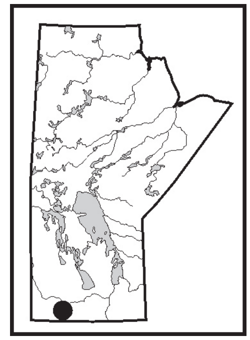
GS-21

Aggregate resources in the rural municipalities of Riverside and Turtle Mountain, southwestern Manitoba (NTS 62G3, 4, 5, 6 and 12)

by H.D. Groom



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Summary

The two rural municipalities of Riverside and Turtle Mountain cover 16 townships between Twp. 1 to 6 and Rge. 16 to 18, W 1st Mer. in southwestern Manitoba. Sand and gravel is found in glaciofluvial deposits across the area; shale, while abundant, forms a very minor component of aggregate consumption. Most of the gravel is privately owned and there is only one active crown pit in the area. There are ten active pits and one active quarry in the Rural Municipality (R.M.) of Turtle Mountain. Most are in shallow meltwater deposits on the east side of the municipality; three are in an alluvial fan deposit in the southwest corner. Shale is present in variable amounts in all deposits. The R.M. of Riverside has one large sand and gravel deposit. It is a terrace deposit within the Pembina spillway, in Twp. 6 to 18, W 1st Mer. The deposit, up to 10 m thick, contains sandy coarse pebble gravel, composed primarily of carbonate and Precambrian clasts with only minor shale. While both municipalities have enough aggregate reserves to meet their immediate needs, neither have abundant resources. Their municipal development plans should ensure that gravel deposits are protected from conflicting uses until they are depleted.

Introduction

This summer, aggregate mapping was carried out in the R.M. of Riverside and R.M. of Turtle Mountain. The R.M. of Riverside has not previously been mapped for aggregate. The R.M. of Turtle Mountain was previously mapped by Conley (1986) and a preliminary aggregate inventory carried out by Groom (2002). This year, work in the R.M. of Turtle Mountain concentrated on mapping deposits and revisiting pits to determine extraction activity. The information collected will be used for resource and land-use planning. Aggregate maps at a scale of 1:50 000 will be published.

Location

The two municipalities lie adjacent to each other, approximately two hundred kilometres southwest of Winnipeg. The R.M. of Turtle Mountain covers slightly less than ten townships, Twp. 1 to 3 in Rge. 16 to 18, W 1st Mer., part of Twp. 4, Rge.16, W 1st Mer. (abbreviated 4-16-W1) and one section in 4-15-W1. The R.M. of Riverside covers six townships, Twp. 4 to 6 in Rge. 17 and 18, W 1st Mer., as well as Section 6 and parts of sections 5 and 7 in 5-16-W1 The municipalities are located on NTS map sheets 62G3, 4, 5, 6 and 12. Provincial highways 3, 18 and 23, Provincial roads 346 and 341 and gravel section roads give good access to all parts of the area (Figure GS-21-1).

The town of Killarney is the major service centre in the R.M. of Turtle Mountain and Ninette is the largest centre in the R.M. of Riverside. Pelican Lake, Killarney Lake and the Souris River Bend Wildlife Management Area (WMA) are major recreational areas.

Agriculture is the major source of income in the municipality. As well as grain farms, there are livestock and mixed farms throughout the area.

The R.M. of Riverside contains three distinct physiographic areas: an end moraine, a glacial spillway and a till plain. A portion of the Darlingford end moraine occupies the northern part of the municipality. The moraine belt is approximately 6 to 8 km wide and the hills of the moraine reach 15 m in height in places. The moraine is cut by the Souris Gorge, a north-trending valley that is 45 m deep, 1 km wide and 6 km long. The south side of the moraine is bounded by the Pembina spillway. The spillway trends southeast. It is approximately 60 m deep and 1.5 km wide in the west part of the municipality and 40 m deep and over 2 km wide in the eastern area. The Souris River flows through the north part of the spillway to the Souris Gorge where it turns north at the 'elbow of capture' and then follows the regional northeast drainage slope to the Assiniboine River. East of the Souris Gorge, the flat, broad spillway floor is mostly dry except for Bone Lake and some marshy areas. The northern end of Pelican Lake occurs within the spillway at the eastern edge of the municipality. The Pembina spillway forms the northern edge of a till plain that is marked by ridges, 2 to 5 m high and trending northeast. The orientation is across the general drainage slope, resulting in many ponds and sloughs forming in the lows between the ridges. Immediately south of the spillway, the till plain has been modified by meltwater; Sun (1996) refers to this as a "scoured upland" and Conley (1986) refers to it as an outwash plain, although the only gravel occurrences associated with it are in small channels.

