Report 73-2
SAND AND GRAVEL RESOURCES OF THE EDMONTON AREA, ALBERTA

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CONTENTS

ILLUSTRATIONS

SAND AND GRAVEL RESOURCES OF THE EDMONTON AREA, ALBERTA

Abstract

Sand and gravel deposits of the Edmonton area can be grouped into preglacial, glacial, and Recent alluvial deposits, distinguishable on the basis of time and mode of deposition. Preglacial deposits are extensively distributed along the floors and terraces of buried channels west and northeast of Edmonton, providing most of the good quality concrete aggregate used in this area. Glacial (Pleistocene) deposits are more limited in extent and generally are suitable only for road-base and fill aggregate. Large quantities of Recent alluvial gravels are found in terraces along the North Saskatchewan River valley; these are suitable for asphalt, road-base, and fill gravel.

INTRODUCTION

This report contains some preliminary results excerpted from a comprehensive urban geological study designed to help formulate guidelines for future development of the greater Edmonton area. The study is based on data obtained from mapping and auger drilling of surficial and shallow subsurface deposits within an area of 36 townships surrounding and including the City of Edmonton. This information is supplemented by testhole data from municipal agencies and consulting engineering firms, and by the results of laboratory investigations designed to differentiate various geological units or materials on the basis of composition and physical properties. The data presently are being processed and synthesized to produce a series of maps in which the greater Edmonton area is being graded for specific land uses pertaining to mineral resource development, agriculture, waste disposal, construction purposes, recreation, and environmental control.

The report describes the general distribution and types of potentially economic sand and gravel deposits in the Edmonton area. It has been prepared with two objectives in mind:

(1) to provide a geological framework for those involved in exploring for sand and gravel;

(2) to aid planners in avoiding possible land use conflicts.

It should be stressed that detailed investigations of specific deposits have not been conducted; rather, emphasis has been placed on delineating those areas - especially in the subsurface - with some potential for containing aggregate deposits. Thus, companies and individuals involved in locating supplies of sand and gravel should be able to use this report as a guide in their exploration programs. Similarly, planners concerned with the orderly development and zoning of the greater Edmonton area will be able to evaluate the relative merits of mineral resource (aggregate) exploitation versus those of alternative land uses for the regions surrounding the city, as well as the possible effects of resource development to the environment.

PREVIOUS WORK

Considerable information has been published on the surficial geology of the Edmonton area. Bayrock and Hughes (1962) prepared a report and a series of maps (scale 1:50,000) on the surficial geology of the Edmonton district between longitudes 113°00' and 114°00' W, and latitudes 53°15' and 53°45' N (an area of 1390 square miles). All near-surface deposits of sand and gravel within this area were delineated and briefly described.

Carlson (1967) outlined the thalwegs of buried valleys in the Edmonton area where extensive sand and gravel deposits are buried in the subsurface.

More recently, a surficial geology map covering National Topographic Series Sheet 83H (Edmonton area) has been published on a scale of 1:250,000

(Bayrock, 1973). A copy of this map, which shows the locations of all surficial sand and gravel deposits in the area between longitudes 112° and 114° W and latitudes 53° and 54° N, accompanies the report (in pocket).

All of these reports can be utilized to locate aggregate deposits in the Edmonton area.

CLASSIFICATION OF SAND AND GRAVEL DEPOSITS

Commercial deposits of sand and gravel in the area can be classified into three major groups, distinguished on the basis of time and mode of deposition. The stratigraphic relationships of these deposits are shown schematically in figure 1, as they might be ideally observed in a cross section of the North Saskatchewan River valley.

Preglacial deposits, called Saskatchewan Sands and Gravels, are found in the bottoms and along the sides of bedrock valleys buried by glacial (Pleistocene) and postglacial (Recent) deposits. Glacial deposits of sand and gravel are present throughout the area; some are buried within the drift, but many are exposed at the present land surface. Recent alluvial deposits occur in the form of bars and terraces along existing streams; those of economic significance are confined to the valley of the present-day North Saskatchewan River.

Preglacial Sands and Gravels

Virtually all of the concrete aggregate used in the Edmonton area is manufactured from preglacial (Saskatchewan) deposits. Most of this material is now supplied by gravel-processing operations near Villeneuve, northwest of St. Albert, and near Heatherdown, just west of the map area shown in figure 2. In addition, these deposits are utilized for the manufacture of asphalt gravel and for road base aggregate.

Saskatchewan Sands and Gravels are found along the courses of buried preglacial valleys delineated by Carlson (1967) or as gravel cappings on the high-

