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SURFICIAL GEOLOGY OF BLOOD INDIAN RESERVE, NO. 148, ALBERTA

(Part of 82H)

A. MacS. Stalker

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CONTENTS

Illustration

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INTRODUCTION

The Blood is the largest Indian Reserve in Canada. It covers some 540 square miles of southern Alberta, west of Lethbridge and north of Cardston, and lies entirely within sheet 82H of the National Topographic System. It is bounded on the west by Belly River, on the northeast by Oldman River, and on the east by St. Mary River. These rivers have carved steep-walled valleys, 50 to 300 feet deep (being deepest in the north), which afford excellent exposures of the surficial deposits and bedrock. The southern boundary lies 2 miles north of the southern edge of township 3. The Reserve also includes about 6 square miles of timber limits in tp. 1, rge. 28, W 4th mer., in the Rocky Mountains. These timber limits are entirely within the confines of Waterton Lakes National Park.

Physiography

The southwestern part of the Blood Reserve lies within the foothills belt of the Rocky Mountains. This region is marked by conspicuous northwest-striking sandstone ridges. The rest of the Reserve lies in the extreme southwestern zone of the Great Plains of western Canada. In the central part, prominent hills formed of fairly flat-lying bedrock rise with gentle slopes high above the prairie level. Some of these hills exist because they are underlain by more resistant beds than surrounding areas, particularly where the hills are Willow Creek Formation and the plains Bearpaw Formation. Most of the hills, however, result from their location in the divide regions between the large valleys of the preglacial rivers[1]. Elsewhere in the Reserve, relief is low and the surface is monotonous, a monotony accentuated by a general lack of trees.

The basic bedrock topography of the Reserve has been modified by various Quaternary glaciers. These glaciers filled many of the earlier valleys with drift and roughened much of the previously smooth surface with small drift hills and ridges.

Previous Work

Dawson (1885, pp. 139c-152c)[2] gave the most complete early description of the surficial deposits on the Reserve, while he was

[1] The major units of the preglacial drainage system are overprinted on Map 40-1963 (in pocket).

[2] Names and/or dates in parentheses refer to publications listed in the References.

engaged in a general study of the geology of southwestern Alberta. His descriptions of exposures along river valleys were particularly detailed. Stalker (1959, 1962) later mapped the surface deposits on a scale of 1 inch to 4 miles. Stalker (1956) also located and described certain erratic blocks on the Reserve, which formed a segment of a long train that he called the "Foothills Erratics Train". These erratics originated near Jasper, Alberta (Mountjoy, 1958).

There is no large-scale bedrock map of the Reserve. Geological Survey of Canada Map 204A, Calgary, on a scale of 1 inch to 8 miles, issued in 1928, includes most of the Reserve; the eastern part was mapped by Russell (1940) on a scale of 1 inch to 4 miles. Douglas (1952) mapped the timber limits.

GENERAL GEOLOGY

Bedrock

Bedrock on the Reserve is normally overlain by drift or lake deposits; it outcrops only locally and there chiefly along river valleys and in hilly country. The surficial geology map (in pocket) shows extensive areas where the bedrock is but thinly covered by these deposits, generally by a thickness of less than 5 feet. On the other hand the bedrock beneath the buried preglacial valleys is covered in places by more than 200 feet of valley fill.

Bedrock formations include the Belly River, Bearpaw, Blood Reserve, and St. Mary River of Late Cretaceous age, and the Willow Creek of Late Cretaceous and Tertiary ages. The Belly River Formation is found only in the disturbed belt of the southwestern part of the Reserve. These five formations consist of beds of claystone, siltstone, and sandstone, with minor coal seams, ironstone bands, volcanic ash beds, and oyster shell beds. They were laid down either in or near the western marginal zone of the great, shallow, inland seas of the Mesozoic and Cenozoic Eras, and as a result include marine, brackish, and fresh-water deltaic sediments. Fresh-water and brackish water sediments predominate on the Reserve. Marine deposits are confined largely to Bearpaw Formation. This formation, which directly underlies the drift in the eastern part of the Reserve, consists mostly of dark shale. Sandstone and siltstone are more common in the other formations, particularly in the Willow Creek Formation, which was deposited early during the building of the Rocky Mountains, and in the Belly River Formation. Most of the bedrock is poorly consolidated, but there is sufficient difference in resistance to erosion to enable certain beds, particularly sandstone beds, to remain as hills and erosion remnants.

The bedrock has undergone several disturbances. Towards the end of the Palaeozoic Era the Sweet Grass Arch folding took place, and this affected some of the lower, subsurface formations. The Reserve lies on the northwestern edge of this arch and as a result the general dip of the beds is to the northwest, rather than conforming to the southwestward dip common over most of the western Great Plains. A second disturbance took place with building of the Rocky Mountains to the west, towards the close of the Mesozoic Era and beginning of the Cenozoic Era. Although this upheaval affected the whole area now occupied by the Reserve, its major effect was in the disturbed or Foothills belt of the southwestern part of the Reserve. The intense folding and thrust faulting that took place was responsible for the numerous northwest-trending, sandstone ridges found there. The final disturbance, which was only minor as compared with the others, took place in the Quaternary Period when pressures from the overriding glaciers contorted and locally strongly folded some of the upper beds. These effects were strongest in the poorly-consolidated beds of the northern part of the Reserve. A series of broad, low, parallel ridges reflected through the thick, overlying lake deposits in secs. 30, 31, 32, tp. 8, rge. 23, W 4th mer.[1], and in secs. 25, 26, 35, 36, tp. 8, rge. 24, W 4th mer., are thought to represent folding of older drift and perhaps also of bedrock through drag beneath a glacier, probably advancing from the northwest. Similarly, in secs. 11 and 12, tp. 7, rge. 22, W 4th mer., large blocks of bedrock have been sheared over preglacial gravel and old tills. Though general dip of the bedrock beds may be northwestward, local strike and dip vary greatly throughout the Reserve. This has had a marked influence on the drainage pattern, which is largely structurally controlled. This control is especially noticed in the southwestern part of the Reserve.

The timber limits area is underlain by Upper Cretaceous beds belonging chiefly to the Wapiabi and Belly River Formations. These consist largely of sandstone and shale. Outcrops are common, particularly above 5,200 feet altitude where only minor deposition by glaciers took place.