The ridged till plain continues into the R.M. of Turtle Mountain and forms the northern third of the municipality. A southeast-trending band of outwash separates this plain

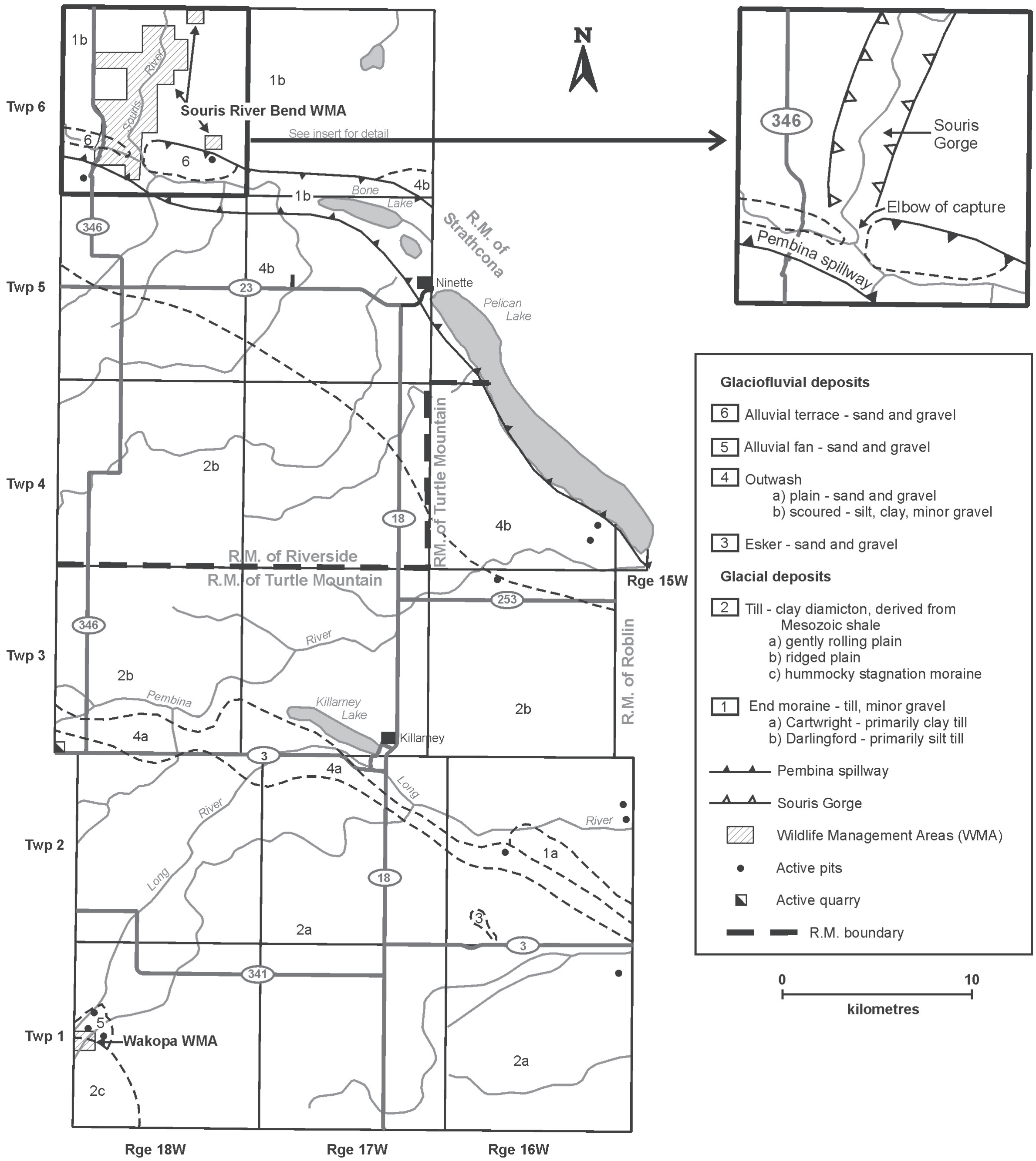

***Figure GS-21-1:** Surficial geology of the R.M. of Riverside and R.M. of Turtle Mountain (*after *Conley, 1986).*

from a till plain with a gently rolling surface that forms the southern part of the municipality. The northwestern edge of the Cartwright moraine (Conley, 1986) occurs in 2-16-W1. The moraine here is a 1 km wide belt of till hills up to 4 m high. In the southwestern corner of the municipality, Turtle Mountain rises to over 650 m above sea level. Several rivers and creeks flow off the mountain and across the plain. The Little Pembina and Pembina rivers flow northeast to the Pembina spillway. Long River flows northeast to Killarney and then turns south-east. Killarney Lake occupies an old water course that existed before present day drainage patterns were established.