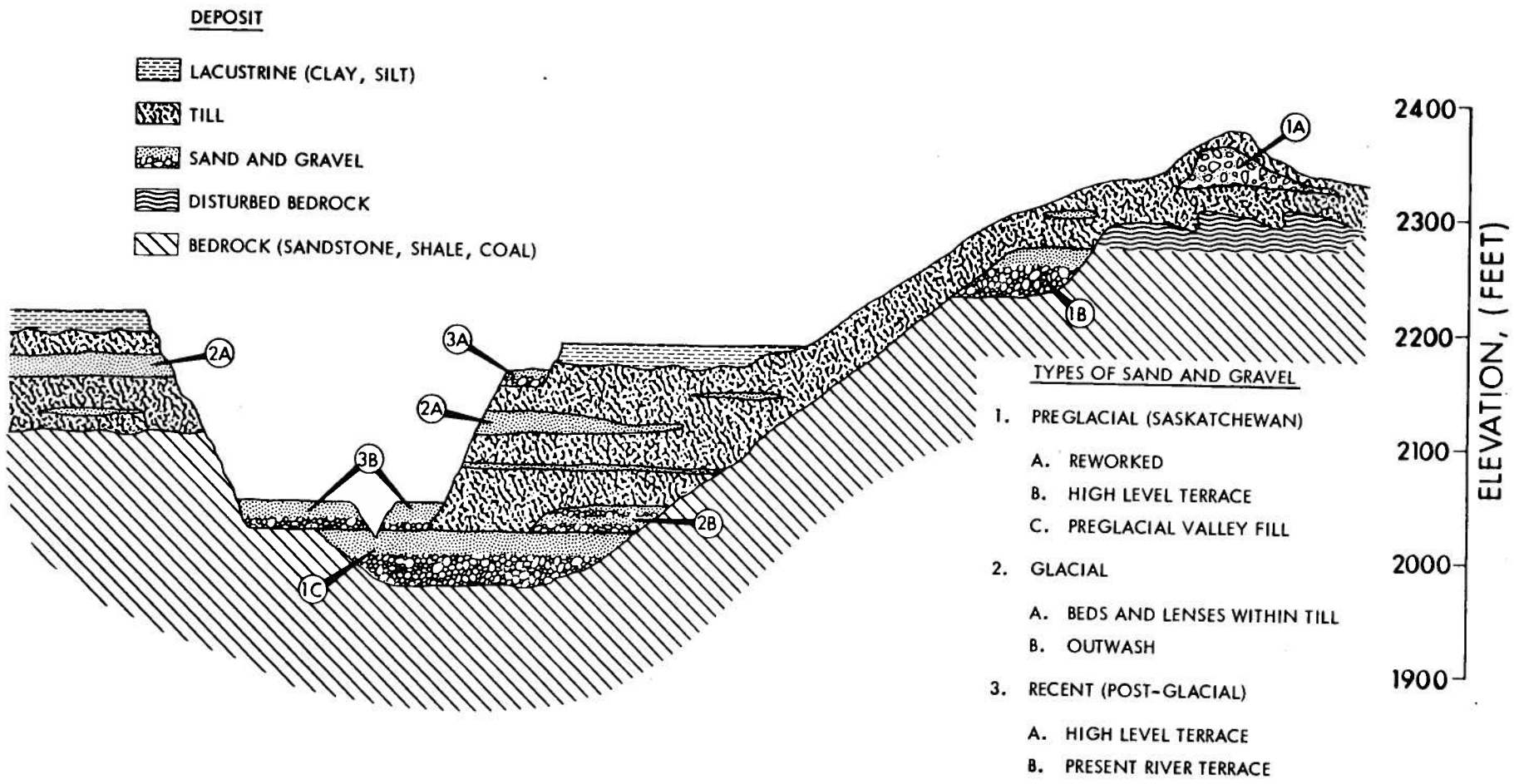

FIGURE 1. Schematic cross section showing stratigraphic relationships of sand and gravel deposits, Edmonton area.