Preglacial Deposits

The oldest surficial deposits are preglacial gravel and sand; these include the 'Saskatchewan Gravel' of McConnell (1885). These materials are widespread on the Reserve, especially throughout the preglacial valley system, and are reported from many drill-holes. They are typically less than 20 feet thick, generally overlain by drift, and are exposed only along the banks of Belly, St. Mary, and Oldman Rivers. Bedrock, commonly weathered to a depth of 20 or 30 feet, underlies them. The preglacial gravel and sand have not been observed on the timber limits, and are probably not present there.

The preglacial deposits consist chiefly of coarse gravel, commonly with a sand matrix. Beds composed entirely of sand are rare, and if present are generally at the top of the deposit. The gravel in the main is clean, well sorted, and well bedded, and commonly has an imbricate structure. The stones are either well rounded or disc-shaped, depending on their composition. Up to 4 per cent of the stones originated locally, the rest were brought from the Rocky Mountains. The gravel does not contain material carried from the Precambrian Shield, such as is found in all younger gravel deposits in the area. In the northern part of the Reserve it consists of about 40 per cent quartzite and hard sandstone, 35 to 40 per cent limestone and dolomite, 10 per cent red and green argillite, and the rest of minor constituents such as flint, local rocks, and mountain volcanic rocks. Preglacial Oldman River brought most of this gravel from the west, but some was brought from the southwest by the ancestral Waterton and Belly

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[1]Most of the Canadian Prairies, including those regions adjacent to the Reserve, are surveyed on a rectangular system. Although only a small part of the Reserve has been surveyed in this manner, locations are given in this report as if the whole Reserve had been thus surveyed.

Rivers. The gravel farther to the southwest was carried in by preglacial Belly or St. Mary Rivers, and in it argillite comprises as much as 30 per cent, mostly at the expense of limestone and dolomite. Argillite outcrops extensively in the Rocky Mountains south of Oldman Valley.

Deposition of the preglacial gravel took place over an extended span of time, including much of the later part of the Tertiary Period and the beginning of the Quaternary Period. The swift ancestors of present Oldman, Waterton, Belly, and St. Mary Rivers slowly wore down their broad, deep valleys, at the same time lowering the general prairie level. Gravel was deposited in many places, particularly where valleys widened and currents slowed after crossing resistant bedrock onto zones of soft beds downstream. This appears to have been the chief cause of the extensive deposits east of Belly River in township 6, and overlying the Bearpaw Formation in the northeastern part of the Reserve. Many of the gravel flats remained, commonly as gravel terraces, after the rivers had incised their valleys lower, or had changed courses. This process was repeated again and again, and as a result gravel deposits are seen at many different altitudes along banks of the modern valleys, representing the different periods and levels of deposition. There was probably never a time during this period when gravel was not being deposited at some place.

The final episode came with approach of the ice-sheets. Mountain (Cordilleran) glaciers advancing down Oldman, Belly, and St. Mary Rivers added some outwash to the gravel beds in the preglacial valleys. This outwash, which is here included with the preglacial deposits, is found on the Reserve as far north as N 1/2, sec. 36, tp. 7, rge. 25, W 4th mer. Continental (Laurentide) glaciers advancing from the north and east dammed the rivers to form proglacial lakes, in which the fine material now found locally above the gravel beds was deposited. The Laurentide glaciers finally overran the whole area now occupied by the Reserve, and stopped deposition of preglacial gravel and sand.

Glacial Deposits

Glacial deposits (or drift) cover all of the Reserve except small areas of exposed bedrock, eroded areas in modern valleys, and an area in the northwest (in tps. 7 and 8, rge. 24, W 4th mer.) where proglacial-lake deposits lie directly on bedrock. The drift probably averages 25 feet thick, but where it forms the fill in preglacial valleys it is locally more than 200 feet thick. It invariably overlies bedrock or preglacial gravel and sand, and is either exposed at the surface or covered by lake deposits or alluvium.

The glacial deposits consist of till and a small amount of glacio-fluvial material. The till is a clay-silt type with few stones — generally less than 5 per cent stones by volume. It is chiefly a basal type till; only a minor quantity of ablation till is present. Its clay-silt nature reflects the composition of the bedrock underlying and adjacent to the Reserve. The soft, nearly unconsolidated state of much of the bedrock enabled the glaciers to erode large quantities of it, to be later incorporated into the drift. This local material forms most (perhaps as much as 90 per cent) of the till, and an even greater part of the fine fractions of the till. Material from other sources occurs chiefly in the coarse particles, and includes stones from the Rocky Mountains, which were gathered mostly from the preglacial gravel but partly brought directly to the scene by mountain ice, and stones transported by Laurentide glaciers from the Precambrian Shield. In general local bedrock contributed 15 to 25 per cent of the stones in the till and the Rocky Mountains supplied about 75 per cent. There are no Shield stones in the Cordilleran tills, but in the Laurentide tills the percentage ranges from 2 per cent in the southwest to 5 per cent in the northwest and 10 per cent in the northeast.

Stalker (1963) described six separate Laurentide tills and four separate Cordilleran tills in southwestern Alberta. Two Cordilleran tills and several Laurentide tills are present on the Reserve, but the lowest Cordilleran till and most of the Laurentide tills are exposed only along the river valleys. The tills all have a somewhat similar composition, though the Cordilleran tills are distinguished by complete absence of stones from the Precambrian Shield. Each till, however, has its own shade of colour, degree of consolidation, system of fracturing, and ability to form steep cliff faces. The tills are separated locally by beds of sand and gravel or varved silt and clay. In addition the topmost till is strongly contorted over broad areas, especially in the central and eastern parts of the Reserve. This contortion is particularly well displayed in the banks of St. Mary and Oldman Rivers along the eastern side of the Reserve, where thick lake deposits overlie the till (e.g. W 1/2, sec. 18, tp. 7, rge. 21, W 4th mer.). Here offshoots or diapirs of the underlying till from a few inches to a few feet wide cut vertically through the varved silt and clay, in places reaching 20 feet or more to the surface. Some, after cutting a short distance vertically, spread horizontally along the beds. A till dyke may thin to an inch or two, elsewhere it may bulge out to a few feet in width. Commonly the till envelops a block of the lake deposits 3 or 4 feet in diameter without otherwise markedly disturbing the varves. Elsewhere varves are twisted completely around blocks of till. In general the deformation is confined to the last till and to overlying lake deposits. In places, however, the contact between two of the lower tills shows somewhat similar deformation, with spurs of the lower till shooting up into and twisting through the lower half of the overlying till, in almost a flame structure (e.g. NE 1/4, sec. 9, tp. 5, rge. 26, W 4th mer.). The cause and means of deformation of the topmost till and overlying lake deposits are not known. The deformation definitely was not caused by overriding ice, but appears to have taken place when the retreating last glacier still lay to the northeast, and perhaps even while the glacial-lake sediments were being deposited. Further to the north and northeast, beyond the Reserve limits, similar deformation is not present in younger till but is common in the second till from the top.