Previous works

The bedrock geology was reported on by several authors (Wickenden, 1945; Bannatyne, 1970; Bamburak, 1978). Bedrock topography was delineated by Klassen et al. (1970) and Sie and Little (1976) included a drift thickness map in their groundwater study of the area. Klassen (1969) described the regional Quaternary geology of southwestern Manitoba. Elson (1956) described the Quaternary geology and history of the Tiger Hills area (approximately the lower two-thirds of NTS 62G). Conley (1981, 1986) described the stratigraphy and glacial history of the Killarney–Holmfield area and produced a map at a 1:50 000 scale. The R.M. of Riverside and R.M. of Turtle Mountain are included within these larger study areas. Sun (1996) discusses the history of glacial Lake Hind, which affected the surficial geology of the R.M. of Riverside.

Geology

Bedrock geology

The primary underlying bedrock strata for both municipalities is shale. Sandstone is a minor component in the southwest corner of the R.M. of Turtle Mountain. Except for this corner, the uppermost bedrock in the municipality is the Odanah Member of the Cretaceous Pierre Formation (Bannatyne, 1970; Bamburak, 1978; McNeil and Caldwell, 1981). This hard, siliceous shale is commonly found in the gravel deposits in the area. Overburden thicknesses range from 20 to >70 m in the municipality (Sie and Little, 1976). Bedrock outcrops are rare except along the Pembina spillway. Shale is very well exposed in cutbanks along the Souris River where it flows through the Souris Gorge.

On Turtle Mountain uplands, in the southwest part of the area, Tertiary sediments of the Turtle Mountain Formation overlie those of the Cretaceous Boissevain Formation. The Boissevain Formation is primarily a crossbedded sand and sandstone with minor amounts of silt and clay (Bamburak, 1978). The flooding from Turtle Mountain this summer created a very good exposure of the sandstone in a creek cut in NW-34-2-19-W1, just west of the R.M. of Turtle Mountain boundary. The Turtle Mountain Formation is not exposed in the municipality, but Bamburak (1978) described it as an assemblage of silts and clays which underlie the Pleistocene sediments on Turtle Mountain.

Quaternary geology

The quaternary geology and glacial history of the Killarney–Holmfield area is described in Conley (1986). The R.M. of Riverside and R.M. of Turtle Mountain form a small part of this area (Figure GS-21-2) and the following description of Late Wisconsinan events in the municipalities is taken from that work. The last major ice flow to affect the area came from the northwest depositing the shale-derived clayey till that forms the plain in the south and the washboard plain in the north below the Pembina spillway. During deglaciation, ice stagnated on Turtle Mountain and, on the southern plain, ice retreated north to the approximate position of the town of Killarney. Much of the sand and gravel in the R.M. of Turtle Mountain was deposited by meltwater finding its way to lower elevations between these two ice masses. Several rivers and creeks carried meltwater from the stagnating ice on the mountain, depositing gravel as alluvial fans at the break in slope and as channel or overflow deposits at intermittent locations along the courses of the rivers and creeks. Most of the aggregate was deposited in channels that were active for short periods before deeper channels became established.

A minor readvance deposited the Cartwright moraine and most of the outwash south of Killarney was deposited when the ice stood at this position. Further ice retreat caused the abandonment of the Long River channel northwest of Killarney and allowed the Pembina River to flow to the Pembina spillway at the northeastern edge of the municipality, and for Long River and the creeks south of it to assume their present day courses.

The Darlingford moraine marks the end position of a major readvance of the Red River lobe in the Manitoba Lowlands. This ice moved into the R.M. of Riverside as far as the Pembina spillway, depositing a carbonate-rich till. A ditch section in SW-23-6-17-W1 shows a typical carbonate till from the lowlands but with large shale cobbles incorporated into it.