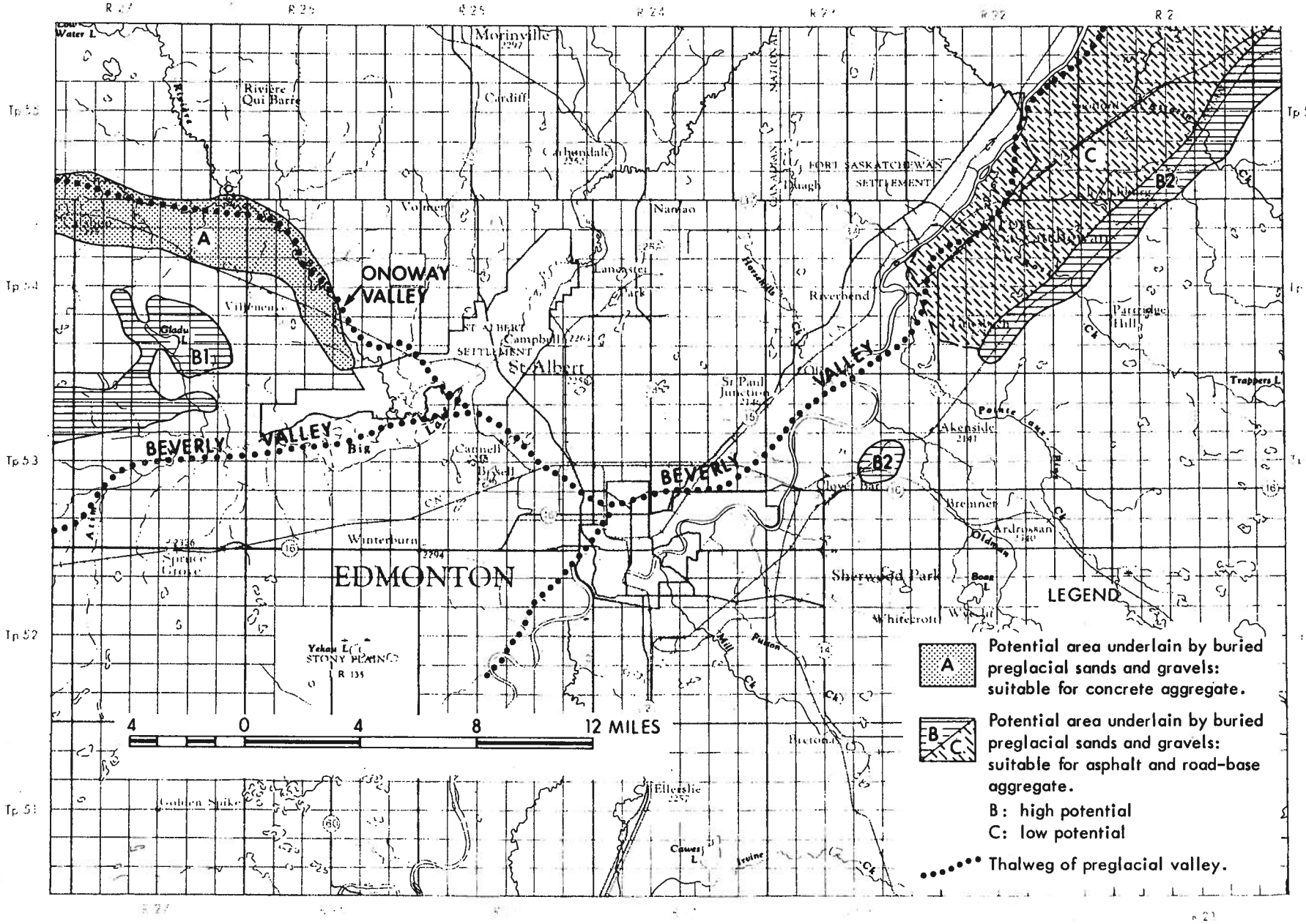

FIGURE 2. Distribution of potential preglacial sand and gravel deposits, Edmonton area.

lands north of Spruce Grove (Fig. 2). Only two of these channels appear to contain commercial gravel deposits in terms of quantity, quality, depth of overburden, and distance from markets. These are the Onoway Channel northwest of Edmonton and the Beverly Channel, which trends approximately east-west in the western portion of the map area and parallels the North Saskatchewan River valley, northeast of Edmonton.

Onoway Channel

The thalweg[1] of the buried Onoway Channel trends east from Calahoo on the western margin of the map area, along the course of the Sturgeon River valley, and then turns southward towards the Beverly Valley, which it joins west of the town of St. Albert (Fig. 2). The valley is generally broad with a gently sloping southwest side and steeper northeast bank.

Data from auger drilling, rotary drilling, and seismic shot holes[2] show that a broad belt of buried sands and gravels extends along the south bank of the Onoway Channel. It is expected that the deposit will not be continuous over the entire length of the valley but will be concentrated in certain localities within area "A" outlined on figure 2. Extensive test drilling will be required to delineate the best aggregate deposits in this area.

The sands and gravels, which directly overlie Cretaceous bedrock, are overlain in turn by lacustrine clay and glacial till. Thickness of overburden may vary considerably over short distances but is expected to be generally 20 to 50 feet. Similarly, the sands and gravels are expected to range from 0 to 50 feet or more in thickness. In many areas, fine-grained sand overlies or is interbedded with the gravel.

Lithologically, the gravels are composed of quartzite and chert, but a small percentage of sandstone and local bedrock material is present. The deposits

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[1] A thalweg is a line marking the deepest portion of a buried valley.

[2] Drill hole data has been published (McPherson and Kathol, 1972) or is on open file at the Research Council of Alberta.

contain only minor amounts of deleterious materials, e.g. coal, clay lumps, ironstone, and iron-stained sandstone.

It is anticipated that most of the deposits will be saturated above bedrock, for the base of the Onoway Channel is at a lower elevation than the present Sturgeon River.

Currently, Consolidated Concrete Ltd. and Alberta Concrete Products Ltd. are utilizing sand and gravel from the Onoway Channel in the vicinity of Villeneuve[1] for the manufacture of concrete aggregate used in the Edmonton area. The deposits within this channel are the only gravels in the map area that have the necessary physical properties and are sufficiently low in deleterious materials to be suitable for this purpose.

Other large deposits, similar to those described above, likely are present along the Onoway Channel within the area delineated.

Beverly Channel

The thalweg of the Beverly Channel enters the map area in township 53, range 28, and trends east beneath the City of Edmonton, then turns north and parallels the course of the North Saskatchewan River, northeast from Edmonton (Fig. 2). The valley is several miles wide with gently sloping sides, particularly along the south bank.

Within the map area preglacial sands and gravels are present along the entire length of the channel, either as valley fill in the bottom of the channel or as terraces on the sides of the valley. However, only in certain areas is gravel present in sufficient quantities and the overburden thin enough for the deposits to be of commercial significance.