The Cordilleran tills were deposited by glaciers moving northeastward from the Rocky Mountains, and the Laurentide tills by glaciers moving from the north-northwest, north, and northeast. The Cordilleran glaciers, when they crossed the map-area, were near the extreme limits of their advance, and are now represented only by minor deposits of till and outwash. Laurentide till is more prominent, but much of the foreign material in it was brought to the Laurentide ice-sheet by Rocky Mountain valley glaciers, principally in Athabasca, Bow, and Oldman valleys.

The surface till is present generally as a rather thin, fairly smooth blanket of ground moraine. This is especially true on the high land where it overlies smooth, broad, bedrock hills, and in the southwestern part of the Reserve where it has had long exposure to the elements. In low areas, lake deposits normally overlie the ground moraine. The surface till also occurs as hummocky moraine; such moraine is particularly well developed in the hilly country of the southwestern part of the Reserve where knobs rise 20 to 50 feet above the kettles. The knobs in the patches of hummocky moraine near the margin of the classical Wisconsin advance, in the southern part of the Reserve, and in the north-central part of the Reserve near Turnip Hill, are from 5 to 25 feet high. Several belts of hummocky moraine in the northeastern part of the Reserve are buried by lake deposits; these are outlined on Map 40-1963 as thin lake deposits over hummocky moraine.

The age relationships of the various tills are not known. The oldest till on the Reserve is of Cordilleran origin, but the oldest Laurentide till is thought to represent the same glacial stade. Each can be found in places directly overlying the preglacial gravels. If Nebraskan ice reached this area, then these tills are of Nebraskan age. The youngest tills are probably Wisconsin, and over most of the Reserve, classical Wisconsin. The classical Wisconsin ice probably did not overrun the southwestern part of the Reserve (roughly the area above 3,800 feet altitude), and its assumed limits are shown on Map 40-1963 (in pocket). Southwest of this boundary there is generally greater depth to the lime zone in the till, much modification (partly by slumping) of the walls of the spillways, and a somewhat smoother glacial topography. In addition, and perhaps most important, there occurs in places in this southwestern region a well-developed soil profile, which is buried beneath river alluvium, volcanic ash, and glacial-lake deposits. This profile evidently took at least as long to form as the present surface soils farther northeast. Its best exposure is on the walls of Belly River valley in sec. 22, tp. 4, rge. 27, W 4th mer., about 110 feet above the present river. This soil developed prior to its burial by lake and river deposits, which were related to the last glaciation, and subsequent cutting of Belly River valley through these deposits to its present depth. Downcutting of the valley commenced immediately upon withdrawal of the last (classical Wisconsin?) glacier from its point of nearest approach and the consequent draining of proglacial lakes. It appears that the soil developed following a pre-classical Wisconsin glaciation, and was subsequently buried by alluvium and lake deposits during classical Wisconsin time.

Timber Limits Area

Glacial deposits cover all of the timber limits area except some small areas of exposed bedrock and the valleys of Belly River and its North Fork, but drift is thin in all the high districts. In general, Laurentide drift overlies the northern half of the limits, whereas Cordilleran drift covers the southern half and an area higher than 5,100 feet in the northwest. A deposit of coarse glacio-fluvial material, consisting of an esker ridge and its associated deposits, crosses the limits southeastward from north centre to Belly River. Otherwise the glacial deposits consist of till that is coarser and much stonier than that described for the main part of the Reserve. In addition the stones themselves are much more angular and more striated. The 'leached' zone at the surface thickens noticeably with increasing altitude, and is in general much thicker than on the main body of the Reserve. The till appears to be of considerably greater age than the surface tills on the Reserve itself.

No stratigraphic sections showing more than one till have been seen on the timber limits.

Late-Glacial and Early Post-Glacial Deposits

Late-glacial and early post-glacial deposits cover more than half of Blood Indian Reserve, but are scarce on the timber limits area. These deposits were laid down beyond the ice-margin during the waning of the last glacier. This last glacier still was able to control the type of deposit laid down, however, either through diversion of rivers and control of their base levels, or by damming them to form proglacial lakes. These deposits include inwash, proglacial lake deposits, and alluvium of spillways or rivers.

The inwash is found in small deposits in the southwestern part of the map-area. It is locally as much as 50 feet, but is generally about 10 feet thick. It occurs only where the last ice-sheet blocked and deflected streams flowing towards it, with resulting lessening of currents and deposition of much of their load. Additional coarse alluvium is found on the early high terraces of Oldman and St. Mary Rivers in the eastern part of the Reserve, and in a few small deltas built by streams entering proglacial lakes. This alluvium generally is only 2 to 10 feet thick.

The fine alluvium typically consists of a thin, commonly discontinuous deposit left on the bottom of glacial spillways. One deposit 2 to 15 feet thick, which covers 5 square miles in the eastern part of the Reserve (in secs. 10, 11, 12, 13, 14, 15, 23, 24, tp. 7, rge. 22, W 4th mer.) appears to consist wholly of small fragments of Bearpaw shale, with few or no stones. Apparently for a short time following the retreat of the last ice-sheet, St. Mary River eroded this shale rapidly and just as rapidly redeposited it as a delta in a short-lived, proglacial lake.

A narrow lake bordered the last glacier during most of the time of its retreat from the Reserve area. It originated as a result of the downward slope of the land surface towards the ice and the damming of the broad valleys, which caused water to be ponded in front of the ice. As a result, lake deposits are more widespread on the Reserve than any other deposit. The fine lake material that forms the extensive, rather featureless parts of the lake basins consists mostly of silt and clay, much of which is varved. The coarse deposits consist mostly of silt and sand, and were laid down where the lake water had sufficient current to remove fine material. As a result they occur near former inlets, which were present chiefly along the present valleys of Belly, Oldman, and St. Mary Rivers and near glacial spillways. An extensive area of sand is also found on a high, marginal part of a former lake basin west and north of Wild Turnip Hill. This sand evidently was deposited during an early stage of the ponding, while the lake was still largely surrounded by ice. This area also contains esker-like features, which are either formed of or covered by sand.

