	6113550	487650	671
94-SB-11	83 N/12	7	21	77	24	5	U11	6171050	458575	419
94-SB-12	83 N/12	11	34	77	24	5	U11	6174450	459975	393
94-SB-13	83 N/3	1	18	70	21	5	U11	6100825	488350	632
94-SB-14	83 N/3	4	18	70	21	5	U11	6100725	487375	643
94-SB-15	83 N/3	4	16	70	22	5	U11	6100875	480575	693

94-SB-16	83 N/3	12	4	70	22	5	U11	6098575	480600	735
94-SB-17	83 K/14	1	26	69	22	5	U11	6094225	485050	632
94-SB-18	83 N/3	8	34	69	22	5	U11	6096475	483700	677
94-SB-19	83 N/3	9	13	70	23	5	U11	6101750	477225	707
94-SB-20	83 N/4	13	33	71	26	5	U11	6116825	439875	648
94-SB-21	83 N/4	4	28	71	26	5	U11	6114300	439625	649
94-SB-22	83 N/4	1	21	71	26	5	U11	6112425	440800	643
94-SB-23	83 N/5	9	29	72	26	5	U11	6124525	439675	686
94-SB-24	83 N/5	9	25	72	1	6	U11	6124700	436500	664
94-SB-25	83 N/4	3	1	72	26	5	U11	6117250	444900	686
94-SB-26	83 N/4	1	22	71	26	5	U11	6112500	442800	648
94-SB-27	83 N/4	4	2	71	26	5	U11	6107550	443050	640
94-SB-28	83 N/4	1	10	70	26	5	U11	6099750	444700	674
94-SB-29	83 N/4	1	33	70	26	5	U11	6106275	442925	625
94-SB-30	83 N/4	16	4	70	26	5	U11	6099250	443975	678
94-SB-31	83 N/4	9	27	69	26	5	U11	6095650	444650	683
94-SB-32	83 N/4	9	13	70	26	5	U11	6102100	448000	686
94-SB-33	83 N/4	1	26	71	26	5	U11	6114100	444400	664
94-SB-34	83 N/4	16	7	71	25	5	U11	6110700	447325	674
94-SB-35	83 N/4	4	32	70	25	5	U11	6105875	449875	707
94-SB-36	83 N/4	4	27	70	25	5	U11	6104550	452975	733
94-SB-37	83 N/4	14	34	70	25	5	U11	6107350	453600	735
94-SB-38	83 N/4	13	36	69	25	5	U11	6097450	456150	732
94-SB-39	83 N/3	4	30	70	22	5	U11	6104275	477325	677
94-SB-40	83 N/3	8	7	71	22	5	U11	6109575	477025	680
94-SB-41	83 N/3	1	13	71	23	5	U11	6110500	475050	693
94-SB-42	83 N/3	15	24	71	22	5	U11	6113550	484550	677
94-SB-43	83 N/3	4	14	70	22	5	U11	6100725	483825	732
94-SB-44	83 N/3	8	22	70	22	5	U11	6102975	483725	719
94-SB-45	83 N/3	13	32	70	21	5	U11	6106825	488700	680
94-SB-46	83 N/3	4	27	70	21	5	U11	6103925	491925	640
94-SB-47	83 N/3	5	31	70	20	5	U11	6106250	496875	668
94-SB-48	83 N/3	12	8	71	20	5	U11	6109700	496800	675
94-SB-49	83 N/3	12	22	71	20	5	U11	6112850	500000	703
94-SB-50	83 N/6	10	21	72	20	5	U11	6122600	499575	614
94-SB-51	83 N/3	16	35	71	21	5	U11	6116450	493450	645
94-SB-52	83 N/3	9	15	72	21	5	U11	6121200	491800	655
94-SB-53	83 N/3	14	8	72	20	5	U11	6120000	497450	610
94-SB-54	83 N/6	8	36	72	21	5	U11	6125525	494750	642
94-SB-55	83 N/6	14	21	73	21	5	U11	6133025	489200	652
94-SB-56	83 N/6	12	25	72	22	5	U11	6124325	483750	652
94-SB-57	83 N/6	12	2	73	22	5	U11	6127650	482400	649
94-SB-58	83 N/6	2	17	73	22	5	U11	6129875	478100	701
94-SB-59	83 N/6	1	16	73	22	5	U11	6130225	480450	652
94-SB-60	83 N/6	3	27	73	23	5	U11	6133125	471350	710
94-SB-61	83 N/6	1	30	73	22	5	U11	6133100	477100	658
94-SB-62	83 N/3	1	2	72	22	5	U11	6116850	483450	681
94-SB-63	83 N/3	2	15	72	22	5	U11	6120125	481350	698
94-SB-64	83 N/6	2	25	73	22	5	U11	6133075	484650	643
94-SB-65	83 N/7	4	15	73	20	5	U11	6129850	500200	613
94-SB-66	83 N/6	13	32	73	20	5	U11	6136225	497100	610
94-SB-67	83 N/6	3	29	73	20	5	U11	6133075	497225	631
94-SB-68	83 N/6	9	8	74	20	5	U11	6138850	498350	591
94-SB-69	83 N/6	12	20	74	20	5	U11	6142175	496800	579
94-SB-70	83 N/6	4	25	74	21	5	U11	6142875	493750	564
94-SB-71	83 N/6	13	19	74	20	5	U11	6142450	495200	579