West of Edmonton sand and gravel is found around the hilly terrain north of Spruce Grove with the area "B1" shown on figure 2. On the south side of the

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[1] a) Consolidated Concrete's operation is located in NW1/4, Sec. 20, Tp. 54, R. 26 W.4th Mer.
b) Alberta Concrete Product's operation is located in NW1/4, Sec. 16, Tp. 54, R. 26 W.4th Mer.

hills, the gravels are interpreted as a high level terrace deposit developed on the north side of the Beverly Channel. In the vicinity of Gladu Lake, the deposits are highly contorted and may have been shoved by glacial ice from the floor of the Onoway Channel or eroded and slumped off the gravel-capped bedrock plateau to the west. As observed in quarries, the gravels as well as the overburden - which consists of glacial lake clay and/or till - vary considerably in thickness.

Lithologically, the gravels are composed of quartzite and chert with minor amounts of sandstone and bedrock fragments. Deleterious materials, such as clay lumps, coal, ironstone, and iron-stained sandstone, are present in sufficient quantities to prevent the sands and gravels from being utilized for the manufacture of concrete aggregate; however, the gravels are suitable for asphalt or road-base aggregate. Several pits have been opened in this area, but it is expected that additional deposits can be located by test drilling within the boundaries indicated in figure 2.

East of Edmonton the thalweg of the Beverly Channel trends northeast, parallel to the North Saskatchewan River. Borehole data have confirmed the geological interpretation that a high level terrace extends along the southeast bank of the channel, approximately parallel to the Canadian Pacific rail line (area "B2", Fig. 2). As is the case with the Onoway Channel, it is expected that economic deposits are not continuous over the entire valley side but are concentrated only in certain areas. Thickness of overburden, which consists of lacustrine clay and till, is estimated to be in the order of 20 to 70 feet or more, whereas sand and gravel thickness may vary between 0 and 50 feet.

The gravels are similar in lithology to those found in the Beverly Channel west of Edmonton. The presence of deleterious materials prevents them from being used for concrete aggregate; however, they may be suitable for the manufacture of asphalt and road-base aggregate. There are no pits developed in these terrace deposits with the exception of those at Clover Bar near the eastern boundary of Edmonton, and the writers feel there is considerable potential for developing

commercial gravel deposits within the boundaries outlined in figure 2.

There is also potential for asphalt or road-base aggregate deposits along the floor of the Beverly Valley between the terrace deposits described above and the present valley of the North Saskatchewan River (area "C", Fig. 2). Borehole data have confirmed the presence of sand and gravel overlying bedrock and overlain by lacustrine clay and till in this area. However, the deposits are generally thin and the overburden relatively thick. Detailed drilling within this area may reveal commercial aggregate deposits, but the potential for development is certainly not as high as the potential along the high level terrace (area "B2", Fig. 2).

Glacial Deposits

Glacial sands and gravels are those materials deposited during the retreat of the last (Pleistocene) ice sheet; they occur as outwash plains, outwash deltas, meltwater channel sediments, kames, and crevasse fillings. These deposits occur within or below other glacial sediments (till, lacustrine deposits) to some extent, but are present at or just below the surface in many areas. The larger deposits have been classified and mapped by Bayrock (1973) on a scale of 1:250,000 (1 inch to 4 miles) for the entire Edmonton sheet (N.T.S. Sheet 83H). A copy of Bayrock's map is included with this report (in pocket).

In addition to "surficial" glacial sand and gravel deposits, irregularly distributed beds and lenses of similar deposits are found in places at the base of the till (overlying bedrock or Saskatchewan Sands and Gravels), or more commonly interstratified with till (Fig. 1). The locations and extent of these buried deposits are difficult to predict, but some data on their distribution in the greater Edmonton area is contained in a report by McPherson and Kathol (1972).

All glacial deposits, whether at the surface or buried, are of limited extent and are characterized by large percentages of rock fragments derived from the Canadian Shield as well as variable amounts of coal, shale, clay lumps, and petrified wood. The sands and gravels vary greatly in grain size over short distances,

and many contain a high clay content. These characteristics prevent them from being utilized for either concrete or asphalt gravel, but they are suitable for local supplies of road-base and fill aggregate. Many of the deposits have been and are presently being used as aggregate sources, but some potentially economic deposits remain undeveloped or undiscovered.

Recent Alluvial Deposits

Recent alluvial deposits of economic importance are confined to the valley of the present North Saskatchewan River, which has been incised since the retreat of the last glacier. They are found in the form of terraces or bars, but new legislation has prohibited exploitation of river bars as aggregate sources. Thus, the ensuing discussion is directed towards terrace deposits.

At least four terrace levels have been delineated along the North Saskatchewan River valley within the map area, but only the lowermost terrace (generally referred to as the "30-foot terrace") is sufficiently extensive to be utilized as a sand and gravel source. These deposits have been mapped by Bayrock and Hughes (1962) and Bayrock (1973).

The sands and gravels range from 0 to 30 feet thick and are overlain by 10 to 30 feet of alluvial silt and clay. They usually overlie bedrock but in isolated instances have been deposited on Saskatchewan Sands and Gravels in the Beverly Channel.

Lithologically, the gravels are heterogeneous, containing rock fragments from the Canadian Shield as well as from erosion of preglacial sediments. Deleterious materials such as coal, local bedrock fragments, ironstone, petrified wood, and bone fragments also are common. These characteristics make terrace sands and gravels unsuitable for concrete aggregate, but they have proven suitable for asphalt, road-base, and fill aggregate.