The lake deposits over extensive areas are only a few feet thick and although they modify they do not fully mask the underlying drift topography. The deposits thicken in the deeper parts of the old lake basins, with thicknesses of 20 feet common, and near sec. 29, tp. 8, rge. 24, W 4th mer., where they lie directly on the bedrock, they are almost 100 feet thick. These thicker deposits fully mask the underlying topography. Wind has locally modified the coarse lake deposits, but not nearly to the extent that would be expected in such open country.

Stones up to 2 feet long are scattered over the areas of lake deposits. A few of these may have been brought in by ice-rafting. Most, however, were raised to the surface when the lake deposits and underlying till were contorted as a unit, as described earlier under "Glacial Deposits", and till locally reached the surface. Such contortion is characteristic in the lake deposits, extending from Oldman and St. Mary Rivers westward to the till plains that stretch along the centre of the Reserve from Cardston northward to Wild Turnip Hill. Similarly the deposits in the eastern part of the old lake basin that lies west of these same till plains, and particularly in townships 4 and 5, are also strongly contorted. The number of stones lying on the surface depends upon the amount of till that has risen through the lake deposits to the surface. In places till forms nearly half of the surface area. Most of these areas of part till and part lake deposit are shown on Map 40-1963 as lake deposits, in order to indicate more closely maximum lake extent.

The last Laurentide glacier retreated downslope. As a result the meltwater streams tended to flow parallel to its margin and carry material out of the area, rather than spreading it outwards beyond the margin as normal outwash. Material carried from the ice thus forms only a minor part of the lake beds, and most of the lacustrine material was brought into the lakes by rivers and streams flowing towards the glacier from the west and south.

Post-Glacial Deposits

The post-glacial deposits include all material laid down after the waning Wisconsin Laurentide glacier had ceased to have any influence on deposition in the area. They include modern stream alluvium, colluvium, slide material, and slump.

The alluvium is found chiefly in the modern large river valleys, and it is thin and discontinuous along smaller streams. It is continuous along Belly and Oldman Rivers where its thickness probably ranges between 5 and 25 feet. It is not as common in St. Mary Valley, which is generally floored with exposed bedrock, but where present is probably of similar or slightly greater thickness. The alluvium consists of clay, silt, and sand in the reaches of the rivers that have slow currents, and of sand and gravel in the faster stretches. Silt is prominent along Belly River. The swift current that caused St. Mary River to incise deeply into bedrock also removed most of the silt, and what alluvium is present in its valley consists predominantly of gravel and sand.

The only important area of slope wash is in secs. 30 and 31, tp. 6, rge. 24, W 4th mer. The wash consists mostly of small pinkish fragments of Willow Creek Formation siltstone that were eroded during formation of the badlands to the southeast and washed onto the flats and terraces in Belly Valley, there to be spread as a fairly even layer. A rock flow or slide is present in sec. 20, tp. 6, rge. 24, W 4th mer., on the gentle eastern slope of Mokowan Butte. This flow also consists chiefly of Willow Creek siltstone, but sand and stones from till and alluvium have been mixed with it.

Large slumps and extensive deposits of colluvium are prominent along Oldman Valley and the northern part of St. Mary Valley. In carving these valleys the rivers had to cut through thick fill in preglacial valleys before reaching bedrock. As there is commonly much water seepage at the base of the fill just above the relatively impermeable Bearpaw shale, slumping occurs readily at this zone, and as a result massive blocks up to a mile in length slump, commonly in a series of rotational slices. Large-scale slumping also takes place along Belly River, in townships 3 and 4, where the river cuts through thick fill in crossing several interglacial valleys. Once again the blocks slip chiefly along the contact between bedrock and surface deposits. Composition of the colluvium and slump material depends upon the composition of the parent material, which slid or slumped, and can include any material found on the Reserve.

Timber Limits Area

Alluvium is the only important post-glacial deposit on the Blood Reserve timber limits, where it is found principally along Belly River and in the delta of North Fork Belly River. It is predominantly coarse and includes many boulders between 1 foot and 3 feet in diameter.

HISTORICAL GEOLOGY

Drainage

The drainage system of southern Alberta had evolved during a span of many millions of years, and was well developed and integrated at the onset of glaciation (Stalker, 1961). The trunk valleys were broad, commonly 5 to 15 miles wide from prairie level on one side to prairie level on the other side, and the sides of the valleys characteristically had low slopes. Regional uplifts changed stream gradients from time to time and added variety to the valleys. In addition much of the drainage near Blood Reserve was structurally controlled, in places being almost a rectangular pattern, which added variety to its general dendritic pattern and overall northeastward trend. In crossing resistant bedrock the rivers characteristically narrowed their valleys and steepened their gradients, but where flowing across soft formations they carved broad valleys with extensive river flats.

The modern valleys are narrow and steep-walled, and generally have not reached the base level of the preglacial valleys. In most other respects, however, the preglacial drainage system resembled the modern. Both had a general northeastward trend, the rivers of both had similar gradients and currents and were of similar size. Long segments of the modern rivers follow preglacial valleys. Thus Oldman River throughout its course along the border of the Reserve flows through thick fill in a preglacial valley, and Belly River does likewise north of township 4. St. Mary River has changed its course completely. In preglacial time it apparently followed the bedrock strike and flowed in a valley 3 to 5 miles wide northwestward through township 4, instead of northeastward as at present, to swing northward in tp. 5, rge. 26 along the course of present Belly River. Northward-flowing preglacial Lee Creek probably joined it in tp. 4, rge. 26. Northward-flowing preglacial Milk River may have reached the southeastern margin of the Reserve a few miles east of St. Mary Dam, where thick drift (including several tills) is present, but its course thence is not known. However, this thick drift could lie in an interglacial channel of this river. The modern Milk River lies about 20 miles southeast of the Reserve.

Between each glaciation, and even between the substages of each glaciation, a drainage system of necessity developed. Drift-filled segments of the interglacial valleys are numerous. The interglacial drainage systems resembled the modern system more closely than the preglacial one, though in general they were more mature, with deeper and broader valleys, than the modern system. Both interglacial and modern systems include segments of preglacial valleys and glacial spillways, connected by sections of entirely new valleys carved by the newly developed rivers. The valleys of both were narrow and relatively steep-walled. Like the preglacial drainage, the interglacial systems were each in turn disrupted and mostly buried with drift by the succeeding glacier.