94-SB-72	83 N/6	8	15	74	21	5	U11	6140125	491850	599
94-SB-73	83 N/6	7	33	74	21	5	U11	6144850	489550	518
94-SB-74	83 N/6	16	24	74	22	5	U11	6142675	485025	590
94-SB-75	83 N/6	4	13	74	22	5	U11	6139700	484050	594
94-SB-76	83 N/6	8	19	74	22	5	U11	6141875	477100	579
94-SB-77	83 N/3	2	1	70	23	5	U11	6097500	476625	739
94-SB-78	83 N/3	13	34	69	23	5	U11	6097450	472600	719
94-SB-79	83 N/5	4	9	73	26	5	U11	6128675	439800	792
94-SB-80	83 N/5	12	17	74	26	5	U11	6140825	438300	648
94-SB-81	83 N/12	1	35	77	24	5	U11	6174000	462525	465
94-SB-82	83 N/6	12	4	75	21	5	U11	6146975	487225	480
94-SB-83	83 M/9	5	36	75	2	6	U11	6155200	425900	587
94-SB-84	83 M/9	2	2	76	2	6	U11	6156450	424850	434
94-SB-85	83 M/8	7	26	74	1	6	U11	6143825	434550	579
94-SB-86	83 M/1	12	9	72	2	6	U11	6120100	420125	533
94-SB-87	83 M/1	2	18	72	2	6	U11	6121225	417700	610
94-SB-88	83 M/8	8	20	72	2	6	U11	6123150	420025	465
94-SB-89	83 N/12	1	2	78	24	5	U11	6175475	462525	450
94-SB-90	83 N/13	13	26	80	26	5	U11	6202650	439800	564
94-SB-91	83 N/4	8	6	72	23	5	U11	6117650	467225	811
DRILL HOLES										
93-SAB-03	83N/14	3	28	80	20	5	U11	6201050	495550	602
93-SAB-04	83N/14	16	35	80	23	5	U11	6204200	470600	565
93-SAB-06	83N/11	12	27	76	22	5	U11	6163025	478775	564
93-SAB-07	83N/11	15	36	75	23	5	U11	6155700	473275	564
93-SAB-10	83N/11	13	12	77	23	5	U11	6168600	472350	556
93-SAB-13	83N/13	4	5	80	25	5	U11	6295025	444475	562
93-SAB-14	83N/13	13	21	79	23	5	U11	6191400	465650	565
94-SAB-02	83N/5	2	3	73	26	5	U11	6127225	442375	847
94-SAB-04	83N/4	1	22	70	26	5	U11	6102650	444700	652
94-SAB-06	83N/3	16	24	70	22	5	U11	6103800	487025	701
94-SAB-08	83N/3	12	5	72	22	5	U11	6117700	477150	780
94-SAB-09	83N/3	13	2	72	21	5	U11	6118250	492150	648
94-SAB-10	83N/6	13	36	73	23	5	U11	6136250	474150	657
94-SAB-11	83N/12	14	19	75	25	5	U11	6152700	444900	620
94-SAB-12	83N/14	13	23	78	21	5	U11	6181375	490225	594
94-SAB-14	83N/6	9	28	74	21	5	U11	6143725	489900	581
94-SAB-15	83N/4	1	16	71	24	5	U11	6110575	460725	716

Appendix A4. Section Descriptions And Samples (# & Type), Peace River Map Area (84CW)

#	SECTION NAME	NTS	DESCRIPTION	LL SAMPLES
1	Weberville Sand Pit	84 C/6	5m; roadside site	93-01(till); 93-02(sand)
2	Chinook Valley Section	84 C/5	80cm; roadside site	93-03(sand)
3	Grimshaw Gravel Pit 1	84 C/4	15m; excavation	93-04(U till); 93-05(M till); 93-06(L till); 93-07(U gravel); 93-08(L gravel); 94-06A(M till); 94-06B(U till); 94-06C(L till); 94-07(L gravel)
4	Mullen Gravel Pit	84 C/4	8m; excavation	93-50(cl-gravel); 93-51(U gravel)
5	Smithmill Site 1	84 C/5	1m; roadside site	93-09(till)
6	Smithmill Site 2	84 C/5	1m; roadside site	no sample
7	Smithmill Site 3	84 C/5	1m; roadside site	93-10(till)
8	Chinook Valley Site 1	84 C/5	1.6m; roadside site	93-11(U till); 93-12(M till); 93-13(L till)
9	Chinook Valley Site 2	84 C/5	2m; roadside site	93-14(till)
10	Chinook Valley Site 3	84 C/5	1m; roadside site	93-15(till)
11	Chinook Valley Site 4	84 C/5	2.3m; creek cutbank	93-16(L till); 93-17(U oxidized gravel); 93-18(U till)
12	Warrensville Site 1	84 C/5	1.3m; roadside site	93-19(U till); 93-20(L till)
13	Warrensville Site 2	84 C/5	5.0m; excavation	93-21(till)
14	Warrensville Site 3	84 C/5	1.3m; roadside site	93-22(till); 93-23(large pebble clast)
15	Whitemud Hills Section	84 C/5	1.4m; roadside site	93-24(till)
16	Figure Eight Lake Section	84 C/5	1.2m; roadside site	93-25(till)
17	Brownvale Site 1	84 C/4	1.2m; roadside site	no sample
18	Brownvale Gravel Pit	84 C/4	12m; excavation	93-26(till); 93-27(<pebble gravel); 93-28(>pebble gravel)
19	Weberville Site 1	84 C/6	1m; roadside site	no sample
20	Weberville Site 2	84 C/6	2m; roadside site	no sample
21	Leddy Lake Gravel Pit	84 C/6	2m; excavation	93-29(M till); 93-30(L till); 93-31(gravel)
22	Weberville Site 3	84 C/6	1.4m; roadside site	no sample
23	Weberville Site 4	84 C/6	1.5m; roadside site	no sample
24	Wesley Creek Site 1	84 C/6	2m; roadside site	no sample
25	Wesley Creek Site 2	84 C/6	5m; roadside excavation	no sample
26	Three Creeks Site 1	84 C/6	2m; roadside site	no sample
27	Three Creeks Site 2	84 C/6	1m; roadside site	no sample
28	Nampa Site 1	84 C/2	80cm; drainage gully	no sample
29	Nampa Site 2	84 C/3	4.6m; roadside site	93-34(clay with dropstones); 93-35(U till); 93-36(L till)