Terrace deposits have been used extensively as sand and gravel sources in the area because of their proximity to Edmonton as well as the relatively thin overburden cover. Large reserves, both developed and undeveloped, are present within the areas outlined by Bayrock and Hughes (1962), and it is anticipated they will continue to serve as aggregate sources for many years.

REFERENCES CITED

Bayrock, L.A. and G.M. Hughes (1962): Surficial geology of the Edmonton district, Alberta; Res. Coun. Alberta Prelim. Rept. 62-6, 40 pages.

Bayrock, L.A. (1973): Surficial geology, Edmonton; Res. Coun. Alberta map with marginal notes, scale 1:250,000.

Carlson, V.A. (1966): Bedrock topography and surficial aquifers of the Edmonton district, Alberta; Res. Coun. Alberta Rept. 66-3, 21 pages.

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Alberta RESEARCH

LEGEND

RECENT

EROSIONAL FEATURES

20 — Gully, creek valley, scarp: *thin colluvial cover on valley slopes; thin alluvial materials along streams; mixed glacial and bedrock materials in slump areas*

ALLUVIAL DEPOSITS AND FEATURES

19 — Beach: *mainly sand, sand and silt*

18 — Lake and slough deposits: *silt, clay, organic muck and marl*

17 — River terrace: *alluvial gravel, sand and silt, along North Saskatchewan River*

16 — Stream alluvium: *silt, clay and sand, along small streams*

AEOLIAN DEPOSITS

15 — Loess: *fine-grained to very fine-grained sand, and silt*

14 — Sand, dunes: *medium- to fine-grained sand, in sheet and dune form; 10 to 50 feet thick in dunes, thin in sheet sand*

PLEISTOCENE

GLACIOLACUSTRINE DEPOSITS

13 — Silt and clay: *bedded silt and clay, with minor sand; varved in places*

12 — Silt, sand and clay: *bedded silt and fine- to medium-grained sand; minor clay*

11 — Sand, silty sand: *mainly sand, with minor silt and clay; minor pockets of coarse sand and gravel*

10 — Mixed: *bedded silt, sand and clay, with pebbles, till pockets and till-like layers; overlying till*

GLACIOFLUVIAL DEPOSITS AND FEATURES

9 — Pitted delta: *fluvial sand, silt and sand, minor clay, with occasional till pockets; topography hummocky to gently rolling*

8 — Eroded lacustrine plain: *thin, fine- to medium-grained sand deposits overlying lacustrine deposits, till and bedrock; local gravelly lenses*

7 — Eroded till plain: *thin, fine- to medium-grained sand and gravelly lenses overlying till, and locally bedrock; lag deposit*

6 — Outwash sand: *coarse- to medium-grained sand with pebbles and small gravel lenses; thickness variable, 2 to 20 feet; topography level to gently undulating*

5 — Outwash sand and gravel: *coarse- to medium-grained sand, with up to 50 per cent gravel; quartzite and granite pebbles and boulders; thickness variable, 2 to 20 feet; topography level to gently undulating*

4 — Outwash gravel: *quartzite and granite pebbles and boulders, with less than 50 per cent sand; occasional very large granite erratics; thickness variable, 2 to 20 feet; topography gently undulating to level*

3 — Kame, esker: *sand and gravel, commonly silty, with inclusions of till; forming local hills and ridges*

GLACIAL DEPOSITS

2 — Hummocky moraine: *till composed of mixed clay, silt and sand, with pebbles and boulders; lenses of sand, gravel and local bedrock; generally more than 40 feet thick; topography undulating to gently rolling*

1 — Ground moraine: *till composed of clay, silt and sand, with pebbles and boulders; variable in thickness, but generally less than 40 feet; topography level to undulating*

Geological boundary: defined, approximate, assumed

Glacial fluting

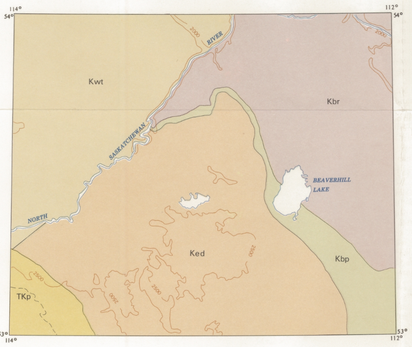
Meltwater channel, large — *eroded lacustrine plains*