Glaciation

Cordilleran ice reached the Blood Indian Reserve area first, either down St. Mary or Belly Valley, or both. Its approach was signalled by outwash carried into the area by meltwater pouring down these preglacial valleys. Laurentide ice, which was slowly expanding westward though its main flow was southward, dammed the preglacial rivers to form constantly deepening proglacial lakes, and the fine sediment deposited in these lakes covered much of the preglacial gravel. This Laurentide ice-sheet spread over the whole area, replaced the Cordilleran ice, and laid down an extensive blanket of till. These first glaciers caused more disruption and change in the drainage system than any of the subsequent glaciers. Glaciation was repeated several times, the exact number not being known, but the successive glaciers varied greatly in strength. Laurentide ice apparently reached the Reserve during each glaciation, but Cordilleran glaciers probably did not advance that far each time. The directions of movement of the successive Laurentide glaciers varied, and these glaciers approached the Reserve at different times from the north-northwest, north, and northeast. Each ice-sheet removed most of the earlier drift, so that tills from the early glaciers are found principally in preglacial valleys where they were partly protected from later glaciers. The surface till in the timber limits was probably not overrun by some of the younger glaciers, and may be the deposit of one or two of these older glaciers.

An important feature of the interglaciations was extensive development of badland topography. Badlands are presently found at and north of Mokowan Butte, but they are not likely to have been present in preglacial time. They were undoubtedly much more widespread in several of the interglaciations than they are at present. Not only were they probably present at Mokowan Butte, but large areas in the northeastern part of the Reserve (shown on Map 40-1963 as interglacial valley) appear to have had badland characteristics. Smaller patches may have been present elsewhere. Otherwise conditions during interglacial times were probably similar to those prevailing now. Ground moraine and hummocky moraine covered the high districts, and lake deposits blanketed the broad areas overlying the buried preglacial valleys.

The final glacier, thought to be of classical Wisconsin age, covered all but the southwestern part of the area now occupied by the Reserve, and most of the known events of glaciation concern its subsequent retreat. Though the ice that covered the Reserve at that time is called Laurentide (for it was part of the vast Laurentide continental glacier and moved southward with it as a unit), its western part included much Cordilleran ice added to it by eastward-flowing valley glaciers in the Rocky Mountains. Thus a large part of the ice in the Laurentide glacier on the Reserve, and perhaps most of it, originated in the Rocky Mountains, and the proportion increased southwestward. Overall flow in this glacier was roughly parallel to the front of the Rocky Mountains (Tyrrell, 1890, p. 401; Stalker and Craig, 1956), and the large-scale addition of this mountain ice to the western margin of the otherwise southward-flowing glacier may have been an important factor in giving the eastward component to its flow. Near the western edge of the ice-sheet, local movement was commonly towards the margin, where dissipation of the ice was greatest, and generally normal to the contour of the ground. This appears to have been the case in the Reserve area when the glacier was at its maximum extent.

At its maximum advance the last glacier dammed or deflected many small streams that flowed downslope towards it, ponding small lakes, and causing formation of deltas. The only good gravel deposits directly connected with glaciation were formed at this time, but these were not large. The southwestern part of the glacier may at this time have contained much ice from Bow Valley, perhaps also from Oldman Valley, and certainly a great deal from Athabasca Valley. With a lowering of ice surface by between 100 and 200 feet, and a retreat of the margin of only a few miles, ice from Athabasca Valley formed most of the marginal part of the glacier. This ice flowed southward along the Foothills through western Calgary and west of High River and Fort MacLeod, to cross the Reserve area in an easterly direction, or roughly parallel to the surface contours. This ice carried the "Foothills Erratics" into place; these are now common in the belt that lies between 3,500 and 3,700 feet altitude, particularly in townships 4 and 5 (Stalker, 1956). There was little proglacial ponding during this stage, and the direction of meltwater flow is not known.

Further lowering of the glacier surface by 200 or 300 feet enabled the southern part of the high land that stretches northeastward through the centre of the Reserve towards Mokowan Butte to become ice-free. This separated the southern part of the ice-sheet into lobes in Belly and St. Mary Valleys. Ponding of the large glacial lakes in these valleys now started, but only in the higher parts of their basins, and the water was shallow. These lakes lasted until the ice retreated beyond the borders of the Reserve, but at a constantly lowering elevation. Most of the ice now forming the western part of the glacier had flowed through the high land south of Bow River and east of Calgary via Highwood and Arrowwood Valleys, and thence southward towards the Reserve, following approximately the contour of the land. Most of the ice-flow markings still preserved formed during this stage; any formed during other stages were mostly destroyed by later ice-movement or buried under lake deposits. The water ponded in Belly River valley at first drained eastward beyond the eastern edge of the Reserve, but later as the ice lowered, it drained through successively lower spillways into the lake in St. Mary Valley, which in turn drained eastward. A spillway that drained from sec. 31, tp. 5, rge. 24, W 4th mer. lowered the surface of the lake in Belly River valley by 50 to 75 feet, from its original level to 3,600 feet. Another spillway, flowing from sec. 7, tp. 6, rge. 24, W 4th mer. subsequently lowered the lake surface to 3,500 feet, and the large spillway that strikes eastward north of Mokowan Butte lowered the lake level to 3,450 feet. This last spillway emptied into the lake (which was ponded at a level of about 3,350 feet) east of the butte and the high land of the central part of the Reserve. Spillways probably also existed at these same places during retreats of some of the former glaciers.

The ice then melted from the high land around Wild Turnip Hill, where it laid down patches of hummocky moraine, and the lake in Belly River valley was able to unite with the lake east of the hill. The surface of the glacier continued to lower, and its northward-trending margin continued to retreat towards the lower land in the east. Opening of lower outlets lowered the level of the combined proglacial lake as it expanded eastward in front of the retreating glacier. The lake steadily withdrew from the high land to the west, and streams entering it from that direction had to flow across the western part of the old lake basin. These streams now carried only local drainage. During its retreat the ice-margin made several stands, and built two or three belts of hummocky moraine. Each of these was in turn buried under lake sediments when the ice retreated from it, but they are still reflected in the present surface topography. The glacier finally retreated beyond the boundaries of the Reserve area, the proglacial lakes drained, and the modern stream system appeared. The final event was the wide-spread contortion of till and lake deposits, as described earlier.