30	Wesley Gravel Pit	84 C/6	3m; roadside excavation	93-32(gravel); 93-33(large pebble clast)
31A	Whitelaw Gravel Pit A	84 D/1	5m; excavation	93-37(brown till); 93-38(grey till); 93-39(gravel); 94-16(gravel)
31B	Whitelaw Gravel Pit B	84 D/1	15m; excavation	93-40(M till)
32	Berwyn Site 1	84 C/4	1m; roadside site	no sample
33	Berwyn Site 2	84 C/4	2m; roadside site	no sample
34	Nampa Section	84 C/3	6m; river cutbank	93-41(U brown till); 93-42(L grey till); 93-43(U gravel); 93-44(gravel with shells); 93-45(dropstone clast)
35	Peace River Gravel Pit	84 C/3	11m; excavation	93-46(gravel)
36	Brick's Hill Section	84 C/4	12m; creek slump face	93-47(till)
37	"Pulpmill" Section	84 C/6	4m; slump face	no sample
38	Warrensville Gravel Pit	84 C/5	1.5m; excavation	93-48(gravel); 93-49(till)
39	Grimshaw Gravel Pit 2	84 C/4	15m; excavation	no sample
40	Judah Hill Section	84 C/3	4m; slump face	no sample
41	Smoky River Section	84 C/3	150m; river failure face	93-52(till); 93-53(U till); 93-54(L till); 94-50 (base of till)
42	McAllister Creek Section	84 C/4	3 consecutive slump exposures along the creek 8m, 18m, & 20m	93-55(U till); 93-56(M till); 93-57(L till); 93-58(till lens in underlying sand & gravel); 93-59(charcoal); 94-12(sand); 94-13(L till);94-14(L till)
43	Dixonville Site 1	84 C/12	70cm; roadside site	no sample
44	Dixonville Site 2	84 C/12	2m; roadside site	94-19(till); 94-20(boulder)
45	Dixonville Site 3	84 C/12	1m; roadside site	no sample
46	Clear Hills Site 1	84 C/12	1m; roadside site	94-21(till)
47	Saskatoon Berry Section	84 C/4	54m; slump face	94-22(gravel); 94-23(till); 94-24(till); 94-25(till)
48	Shaftesbury Ferry Section	84 C/4	25m; roadside site	94-17(gravel); 94-18(charcoal); 94-64(shale)
49	Heart River Site 3	84 C/3	40m; river slump face	94-25A(till); 94-25B(till-pebble)
50	Notikewin River Site 1	84 C/13	40m; river cutbank	94-01A(U till); 94-01B(U till-pebble); 94-01C(fossil wood); 94-02A(M till); 94-02B(M till-pebble); 94-41A(L till); 94-41B(L till-pebble); 94-77 to 94-96 (till geochem)
51	North Star Gravel Pit 1	84 C/14	5m; excavation	94-03A(U gravel); 94-03B(rock);94-04(L gravel)
52	North Star Gravel Pit 2	84 C/14	7m; excavation	94-04(gravel)
53	Berwyn Site 3	84 C/4	1.3m; roadside site	94-08(till)
54	Griffin Creek Section	84 C/4	8m; creek cutbank	94-09A(till); 94-09B(till-pebble); 94-35(heavies pail sample)
55	Weberville Site 5	84 C/6	3m; excavation	94-10(till); 94-11A(sm gravel); 94-11B (lg gravel); 94-34(heavies pail sample)
56A	Heart River Site 1	84 C/3	12m; river cutbank	no sample
56B	Heart River Site 1	84 C/3	13m; river cutbank	no sample
57	Heart River Site 2	84 C/3	10m; river slump face	94-15A(till); 94-15B(till)