Meltwater channel, small

Geology by L. A. Bayrock, 1958, 1959, 1960, 1967, 1968, 1969

BEDROCK GEOLOGY

from R. Green, 1972 — Scale 1:1,000,000



LEGEND

CRETACEOUS

TKp — Paskapoo Formation: *sandstone, siltstone; coal and tuff beds*

Kwt — Wapiti Formation: *sandstone, mudstone and shale; ironstone and coal beds*

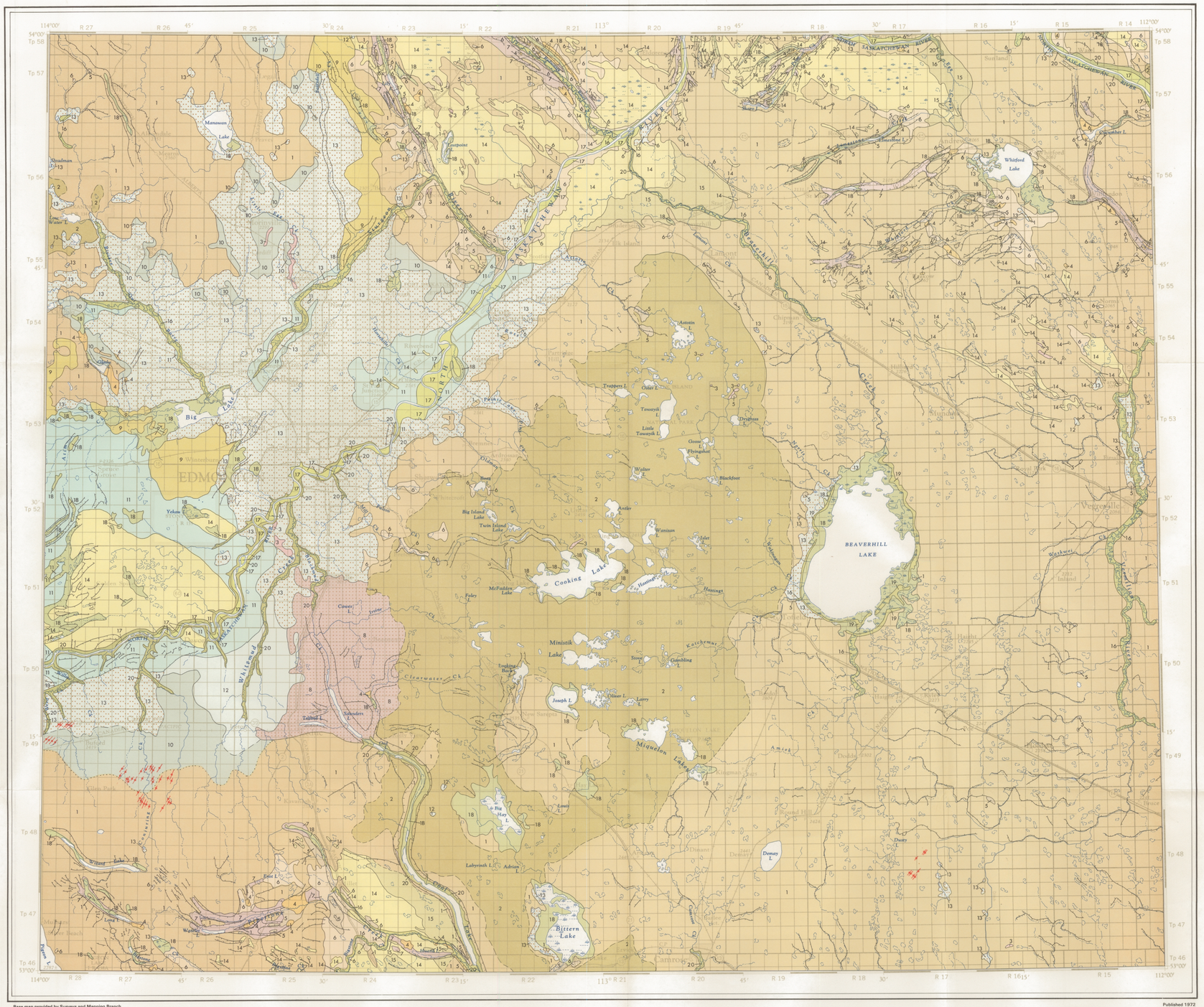
Ked — Edmonton Group: *sandstone, mudstone, shale; ironstone and coal beds*

Kbp — Bearpaw Formation: *silty shale, minor clayey sandstone*

Kbr — Belly River Formation: *sandstone, siltstone and mudstone; ironstone beds*

Geological boundary

Surface contour (contour interval 500 feet) — 2600



Base map provided by Surveys and Mapping Branch, Department of Energy, Mines and Resources; modified by Surveys Branch, Alberta Department of Highways and Transport

Cartographic editing by J. D. Root

Drawn by D. E. Jacobs

LEGEND

River or stream

Intermittent river or stream

Lake

Intermittent lake

Road, hard surface, all weather — 2

Railway

Township boundary

Section line

SCALE 1:250,000
1 Inch to 4 Miles Approximately

Miles 5 0 5 10 15 20

Kilometres 5 0 5 10 15 20 25 30

SURFICIAL GEOLOGY EDMONTON NTS 83H

Published 1972

DESCRIPTIVE NOTES

BEDROCK GEOLOGY

The near-surface bedrock in the Edmonton area is mainly of Late Cretaceous age; the beds dip gently southwestward, so that the oldest rocks occur in the northeast and the youngest, of early Tertiary age, are present in the southwest corner. All are nonmarine except for a thin tongue of marine strata present in the southeast.