During most of their existence the large proglacial lakes extended northwestward and eastward beyond the Reserve area boundaries. The major inlets were north and west of the Reserve area, and most of the major outlets were east of it. The Reserve area proper formed a quiet bay in one of the large proglacial lakes, although the main events were taking place elsewhere in the lake.

ECONOMIC GEOLOGY

The economic value of the surficial deposits lies chiefly in their being a source of gravel, sand, and clay, and in their potentiality as a source of groundwater. The groundwater resources are described elsewhere (Scott, 1963). Properties of the various clays on the Reserve were not studied, but their surface exposures are shown on Map 40-1963.

Gravel

The chief gravel deposits exposed on the surface are listed in the Appendix. The gravel deposits found on the Reserve consist of (1) preglacial river deposits, (2) interglacial alluvium (3) glacial gravels, and (4) alluvium of the modern rivers. The glacial gravels consist mostly of coarse alluvium laid down as ice-margin deposits, in spillways, or as deltas in glacial lakes.

Buried Gravel

The preglacial gravel was described earlier in this report as a clean, well-sorted gravel, composed largely of round or disc-shaped stones of quartzite, hard sandstone, dolomite, and argillite. It is present in much of the preglacial valley system and is mostly confined to the valleys shown on Map 40-1963. The deposits are commonly extensive and fairly continuous, as can be seen along the banks of the modern valleys cutting through them. There is an estimated 300,000,000 cubic yards of this gravel on the Reserve, concentrated largely east of Belly River in townships 4, 5, and 8, and in the northern part of the Reserve in township 9, and between Oldman and Belly Rivers. This gravel is generally buried too deeply (commonly 50 to 150 feet deep), for economic use, and it is typically coarse and requires crushing for many uses; if it could be developed, however, it would be the best gravel available in the area. Small quantities might be obtained where it is exposed along river banks, particularly along Oldman River in the northeastern part of the Reserve. Along Belly River a small amount might be developed in N 1/2, sec. 36, tp. 7, rge. 25, W 4th mer. Here, a bed 12 feet thick outcrops for some 500 feet along the river bank, but is overlain by 16 feet of till and 13 feet of lake and stream deposits. It is a coarse gravel, and large boulders are present 3 feet above the base.

Gravel reported from drill-holes in NW 1/4, sec. 19, and SW 1/4, sec. 30, tp. 7, rge. 23, W 4th mer., at a depth of 25 to 50 feet, is probably preglacial.

Interglacial gravel is reported from many drill-holes. It is present locally between till sheets along many of the preglacial and interglacial valleys. Some of the deposits undoubtedly are extensive, and commonly are present in the same areas that are underlain by preglacial gravel, though at less depth. Such gravel, however, is neither shallow enough nor present in thick enough beds to be utilized.

Surface Gravel: Reserve Area

The surface gravel includes both glacial and post-glacial deposits. The chief deposits of surface gravel are listed in the Appendix. In addition there are numerous other small pockets of gravel on the early post-glacial terraces and in the alluvium of the modern rivers, particularly where Map 40-1963 shows coarse alluvium but also as thin beds or pockets in the fine alluvium. For instance, there are many small patches of poor-quality surface gravel, 1 foot to 4 feet thick, along Lee Creek in sec. 15, tp. 3, rge. 25, W 4th mer., and others in secs. 22, 23, 26, 27, tp. 3, rge. 25, W 4th mer., along St. Mary River. In general most of these terrace and modern alluvial deposits are too small and too far from transportation to have much value. Thin, local layers of poor gravel are common along Prairie Blood Creek and other small streams, and along some of the glacial spillways, but they also are too small to be developed.

Though exposed gravel deposits have supplied all local gravel used thus far, there is practically no surface gravel over most of the Reserve. The only economically important deltaic gravel deposits are the few small ones constructed during early stages of glacier retreat in the southwestern part of the Reserve area. All the large deltas associated with the glacial lakes were built outside the Reserve area. Even the spillways that connected the lakes in Belly Valley to those farther east flowed through silty or sandy bedrock, which could not supply coarse material, and their deltas consist mostly of sand. In addition the lake deposits have buried any glacio-fluvial gravel that may have been laid down in the northern part of the Reserve.

Surface Gravel: Timber Limits Area

Much good gravel is present on the timber limits, and most of it is near transportation and in accessible districts. The oldest deposit is found in an esker ridge and its associated deposits, which extend for 1 1/2 miles across the northeastern part of the limits. This deposit is estimated to contain 1,000,000 cubic yards of gravel, which is variable in quality and is mostly coarse, but includes valuable deposits of fine or medium gravel. It contains a wide range of material, including stones from the Precambrian Shield; many of these are weathered.

The post-glacial alluvium includes fine to coarse gravel on the flats of Belly River. This alluvium extends for 3 1/2 miles northward across the timber limits in a strip averaging 1/3 mile in width, but sand and silt locally replace the gravel. This gravel is generally of good quality, contains but little soft or rotten material, is commonly well sorted, and much of it is readily accessible. Stones from the Precambrian Shield are present only in the northern half of the deposit, but are rare even there. Though much of the gravel is coarse, deposits of fine or medium gravel are present. The thickness of the deposit is not known, but probably averages about 5 feet. Between 1,000,000 and 3,000,000 cubic yards should be present, but part of it is buried beneath the fan of North Fork Belly River.

The fan formed by the North Fork above where it joins Belly River is nearly 2 miles long and more than 1/2 mile wide at its maximum. It may be 20 feet thick near the centre, but is generally much thinner. It consists of gravel with locally a thin cover of sand or silt. Altogether 2,000,000 cubic yards of gravel should be present. Though this gravel is typically coarse and angular, and contains many boulders up to 3 feet in diameter, pockets of fine to medium gravel should be present, chiefly near the margins of the fan. Most of the gravel is of good quality, apart from its size range; soft material is rare, and stones from the Precambrian Shield are lacking. This gravel is readily accessible and could be readily developed. In general, however, the flats of Belly River and the esker ridge are better immediate sources of gravel.

Sand

There has been little demand for sand on the Reserve, though it is common and fairly well distributed. Sand is generally associated with the gravel deposits, though little occurs with the preglacial gravel deposits, and in some of the deposits it would need to be separated from the gravel. In addition, large reserves of sand occur in the fine-grained modern stream alluvium, though much of it is clayey or silty. Much sand is also present in the coarse glacial-lake deposits that cover more than 20 square miles of the Reserve, but much of it also is silty. Sand is particularly prominent in the lake beds around Wild Turnip Hill. Another good source of sand, particularly in the southwestern part of the Reserve, is the poorly consolidated sandstone beds of the bedrock.