58	Rousseau Creek Site 1	84 C/14	10m; creek cutbank	no sample
59	Rousseau Creek Site 2	84 C/14	26m; creek cutbank	94-26A(gravel); 94-26B(gravel); 94-27 (heavies pail sample)
60	Deadwood Site 1	84 C/14	1m; roadside site	94-28(sand)
61	Deadwood Site 2	84 C/14	1.5m; roadside site	no sample
62	Notikewin River Site 2	84 C/13	16m; river cutbank	94-29A(till); 94-29B(till-pebble)
63	Notikewin River Site 3	84 C/13	20m; river cutbank	94-30(gravel); 94-31(till); 94-32(till)
64	Slump Creek Section	84 C/6	18m; gully slump face	94-33(till)
65	Jim Creek Section	84 C/13	5m; creek cutbank	94-36A(till); 94-36B(till-pebble)
66	Pulpmill Road Site 1	84 C/6	7m; gully slump face	94-37(gravel); 94-38A(till); 94-38B(till-pebble)
67	Pulpmill Road Site 2	84 C/6	15m; creek slump face	94-39(till)
68	Heart River Site 4	84 C/3	9m; river slump face	94-40A(heavies pail sample); 94-40B(till-pebble)
69	Peace River Site 1	84 C/14	140m; river cutbank	no sample
70	Deadwood Tower Site 1	84 C/11	5m; roadside site	94-42(heavies pail sample); 94-46A(till); 94-46B(till-pebble)
71	Notikewin River Site 4	84 C/13	13m; river cutbank	94-43A(U till); 94-43B(U till-pebble); 94-44A(L till); 94-44B(L till-pebble)
72	Smoky River Site 2	84 C/3	28m; river slump face	94-47(siltstone); 94-48(till& sand); 94-49(till)
73	Highway 686 Site 1	84 C/6	10m; roadside site	94-51(till)
74	Highway 686 Gravel Pit 2	84 C/6	4m; excavation	94-52A(gravel); 94-52B(rock)
75	Peace River Site 2	84 C/14	7m; gully slump face	94-53A(till); 94-53B(till); 94-54(cl-silt)
76	Jnct Hwy 35 & 686 Section	84 C/5	2m; dugout excavation	94-55(till)
77	Highway 686 Site 2	84 C/5	4m; roadside site	94-56A(till); 94-56B(till-pebble)
78	Buchanan Creek Site 1	84 C/14	35m; creek cutbank	94-57(L till); 94-58(gravel); 94-59(M till); 94-60(U till)
79	Clear Hills Site 2	84 C/12	4m; roadside site	94-61A(till); 94-61B(till-pebble)
80	Highway 686 Site 3	84 C/5	3.5m; roadside site	94-65(till); 94-66(gravel)
81	Highway 686 Site 4	84 C/5	2m; roadside site	94-67(till)
82	Highway 35 Site 1	84 C/5	5m; roadside site	94-68(sand); 94-69(till)
83	Highway 35 Site 2	84 C/5	4m; roadside site	94-70(shale)
84	Deadwood Site 3	84 C/12	6m; roadside site	94-72A(till); 94-72B(till-pebble)
85	Deadwood Tower Site 2	84 C/11	12m; roadside site	94-73(shale)
86	Whitemud River Site 1	84 C/11	12m; roadside site	94-74(shale)
87	Buchanan Creek Site 2	84 C/14	10m; creek slump face	94-75(gravel); 94-76(shale)
88	Heart River Site 5	84 C/3	3m; slump face	94-98(till); 94-99(sand)
89	Highway 35 Site 3	84 C/12	5m; roadside site	94-71(till)
90	Notikewin River Site 5	84 C/13	14m; river cutbank	no sample

(Note: Abbreviations are 'U' is upper, 'M' is middle, and 'L' is lower positions within the unit; 'till-pebble' is a sample of clasts >2cm within the till unit; and 'heavies' is a sample designated for heavy mineral separation)

Appendix A5. Borehole Sub-Sample Descriptions, Peace River Map Area (84C/W)

LEL#	NAME	NTS	LL SUB-SAMPLES
BH-01	Weberville	84 C/6	1993 sample numbers: 120(15.25m);121(16.2m);122(17.7m);123(18.7m); 124(19.7m); 125(21m);126(22.4m);127(22.9m); 128(24.3m); 129(25.6m); 130(27.4m);131(28.6m); 132(30.5m); 133(bedrock;31.7m) Heavy mineral sample 93-PR-003 (16.1-31.7m)
BH-02	Weberville	84 C/6	no sub-samples
BH-03	Figure 8 Lake	84 C/5	1993 sample numbers: 140(1.5m);141(2.1m);142(3.1m);143(4.1m);144(5.15m); 145(6.1m);146(7.1m);147(8.1m);148(9.15m);149(10.1m); 150(11.6m);151(bedrock;13.6m)
BH-04	Peace River	84 C/4	1993 sample numbers: 100(siltyclay;3.65m);101(4.29m);102(4.91m);103(6.2m); 104(7.46m);105(8.5m);106(11.5m);107(17.6m); 108(18.7m);109(19.9m);110(21.5m);111(28.2m); 112(30.1m);113(bedrock;31.5m) Heavy mineral sample 93-PR-010 (5.3-19.1m)
BH-05	Brownvale	84 C/4	no sub-samples
BH-06	Nampa Site 1	84 C/3	no sub-samples
BH-07	St Isidore	84 C/3	no sub-samples
BH-08	Nampa Site 2	84 C/3	1994 sample numbers: 250(6.0m);251(9.0m);252(10.1m);253(14.8m); 254(18.5m);255(24.3m);256(27.8m);257(31.0m); 258(40.3m)
BH-09	Notikewin	84 C/13	no sub-samples
BH-10	Manning Airport	84 C/13	1994 sample numbers: 215(3.6m);216(siltyclay;4.4m);217(5.4m);218(6.9m); 219(8.3m);220(9.5m);221(11.3m);222(14.0);223(15.4m); 224(15.7m);225(17.4m);226(19.5m);227(21.0m); 228(22.5m);229(24.0m);230(26.0m);231(29.5m); 232(36.0m);233(39.4m);234(41.8m)
BH-11	Buchanan Creek	84 C/14	1994 sample numbers: 245(siltyclay;16.8m);246(21.8m);247(27.2m); 248(33.0m); 249(bedrock34.0m)
BH-12	Manning Site 1	84 C/13	no sub-samples
BH-13	Manning Site 2	84 C/14	no sub-samples
BH-14	Deadwood	84 C/14	1994 sample numbers: 235(11.8m);236(17.8m);237(24.8m);238(31.8m)
BH-15	Smithmill	84 C/5	1994 sample numbers: 200(2.0m);201(5.0m);202(6.4m);203(8.0m);204(10.9m); 205(silty clay;14.0m);206(siltyclay;18.0m); 207(silty clay;21.0m);208(siltyclay;24.0m); 209(silty clay;28.4m);210(silty clay;31.9m); 211(32.9m);212(siltyclay;35.3m);213(siltyclay;37.4m)
BH-16	Three Creeks	84 C/6	1994 sample numbers: 240(10.6m);241(14.0m);242(16.6m);243(20.0m); 244(22.7m)