The oldest beds belong to the Belly River Formation—grey to greenish-grey sandstones, clayey siltstones and mudstones with local ironstone beds. These are overlain by thin brownish and dark grey shales and siltstones of the Bearpaw Formation, containing marine microfossils. The overlying Edmonton Group consists of grey clayey sandstones and mudstones, dark carbonaceous shales, volcanic tuff and ironstone beds, and commercial coal seams. Dinosaur bones and petrified wood can sometimes be found on outcrops, as in the North Saskatchewan River valley between Edmonton and Devon. North of the North Saskatchewan River, the Bearpaw Formation thins to zero, and the Belly River and Edmonton strata are grouped together as Wapiti Formation. In the southwest, the Paskapoo Formation is the youngest rock unit, containing the thick Ardley coal zone near the base, and consisting of similar beds to the Edmonton Group, but with no ironstone, less coal, and generally more sandstone.

Erosion of the bedrock surface during later Tertiary time established a pattern of drainage towards the northeast, as indicated by the centrelines of preglacial valleys shown on the side map. Stream and terrace deposits are commonly quartzite-rich gravel in the main valleys (and are extensively used for aggregate), and sandy in the smaller valleys. The deposits are classed as Saskatchewan Gravels and Sands.

SURFICIAL DEPOSITS AND LANDFORMS

Glacial History

During the Pleistocene epoch, a continental ice sheet originating on the Precambrian Shield in Keewatin advanced from the northeast and covered the region at least twice. The last ice advance took place some 25,000 to 30,000 years ago, in late Wisconsin time; this ice sheet extended southward into Montana, and westward to beyond Edson to coalesce with mountain ice sheets. Melting of this glacier, which was essentially complete about 9000 years ago, left all of the area covered by surficial deposits of various types.

Glacial Deposits

Till is unsorted sediment deposited directly from a glacier and is composed of varying proportions of all materials eroded by the glacier upstream from any point of deposition. Till forms the surface deposits over the greater part of the map area and, in addition, underlies much of the area covered by younger lacustrine and aeolian sand deposits. Till deposits are divisible on the basis of topography into two types: *ground moraine*, with local relief of less than 15 feet, and *hummocky moraine*, with local relief of more than 15 feet. Ground moraine, which has a wide distribution, is generally thin (10 to 40 feet) and fairly uniform in composition. Hummocky moraine is confined mainly to the central part of the area, underlying the hilly terrain which extends from Elk Island Park in the north to the southern boundary of the map area west of Camrose. The till in hummocky moraine is generally thick (40 to 150 feet) and contains many lenses of gravel, sand, and silt.

Tills of the Edmonton area consist mainly of local bedrock materials (disintegrated Cretaceous sandstones and bentonitic shales with coal and sideritic ironstone fragments) with significant amounts of igneous and metamorphic rocks derived from the Canadian Shield to the northeast. The presence of rocks and minerals from the Shield (e.g., granite, schist, green hornblende) readily distinguishes the glacial deposits of the area from preglacial sands and gravels and local bedrock materials. The tills also contain Devonian carbonate rocks from outcrops along the Shield margin; hence, although the local Cretaceous bedrock formations tend to be low in calcium carbonate, the tills are calcareous owing to the presence of Devonian limestones. The tills contain approximately equal proportions of sand, silt, and clay, but have low gravel contents—less than 10 per cent. Montmorillonite forms a significant fraction of the total clays—between 10 and 20 per cent. Near the surface the tills are oxidized and brown in color, but deeper than 10 to 20 feet from the surface they are typically unoxidized and grey to dark grey in color. In groundwater discharge areas till near the surface may contain significant amounts of sulfate salts.

Glaciofluvial Deposits and Features

Ice-contact deposits in the form of *kames and eskers* are very rare in the area. Four small moulin-type kames have been found in Elk Island Park. A large kame partly covered by glaciolacustrine (Lake Edmonton) sediments and supporting small beaches forms Rabbit Hill south of Edmonton. Two eskers, also covered partly by Lake Edmonton sediments, are located near the town of Morinville, north of Edmonton. Other kames are very small. Generally, the kames and eskers are composed of impure sand and gravel with large inclusions of till and silt and are not suited for use as aggregate.

Outwash deposits are deposits of sand and gravel laid down by glacial meltwater, usually on ice-free terrain, either along meltwater channels or as sheet deposits. On the basis of composition, outwash deposits in the Edmonton area are subdivided into three categories: *outwash gravel, outwash sand and gravel,* and *outwash sand. Outwash gravel* is found mainly in association with glacial meltwater channels, mostly as terraces along the channels, but rarely (as near Millet and Andrew) as channel floor deposits. Most outwash gravel in the area is of good commercial grade and is mined for aggregate. *Outwash sand and gravel* also is associated with former glacial meltwater channels but, in addition, occurs as sheet deposits, as in the Fort Saskatchewan-Redwater and Millet areas. These deposits contain a significant proportion of coarse sand in addition to fine sand and large layers and pockets of gravel. Many are mined for aggregate. *Outwash sand* is found mainly as sheet deposits. Generally the sand is fine to medium grained with a very small proportion of gravel; the fine grain-size precludes its use for aggregate. Most outwash sand deposits have had their surface modified by aeolian action and support sand dunes stabilized by vegetation.