REFERENCES

Dawson, G.M.
1885: Report on the Region in the Vicinity of the Bow and Belly Rivers, Northwest Territories; Geol. Surv., Can., Rept. Prog. 1882-83-84, pt. C.

Douglas, R.J.W.
1952: Waterton, Alberta; Geol. Surv., Can., Paper 52-10.

McConnell, R.G.
1886: Report on the Cypress Hills, Wood Mountain, and Adjacent Country; Geol. Surv., Can., Ann. Rept. (New Ser.) 1885, vol. 1, pt. C.

Mountjoy, E.W.
1958: Jasper Area—Source of Foothills Erratics; J. Alta. Soc. Petrol. Geol., vol. 6, No. 9, pp. 218-226.

Russell, L.S.
1940: Taber, Alberta; Geol. Surv., Can., Map 565A with descriptive notes.

Scott, J.S.
1963: Groundwater Potential, Blood Indian Reserve, Alberta; Geol. Surv., Can., Paper 63-15.

Stalker, A.MacS.
1956: The Erratics Train, Foothills of Alberta; Geol. Surv., Can., Bull. 37.

1959: Surficial Geology, Fort MacLeod, Alberta; Geol. Surv., Can., Map 21-1958 with descriptive notes.

1961: Buried Valleys in Central and Southern Alberta; Geol. Surv., Can., Paper 60-32.

1962: Surficial Geology, Lethbridge (East Half), Alberta; Geol. Surv., Can., Map 41-1962.

1963: Quaternary Stratigraphy in Southern Alberta; Geol. Surv., Can., Paper 62-34.

Stalker, A.MacS., and Craig, B.G.
1956: Use of Indicators in the Determination of Ice-Movement Directions in Alberta, Canada: A Discussion; Bull. Geol. Soc. Amer., vol. 67, pp. 1101-1104.

Tyrrell, J.B.
1890: Post-Tertiary Deposits of Manitoba and the Adjoining Territories of Northwestern Canada; Bull. Geol. Soc. Amer., vol. 1, pp. 395-410.

— APPENDIX —

Chief Gravel Deposits Exposed at Surface

1. Location[1] — SW 1/4 sec. 18, tp. 3, rge. 25, W 4th mer.

   Type of deposit — Late-glacial or early post-glacial coarse alluvium.

   Maximum dimensions (yards) — 200 long by 30 wide by 5 thick.

   Estimated quantity — 12,000 cubic yards maximum.

   Composition — 25 per cent stones from local bedrock, 20 per cent from Precambrian Shield, rest mostly sandstone, quartzite, dolomite, limestone.

   Remarks — This is a northward continuation of a much longer deposit present south of the Reserve. In general this gravel is poorly sorted and contains many blocks of till and other soft or decomposed material. However, as the deposit was laid down by a stream flowing from the southwest the material on the Reserve is better sorted and somewhat finer than that developed in the pits south of the Reserve. It needs size sorting and removal of weak material for most uses, and is not of much economic value.

2. Location — SE 1/4 sec. 13, tp. 3, rge. 26, W 4th mer.

   Type of deposit — Late-glacial or early post-glacial coarse alluvium.

   Maximum dimensions (yards) — 80 long by 70 wide by 5 thick.

   Estimated quantity — 7,000 cubic yards.

   Composition — 5 per cent stones from Precambrian Shield, 5 per cent stones from local bedrock, rest mostly hard sandstone, quartzite, argillite, limestone, and dolomite, from Rocky Mountains.

   Remarks — The deposit was laid down by a stream flowing from the southwest. It is a sandy gravel with subround to subangular stones mostly 2 to 5 inches long but up to 12 inches long. The thinness and small size of the deposit, and the poor quality of the gravel, make the deposit of little economic value.

3. Location — NW 1/4 sec. 27 and NE 1/4 sec. 28, tp. 3, rge. 26, W 4th mer.

   Type of deposit — Late-glacial or early post-glacial coarse alluvium.

   Maximum dimensions (yards) — 800 long by 200 wide by 5 thick.

[1] Deposit numbers refer to those on Map 40-1963, in pocket.

Estimated quantity — 400,000 cubic yards (an additional 100,000 cubic yards has been removed).

Composition — Mostly hard sandstone, quartzite, dolomite, limestone, and argillite from the Rocky Mountains, with about 10 per cent stones from Precambrian Shield and 3 per cent local material.

Remarks — This has been the most valuable gravel deposit on the Reserve, and about half of its economically available gravel, including the thicker parts, has been removed. The deposit was laid down by a stream flowing from the southwest, and in that direction the gravel is coarse, with round to subround stones mostly 1 inch to 4 inches, but as much as 10 inches long. Northeastward the material grades into a grit or sand, and the deposit is thin.

4. Location — Sec. 12, tp. 5, rge. 24, W 4th mer., and secs. 6, 7, 8, 9, 10, tp. 5, rge. 23, W 4th mer.

   Type of deposit — Late-glacial and post-glacial coarse alluvium.

   Remarks — This deposit stretches in a zone about 1/2 mile wide along the north or Reserve side of St. Mary River. This area has a thin and discontinuous cover of poor gravel. Local pockets of good gravel are present, but the best of these were used during construction of St. Mary Dam. Otherwise most of this gravel has little value.

5. Location — NE 1/4 sec. 15, E 1/2 sec. 22, W 1/2 sec. 23, tp. 3, rge. 26, W 4th mer., and in sec. 21 and S centre sec. 28, tp. 3, rge. 26, W 4th mer.

   Type of deposit — Late-glacial or early post-glacial coarse alluvium.

   Remarks — These areas represent deltas built by streams that flowed towards the ice-margin. Scattered deposits of gravel are present in these deltas, but size of the deposits and quantity of gravel present are not known. Seismic-shot-hole logs show thicknesses of as much as 45 feet of fine gravel in the eastern area, and 20 feet of gravel in the western area. The gravel evidently is mostly fine (pea gravel), though coarser material may be present locally. The deposits should include a broad variety of material.

6. Location — E 1/2 sec. 9, W 1/2 sec. 10, SW 1/4 sec. 15, SE 1/4 sec. 16, tp. 7, rge. 23, W 4th mer.

   Type of deposit — Late-glacial or early post-glacial coarse alluvium.