(Note: depth of sample is given in brackets; and type of sample is till except where indicated otherwise)

Appendix A6 Sample Descriptions, Winagami Map Area.

SAMPLE #	DEPTH (m)	SAMPLE DESCRIPTION
Section		
93-SB-05a	0.80	Mottled, silty-clay till, fractured
93-SB-05b	1.75	Mottled, silty-clay till, fractured
93-SB-05c	2.60	Mottled, silty-clay till, fractured
93-SB-06a	0.50	Clay till with silt stringers
93-SB-06b	0.88	Clay diamict, some silt stringers
93-SB-06c	0.50	Gravel lag interbedded with clay diamict
93-SB-07a	0.85	Massive clay
93-SB-07b	1.55	Massive clay diamict
93-SB-08a	0.80	Massive, clay till
93-SB-08b	1.90	Massive, clay till
93-SB-09a	1.80	Sand and gravel, oxidized
93-SB-09b	2.25	Clayey till, massive
93-SB-10a	1.35	Mottled, silty-clay till, fractured
93-SB-10b	2.60	Mottled, silty-clay till, fine sand lenses
93-SB-11b	4.70	Laminated, clay diamict, white specks
93-SB-11c	6.10	Laminated, clay diamict, white specks
93-SB-11d	6.90	Mottled, clayey-silt till
93-SB-11e	8.00	Mottled, clayey-silt till
93-SB-11f	7.50	Fine sandy-silt rip-up lens
93-SB-26a	1.25	Mottled, silty-clay till, white veining
93-SB-26b	2.20	Sandy, silty till, some stratification
93-SB-26c	1.80	Stratified silty-clay diamict, flow nose
93-SB-32	0.79	Mottled, clay-silty till, massive
93-SB-38a	1.35	Laminated, clayey-silt till
93-SB-38b	1.95	Laminated, clayey-silt till
93-SB-38c	3.00	Massive, sandy-silt till, very compact
93-SB-39a	0.60	Laminated, silty-clay diamict
93-SB-39b	1.35	Laminated, clayey-silt till, gypsum lenses
93-SB-39c	2.00	Mottled, clayey-silt till, fine sand lenses
93-SB-39d	3.10	Mottled, clayey-silt till, fine sand lenses
93-SB-40a	1.15	Laminated silt, clay, and clayey-silt till
93-SB-40b	1.30	Mottled, clayey-silt till, white veining
93-SB-40c	2.20	Stratified, clayey-silt till and fine sand
93-SB-40o	2.50	Coal fragments
93-SB-41a	0.45	Massive, silty-clay till
93-SB-41b	1.15	Mottled, silty-clay till, medium sand laminae
93-SB-42a	0.48	Massive, silty-clay till, fine sand lens
93-SB-42b	1.00	Mottled, clayey-silt till, gypsum pockets
93-SB-43a	1.50	Silty-clay diamict, highly weathered
93-SB-43b	2.35	Mottled, clayey-silt till, silty-fine sand laminae
93-SB-44a	1.00	Clayey-silt till, highly convoluted
93-SB-44b	1.30	Silty-clay till, highly convoluted, rip-up lenses
93-SB-44g	0.70	Poorly sorted, oxidized gravel
93-SB-44o	2.50	Organic lens
93-SB-46	1.10	Massive, silty-clay diamict
93-SB-47a	0.40	Mottled, silty-clay till, compact
93-SB-47b	1.30	Mottled, clayey-silt till, fine sand pockets
93-SB-48	1.00	Mottled, clayey-silt till