The *eroded plains* outlined on the map are areas from which some or all of the surficial deposits have been removed by running water. Two types of eroded plains are present: *eroded till plains* and *eroded lacustrine plains.* On *eroded till plains,* which cover small areas in the Redwater and Millet regions, the ground moraine has been wholly or partially removed by glacial meltwater, leaving a thin cover of fluvial material on the bedrock surface. Lag gravel deposits 1 to 2 feet thick are common and contain numerous large boulders. A thin sand or fine gravel layer is present in many places, and bedrock exposures are common. A few small gravel pockets of commercial size are found in these areas. The *eroded lacustrine plain* is associated with glaciolacustrine sediments along the southeast margin of former Lake Edmonton. It is an area near the lake outlet from which lacustrine deposits and the underlying till have been partially or completely removed by discharging Lake Edmonton waters (see below). Lag gravel is found only where the till has been partially or completely eroded after removal of the lacustrine material. Bedrock exposures are found only along the major channels.

Glaciolacustrine Deposits

Much of the west-central part of the area, adjacent to and including the City of Edmonton, is underlain by glaciolacustrine sediments of various types deposited in a large proglacial lake called Lake Edmonton. Lake Edmonton formed during the recession of the ice sheet in Late Pleistocene time, when a minor readvance of the glacier from the northeast blocked the regional drainage along the North Saskatchewan River valley. The readvancing ice reached the Bruderheim region northeast of Edmonton, and an ice lobe apparently also moved into the Stony Plain region just west of the map area. The low-lying area between the two ice lobes was filled by glacial meltwater, which eventually overflowed and escaped through the Gwynne Outlet, a large channel southeast of Edmonton in which Saunders and Coal Lakes now are situated. Most of the lacustrine sediment was derived from the Stony Plain lobe on the west, but some is from the Bruderheim lobe. Deltas were built into the lake by meltwater streams from the glacier, and in places stranded icebergs and blocks of ice were surrounded and covered by the sediments. On subsequent melting depressions were left in the delta; thus *pitted deltas,* a hummocky terrain made of fine sand and silt of fluvial origin, were formed.

Near the pitted deltas, lake sediments are mainly sandy, whereas farther out they become silt and sand, then silt and clay which is varved at depth. Along other lake margins clay was deposited; these clay areas are grouped together with the silt and clay deposits. In many places along the margin of former Lake Edmonton, the lacustrine deposits contain large amounts of material deposited from melting icebergs; thus, the lacustrine deposits locally may approach till in composition. "Glir" deposits (glaciolacustrine ice-rafted deposits) cover a large area south of Calmar and another near Morinville. On the map, lacustrine deposits containing a large proportion of "glir" materials are designated as *mixed lacustrine deposits.*

Aeolian Deposits

Aeolian sand deposits in the area are derived from glacial outwash sand, except those southwest of Edmonton which have been formed partly from glaciolacustrine sand. After the recession of the glacier, but before vegetation stabilized the land surface, strong winds reworked the sands forming large dunes up to 50 feet in height. Most sand dunes are U-shaped, showing the dune-forming wind direction to have been from the northwest. Between the sand dunes in the dune fields are aeolian sheet sand deposits. Most sand dunes directly overlie the source sand, but in the Redwater and the Andrew areas northeast of Edmonton some dunes have migrated beyond the source area onto ground moraine. The dunes are composed of fine- to medium-grained sand, except those southwest of Edmonton which are made of fine-grained sand. All sand dunes at present are stabilized by vegetation.

Loess is aeolian-deposited silt and very fine sand. Three areas of loess are present in the Edmonton district: near Millet south of Edmonton, and near Bruderheim and Andrew northeast of Edmonton. The loess is composed of silt except near sand dunes where it consists of very fine sand. The deposits vary in thickness from 10 feet near dunes to zero at the outer margins of the deposits.

Alluvial Deposits and Features

Recent alluvial deposits are found along most streams in the area. *Small stream alluvium* is composed of silt and clay with a small proportion of sand, but small streams flowing through dune areas contain alluvium made entirely of sand. *Alluvial deposits associated with the North Saskatchewan River* contain a large proportion of gravel. In the floodplain the gravel is buried by flood-deposited silts from 2 to 10 feet in thickness. From Fort Saskatchewan eastward, the North Saskatchewan River alluvium is composed predominantly of sand. All *terraces of the North Saskatchewan River* situated higher than 40 feet above the present river level contain gravel.

Recent lacustrine deposits (lake and slough deposits) are predominantly silt and clay, although locally marl deposits are found. Many of these deposits are too small to be shown on the map. Lake deposits in sand areas are predominantly sand or organic material (muskeg).

Postglacial- beaches are well developed around Beaverhill Lake east of Edmonton, and are composed of sand with minor amounts of silt.

Erosional Features

Recent erosional features are limited to valley walls of rivers and streams. Generally, these are covered with a thin veneer of colluvium—a mixture of glacial materials and bedrock. Only very small alluvial deposits are found in the gullies. Slumping of valley walls is essentially limited to the North Saskatchewan River and mainly to areas where active river bank erosion is in progress.

Glacial flutings are poorly developed. A few flutings are present south of Calmar, near Kavanagh, and east of Camrose, all south of Edmonton.

Glacial meltwater channels are common. Large channels such as the Gwynne Outlet near Millet are up to one mile wide; through this channel Lake Edmonton drained. Large impressive channels are present also in the Redwater and Willingdon-Andrew areas, the former carrying meltwaters into the North Saskatchewan River system from the northwest. Most of the channels are incised into bedrock.

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