   Maximum dimensions (yards) — 2,000 long by 1,200 wide by 1 thick.

   Estimated quantity — 150,000 cubic yards.

Remarks — This gravel is the thin delta deposit of a spillway stream that flowed into a proglacial lake. It has an average thickness of 1 foot, is discontinuous, and locally covered by lake deposits. It contains a wide variety of stones, including ones from the Precambrian Shield, ranging up to 2 feet long. The best medium-size gravel is towards the centre of the deposit. The thinness and patchy nature of this deposit makes it difficult to develop.

7. Location — N centre sec. 26, NE 1/4 sec. 34, sec. 35, tp. 3, rge. 25, W 4th mer., and SE 1/4 sec. 3, tp. 4, rge. 25, W 4th mer.

   Type of deposit — Post-glacial coarse alluvium.

   Maximum dimensions (yards) — 2,500 long by 1,000 wide by 5 thick.

   Estimated quantity — 1,300,000 cubic yards.

   Remarks — This gravel occurs in two main bodies, present in flood-plain deposits of St. Mary River. Only the southern body has been developed, and about 20,000 cubic yards of its roughly 800,000 cubic yards has been removed. It reaches a maximum thickness of 8 feet, with an average of about 4 feet, and contains medium to coarse gravel with scattered large boulders. Alluvial silt covers most of this body.

   The northern gravel body consists primarily of medium, well-rounded gravel with a few boulders and few soft and decomposed stones. This is very good gravel; it commonly reaches a thickness of 10 feet, and about 500,000 cubic yards are present. Much of the deposit is covered by a few feet of alluvial silt, but it is easy to develop and appears to be a better deposit than the northern one.

8. Location — SW, NW, and NE quarters, sec. 33, tp. 3, rge. 27, W 4th mer., on river flats on Reserve side of Belly River.

   Type of deposit — Post-glacial coarse alluvium.

   Maximum dimensions (yards) — 1,000 long by 500 wide by 3 thick.

   Estimated quantity — 1,000,000 cubic yards.

   Composition — Similar to deposit No. 11.

   Remarks — Most of the deposit is 1 yard to 2 yards thick. Otherwise it is similar to deposit No. 11.

9. Location — NW 1/4 sec. 2, NE 1/4 sec. 3, tp. 4, rge. 25, W 4th mer.

   Type of deposit — Post-glacial alluvium.

   Maximum dimensions (yards) — 800 long by 500 wide by 3 thick.

   Estimated quantity — 100,000 cubic yards.

Remarks — This gravel occurs in flood-plain deposits of St. Mary River, and is similar to the gravel described under deposit No. 7. A small amount of this gravel has been used.

10. Location — Two deposits, in E 1/2 sec. 10, tp. 4, rge. 25, W 4th mer., and NE 1/4 sec. 11, SE 1/4 sec. 14, tp. 4, rge. 25, W 4th mer., respectively.

Type of deposit — Post-glacial coarse alluvium.

Maximum dimensions (yards) — Southern deposit 800 long by 400 wide, thickness not known; northern deposit much smaller.

Estimated quantity — Southern deposit 50,000 cubic yards; northern deposit much less.

Remarks — This gravel occurs in flood-plain deposits of St. Mary River, and is similar to the gravel described under deposit No. 7.

11. Location — Secs. 27, 34, 35, 36, tp. 4, rge. 27, W 4th mer., and sec. 31, tp. 4, rge. 26, W 4th mer.

Type of deposit — Post-glacial coarse alluvium.

Maximum dimensions (yards) — 6,000 long by 600 wide by 4 thick.

Estimated quantity — 4,000,000 cubic yards.

Composition — 30 per cent argillite, 25 per cent limestone and dolomite, 15 per cent quartzite, 15 per cent hard sandstone, 5 per cent other stones from Rocky Mountains, 5 per cent stones from Precambrian Shield, 5 per cent stones from the local bedrock.

Remarks — This deposit stretches for 4 miles along the flats on the Reserve side of Belly River. Its average thickness is about 5 feet. Gravel is absent in many parts of the flats, and the thickest and best deposits are on the higher terraces. Most of the gravel is poorly sorted, with round to subround stones up to 24 inches long but mostly 1 inch to 4 inches long. It requires sorting and perhaps crushing for many uses, and because of its thinness is difficult to develop economically. A small amount of the gravel has been used.

12. Location — S 1/2 sec. 8, and N 1/2 sec. 5, tp. 5, rge. 23, W 4th mer.

Type of deposit — Post-glacial coarse alluvium.

Maximum dimensions (yards) — 700 long by 90 wide by 5 thick.

Estimated quantity — 100,000 cubic yards

Remarks — This deposit is found on a slip-off terrace on the north side of St. Mary River; it averages 10 feet thick. It has a wide range of composition, and includes stones from the Precambrian Shield. The lower part of the gravel is coarse, with boulders to 1 foot or more long, but the upper part is finer. Gravel from this deposit was used during construction of St. Mary River Dam.

13. Location — NW 1/4 sec. 4, tp. 5, rge. 26, W 4th mer.

Type of deposit — Post-glacial coarse alluvium.

Maximum dimensions (yards) — 400 long by 70 wide by 3 thick.

Estimated quantity — 20,000 cubic yards.

Remarks — The gravel underlies a river terrace, and although locally exposed is mostly covered by as much as 10 feet of silt and sand, and the gravel is patchy. It is sandy, poor-quality gravel with stones mostly 2 to 4 inches long. The deposit is not easy to develop and probably of little value.

14. Location — W 1/2 sec. 29, E 1/2 sec. 30, tp. 7, rge. 24, W 4th mer.

Type of deposit — Post-glacial coarse alluvium.

Maximum dimensions (yards) — 120 long by 70 wide by 3 thick.

Estimated quantity — 8,000 cubic yards.

Remarks — This gravel is fine to medium coarse in size; the stones are rounded and represent a wide variety of rock types, including types from the Precambrian Shield. The gravel is of good quality and is readily developed, as it is on the surface and close to roads.

15. Location — NW 1/4 sec. 12, tp. 7, rge. 22, W 4th mer.

Type of deposit — Post-glacial coarse alluvium.

Estimated quantity — 12,000 cubic yards.

Remarks — Similar deposits are present on other slip-off slopes on this section of St. Mary River. They are composed of a wide range of material, including stones from the Canadian Shield. It is moderately well sorted. Much of the gravel is of good quality, but most of the scattered deposits are too small to be developed economically.

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