93-SB-50a	0.80	Massive, silty-clay till, gypsum veining
93-SB-50b	1.40	Massive, clayey-silt till, gypsum veining, fine sand
93-SB-51	1.70	Massive, silty-clay till, gypsum veining
93-SB-52a	1.15	Mottled, silty-clay till, gypsum veining
93-SB-52b	2.50	Massive, clay till, fractured
93-SB-52c	3.50	Massive, clay till, fractured
93-SB-53a	1.10	Laminated, silty-clay till and silty-clay
93-SB-53b	2.05	Mottled, silty-clay till, white specks
93-SB-53c	3.25	Massive, clayey-silt till, white veining
93-SB-55a	0.73	Slightly mottled, silty-clay till, compact
93-SB-55b	0.95	Slightly mottled, silty-clay till, white lenses
93-SB-56	1.00	Massive, silty-clay till, very compact
93-SB-62	1.65	Massive, silty-clay diamict
93-SB-65a	1.35	Mottled, silty-clay till, fine sand lenses
93-SB-65b	0.90	Mottled, silty-clay till, very compact
93-SB-65c	2.85	Mottled, silty-clay till, very compact
93-SB-67a	14+	Cross-stratified gravel and coarse sand
93-SB-67b	10+	Cross-stratified gravel and coarse sand
93-SB-67c	6+	Wood fragment
93-SB-67d	6.5+	Organics, coal and fine sand
93-SB-67e	7.00	Oxidized gravel and coarse to medium sand
93-SB-68a	7.00	Coal
93-SB-68b	7.25	Cross-stratified gravel and fine-coarse sand
93-SB-72a	4.00	Mottled, silty till, oxidized, some sand
93-SB-72b	8.50	Massive, clay-silty till, very compact
94-SB-01a	1.12	Clay-silt till, fine-medium sand stringers
94-SB-01b	2.12	Clay-silt till, fine-medium sand stringers
94-SB-01c	1.40	Clay-silt till, fine-medium sand stringers
94-SB-01d	1.75	Laminated, fine-medium sand
94-SB-01e	2.20	Stratified siltstone and sandstone
94-SB-01f	2.10	Gravel
94-SB-02	1.20	Clay till, irregular lenses and laminae of silt
94-SB-03a	0.68	Massive, silty-clay till, coal fragments
94-SB-03b	1.35	Massive, clay-silt till
94-SB-04a	0.50	Massive brown-grey clay
94-SB-04b	0.70	Mottled, silty-clay till
94-SB-04c	1.40	Mottled, silty-clay till, calcareous
94-SB-05	1.25	Mottled, silty-clay till
94-SB-06a	1.20	Fine-medium sand, well-sorted
94-SB-06b	1.50	Stratified fine sand and clay, some granules
94-SB-06c	1.80	Fine-medium sand, well-sorted
94-SB-07	0.80	Clayey-silt till
94-SB-08	2.30	Fine sand, well-sorted, massive
94-SB-09	1.15	Silty-clay till, mottled
94-SB-10	1.20	Mottles, silty-clay till, calcareous
94-SB-11a	3.20	Fine-medium sand, laminated
94-SB-11b	0.90	Weathered silty-clay till, fine sand laminae
94-SB-12a	6.00	Medium sand, well-sorted, shells
94-SB-12b	5.00	Massive to laminated silty clay, convoluted
94-SB-13a	0.75	Stratified silty-clay
94-SB-13b	1.04	Very fine sand and silt, laminated
94-SB-14a	0.45	Massive clay, minor silt
94-SB-14b	0.75	Clay, rhythmic lamination
94-SB-14c	1.15	Laminated, silty-clay till and clay, coal and wood
94-SB-14d	1.70	Massive, fine sandy-clay till, coal and petrified wood
94-SB-14e	2.60	Massive, fine sandy-clay till, coal and petrified wood
94-SB-14f	0.20	Mottled, silty-clay till
94-SB-15	1.00	Silty-clay till

94-SB-16a	0.40	Silt, colour lamination
94-SB-16b	0.70	Mottled. silt-clay till
94-SB-16c	1.20	Fine-medium sand, clay blebs
94-SB-16d	1.10	Fine-medium sand, clay blebs, red-brown staining
94-SB-16e	1.50	Medium sand, well-sorted
94-SB-17a	1.05	Rhythmically laminated silt and clayey-silt
94-SB-17b	2.90	Laminated clay and very fine sand
94-SB-18	0.75	Massive, clay till
94-SB-19a	1.00	Massive, clay till, calcareous
94-SB-19b	1.25	Massive, silty-clay till, calcareous
94-SB-20	0.80	Mottled, silty-clay till
94-SB-21a	0.45	Loam
94-SB-21b	0.60	Silty-clay loam
94-SB-21c	1.35	Massive, very fine sand and silt
94-SB-21d	1.70	Laminated, fine and coarse sand
94-SB-21e	1.85	Laminated, fine sand and organics
94-SB-21f	2.00	Massive, silty-clay till, minor sand
94-SB-22a	0.90	Massiv,e fine sand and clay
94-SB-22b	1.30	Clay till, marl laminae and pockets
94-SB-23	1.00	Massive, silty-clay till
94-SB-24a	0.55	Massive, clay till, minor silt
94-SB-24b	0.95	Massive, clay till, calcareous
94-SB-25a	0.80	Massive, clayey-silt till, minor sand
94-SB-25b	1.20	Massive, clayey-silt till, minor sand
94-SB-26aa	0.65	Mottled, very fine sand and silt
94-SB-26ab	1.15	Massive, silty-clay till
94-SB-26ac	1.50	Massive, silty-clay till, calcareous
94-SB-26b	3.05	Massive, silty-clay till, calcareous
94-SB-27	1.10	Gravel, some sand, poorly sorted
94-SB-28	1.15	Mottled, silty-clay till
94-SB-29a	0.95	White shelly lenses
94-SB-29b	1.00	Fine sandy-silt quasi till
94-SB-29c	1.30	Fine sandy-silt quasi till
94-SB-29d	1.60	Silty fine sand
94-SB-29e	2.00	Clayey-silt diamict
94-SB-29f	2.25	Laminated silty fine sand
94-SB-29g	2.70	Massive, medium sand, well-sorted
94-SB-29h	0.80	Blocky, clayey-silt till
94-SB-29i	1.60	Silt and clay
94-SB-30a	0.70	Massive, silty-clay till, calcareous
94-SB-30b	1.30	Massive, silty-clay till, calcareous
94-SB-31a	0.95	Massive silty clay, calcareous
94-SB-31b	1.15	Massive clayey silt, calcareous
94-SB-32	1.05	Mottled, silty-clay quasi till
94-SB-33a	0.65	Clayey silt
94-SB-33b	1.15	Clayey silt, calcareous
94-SB-33c	1.35	Medium sand, moderately sorted
94-SB-34	0.95	Massive silty clay
94-SB-35a	0.65	Massive, silty-clay till, calcareous
94-SB-35b	1.05	Massive, silty-clay till, minor sand, calcareous
94-SB-35c	2.30	Massive, silty-clay till, minor sand, calcareous
94-SB-36	0.75	Massive, clayey-silt quasi till, some sand
94-SB-37	0.90	Massive, silty-clay till
94-SB-38	1.03	Medium sand, organic and marl lenses
94-SB-39	1.15	Laminated, silty-clay till, calcareous
94-SB-40	1.15	Massive, silty-clay till
94-SB-41	1.40	Silty-clay till, laminae of marl, calcareous
94-SB-42a	0.80	Massive, silty-clay till

94-SB-42b	1.80	Massive, silty-clay till, calcareous
94-SB-43	1.00	Massive, silty till
94-SB-44	1.20	Colour laminated silty clay
94-SB-45a	0.60	Laminated silt and fine sand
94-SB-45b	1.30	Massive ,silty-clay diamict
94-SB-46a	0.80	Massive, clayey-silt diamict
94-SB-46b	1.25	Massive, silty-sand diamict
94-SB-47	1.00	Silty-clay till, subtle lamination, calcareous
94-SB-48	1.00	Massive, clay till, calcareous
94-SB-49	1.05	Massive, silty-clay diamict, calcareous
94-SB-50a	0.48	Laminated silty clay, calcareous
94-SB-50b	0.85	Mottled, silty-clay till, calcareous
94-SB-50c	1.30	Massive, clay till, calcareous
94-SB-51a	0.65	Massive, clay till, calcareous, marl pockets
94-SB-51b	1.55	Massive, silty-clay till, calcareous, marl and gypsum
94-SB-52a	0.75	Massive, silty-clay till, calcareous
94-SB-52b	1.40	Massive, clayey-silt till, calcareous
94-SB-53	0.50	Laminated fine sand and silt
94-SB-54a	0.15	Massive, silty-clay diamict?
94-SB-54b	0.35	Massive, silty-clay till
94-SB-54c	1.05	Laminated clayey silt
94-SB-54d	0.65	Fine-medium sand, minor gravel
94-SB-55a	0.70	Massive, silty-clay diamict, some sand
94-SB-55b	1.00	Massive, silty-clay till, some sand
94-SB-56a	0.45	Mottled, clayey-silt quasi-till
94-SB-56b	1.30	Laminated, silty-fine sand and silty clay, organics
94-SB-57	1.35	Mottled, clayey-fine sand and silt
94-SB-58	1.40	Mottled, silty-fine sand till
94-SB-59a	0.80	Massive, clayey-silt, marl laminae
94-SB-59b	1.30	Fine-coarse sand with silt and clay, some gravel
94-SB-59c	2.00	Cross-laminated coarse sand and gravel
94-SB-60	1.30	Mottled, clayey-silt till
94-SB-61a	0.55	Massive medium-fine sand, mod-well sorted
94-SB-61b	1.30	Massive, clayey-silt till
94-SB-62	1.10	Mottled, silty-clay till, calcareous
94-SB-63a	0.55	Massive fine sand, stringers of diamict
94-SB-63b	0.65	Lens of silty-clay diamict
94-SB-64a	0.65	Mottled, silty-clay till, calcareous
94-SB-64b	1.65	Mottled, silty-clay till, calcareous
94-SB-65	0.95	Medium-coarse sand and gravel
94-SB-66a	0.30	Massive, silty-clay quasi-till
94-SB-66b	0.80	Laminated, silty-clay till
94-SB-66c	1.60	Massive, silty-clay till
94-SB-67	1.80	Compact, silty-clay sandstone
94-SB-68	1.15	Massive, silty-clay till, calcareous
94-SB-69a	1.00	Laminated silty caly
94-SB-69b	4.10	Mottled silty clay
94-SB-69c	5.00	Massive, silty-clay till
94-SB-69d	10.00	Massive, silty-clay till
94-SB-70a	11.00	Laminated fine sand
94-SB-70b	12.50	Banded sandstone, iron staining
94-SB-71	1.10	Massive, silty-clay till, calcareous
94-SB-72	1.20	Massive, clayey-silt till
94-SB-73a	3.48	Crushed wood and organics
94-SB-73b	5.70	Massive, clayey-silt till
94-SB-73c	2.50	Rhythmites of clay and diamict
94-SB-74a	0.80	Massive silty clay, calcareous
94-SB-74b	1.10	Massive, clayey-silt till, calcareous

94-SB-74c	1.80	Mottled, clayey-silt till, calcareous
94-SB-74d	3.50	Mottled, clayey-silt till, calcareous
94-SB-75a	2.00	Massive, silty-clay till, silt stringers
94-SB-75b	4.50	Massive, silty-clay till, silt stringers
94-SB-75c	7.50	Massive, silty-clay till, silt stringers
94-SB-76c	2.20	Massive, silty-clay till, calcareous
94-SB-76d	5.20	Massive, silty-clay till, calcareous
94-SB-76e	8.50	Massive, silty-clay till, calcareous
94-SB-77	0.75	Clayey-silt till, fine sand stringers, calcareous
94-SB-78	1.05	Massive, clayey-silt till, calcareous
94-SB-79	1.00	Massive, clayey-silt quasi till, calcareous
94-SB-80	1.05	Massive, clayey-silt till
94-SB-81	1.50	Massive, silty-fine sand till
94-SB-82a	8.00	Silty-fine sand diamict with shale
94-SB-82b	10.00	Grey shale, fossiliferous
94-SB-83	1.80	Stratified sand and gravel
94-SB-89	5.00	Micaeous silty-fine sandstone, stratified
94-SB-91a	4.10	Massive, fine sandy-silt till, calcareous
94-SB-91b	7.40	Massive, clayey-silt till
Drill Core		
93-SAB-06	2.13	Laminated silt and clay
	3.35	Finely laminated silty-clay, calcareous laminae
	4.11	Thinly laminated silty-clay diamict
	5.79	Thinly laminated, clayey-silt diamict
	7.16	Laminated, clayey-silt diamict
	8.53	Laminated clayey-silt till, fractured
	9.91	Massive, silty-clay till, fractured
	11.28	Massive, silty-clay till
	12.65	Massive, silty-clay till
	14.02	Massive, silty-clay till
	15.39	Massive, silty-clay till
	16.76	Massive, silty-clay till
	19.05	Massive, silty-clay till
	20.42	Massive, silty-clay till
	21.79	Massive, silty-clay till
	23.16	Massive, silty-clay till
	24.54	Massive, silty-clay till
	25.91	Massive, silty-clay till
	27.28	Massive, silty-clay till
	28.65	Massive, silty-clay till
	30.02	Massive, silty-clay till
	31.39	Massive, silty-clay till
	32.77	Massive, silty-clay till
	37.64	Massive, silty-clay till
	39.01	Massive, silty-clay till
	40.39	Massive, silty-clay till
	41.76	Massive, silty-clay till
	43.13	Massive, silty-clay till
	44.50	Massive, silty-clay till
93-SAB-13	1.52	Stratified silt and sandy-silt, calcareous
	2.44	Laminated sandy-silt, and clay, calcareous
	3.66	Finely stratified silt and fine sand, calcareous
	5.03	Thinly laminated silt and clay, convoluted
	5.33	Massive silty clay, fine sand lenses
	6.86	Laminated fine sandy-silt and silt/clay, calcareous

	8.38	Massive silty clay, fine sand lenses
	9.91	Contorted laminae of silt and clay, calcareous
	10.52	Massive silty clay, fine sand lenses
93-SAB-13	12.65	Contorted laminae of silt and clay, calcareous
	13.72	Massive silty clay, fine sand lenses
	14.94	Massive clayey-silt diamict
	16.00	Massive silty clay, fine sand lenses
	17.53	Silt, some silty-clay laminae, calcareous
	19.05	Massive silty clay, fine sand lenses
	20.57	Laminated silt and silty-clay, convoluted
	21.34	Stratified silty-clay till, calcareous silt lenses
	22.10	Massive, silty-clay till
	23.32	Stratified silty-clay till, calcareous silt lenses
	24.38	Massive, silty-clay till
	25.76	Massive, silty-clay till
	27.13	Massive, silty-clay till
	28.50	Massive, silty-clay till
	29.87	Massive, silty-clay till
	31.24	Massive, silty-clay till
	32.61	Massive, silty-clay till
	34.00	Massive, silty-clay till
	35.36	Massive, silty-clay till
	36.73	Massive, silty-clay till
	38.10	Massive, silty-clay till
	39.47	Massive, silty-clay till
	40.84	Massive, silty-clay till
94-SAB-02	1.21	Mottled silty till, clay patches
	3.35	Massive coarse sandy till, contains bedrock
	3.81	Grey silty sandstone
94-SAB-08	0.76	Massive, clayey-silt till, minor sand, calcareous
	2.13	Massive, clayey-silt till, minor sand, calcareous
	2.44	Laminated silty-clay and clayey-silt, calcareous
	5.33	Laminated fine-medium sandstone, grey
94-SAB-09	1.22	Massive, silty-clay till
	3.51	Massive, silty-clay till, some mottling
	9.60	Massive, silty-clay till
	15.70	Massive, silty-clay till, silt lenses
	21.79	Massive, silty-clay till
	27.89	Massive, silty-clay till
	35.81	Massive, silty-clay till
	40.08	Massive, silty-clay till
94-SAB-10	1.52	Mottled silty-clay till, minor sand
	4.72	Mottled silty-clay till, minor sand
	5.33	Laminated fine sand and silty-clay sand
	6.86	Massive, silty-clay till
	10.52	Massive, silty-clay till
	12.04	Brown siltstone
94-SAB-11	1.52	Mottled clayey-silt till, minor sand, calcareous
	4.11	Mottled clayey-silt till, minor sand, calcareous
	8.38	Massive silty-clay till
	8.84	Massive, fine sand, well-sorted, blue-grey
	10.97	Laminated silty-clay till
	13.72	Massive, silty-clay till

	18.44	Laminated silty-clay till and silt
	18.90	Grey siltstone
94-SAB-15	2.74	Mottled silty-clay till, calcareous
	5.18	Laminated silty-clay till, calcareous
	10.67	Massive, silty-clay till
	16.76	Massive to laminated silty-clay till
	18.75	Massive clayey-silt till, minor sand
	19.20	Monolithic clayey-silt diamict with shale granules