The history of the Pembina spillway is complex. Sun (1996, p. 151) states "This spillway began as an ice-marginal channel and was enlarged, in steps, by multiple floods." However, despite its ice-marginal position along the south side of the Late Wisconsinan Darlingford moraine, parts of the valley may be

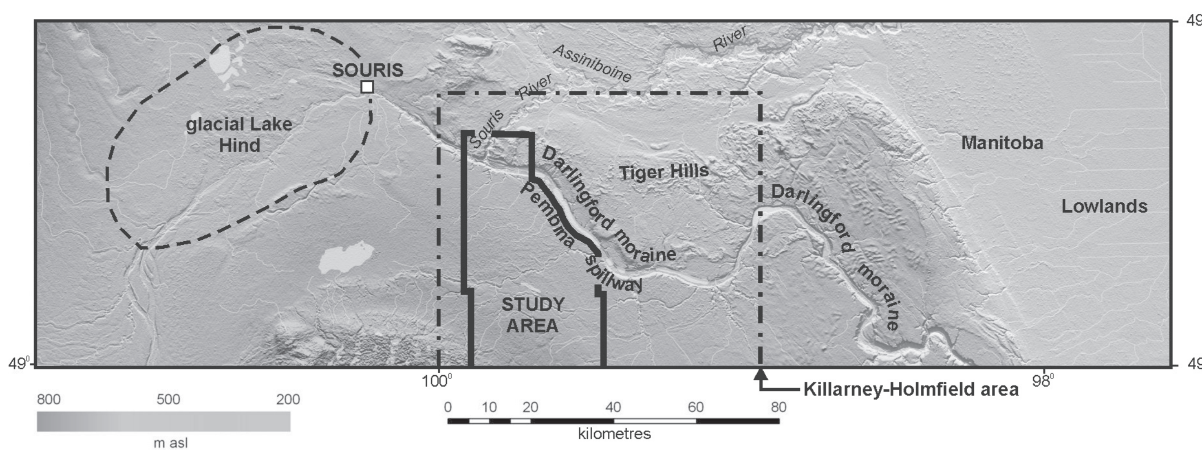

Figure GS-21-2: *Regional setting of the R.M. of Riverside and R.M. of Turtle Mountain.*

pre-Wisconsinan or older in age and re-excavated by the meltwater flows of the last deglaciation. Elson (1956) refers to the presence of till on the spillway floor to conclude that at least the lower portions of the spillway pre-dated the last glaciation. He felt the upper reaches, from the town of Souris to the Souris Gorge, were formed as an ice margin channel during the last deglaciation (Elson, 1956, p. 229). However, an exposure (NE-2-6-18-W1) of the pre-Wisconsinan Shell till within this portion of the spillway led Conley (1986, p. 27) to state valley formation had to pre-date the deposition of this till.

This idea of a pre-existing valley is supported by the presence of clasts of the 'Souris gravel and sand' at the surface of a terrace deposit in SE-8-6-18-W1 in the Souris River Bend WMA. This stratigraphic unit, informally named by Klassen (1969), contains a high percentage of western provenance clasts mixed with glacial gravels of common rock types; it is very distinctive due to the presence of petrified wood, agates, rounded quartzites and jaspers.

The Souris gravel and sand is believed to be early Pleistocene and resulted when western provenance gravels, deposited by Tertiary streams, were mixed with glacial gravels (primarily granite and carbonate clasts) and "probably deposited by interglacial streams that occupied preglacial valleys after the first Quaternary glaciation" (Klassen, 1969, p. 8). The type section is found in a gravel pit in the SE and NE quarter sections of 34-7-21-W1 near the town of Souris, outside the study area. The contact between the gravel and the underlying shale bedrock is now exposed in the pit. The gravel at this location is exposed at the surface and is overlain by alluvium of the present day Souris River. In most other instances, deposits of Souris gravel and sand are only encountered in boreholes. The gravels in the Souris River Bend terrace may be in situ, as they are at approximately the same elevation as the Souris pit, but alternatively, they may have been eroded from the Souris deposit and redeposited downstream by meltwater during the last deglaciation.

Whatever its early genesis, during the last deglaciation, the Pembina spillway carried meltwater from glacial lakes in western Manitoba and southern Saskatchewan to glacial Lake Agassiz in the east (Elson, 1956). It was the major outlet for glacial Lake Hind (Sun, 1996). The final configuration of the spillway is the result of a series of floods as these lakes drained (Kehew and Clayton, 1983; Kehew and Lord, 1986; Sun, 1996). These floods eroded most of any pre-existing deposits along the stretch of the spillway within the present study area.

Aggregate resources

Aggregate inventory methodology

The aggregate inventory was carried out in two stages: office compilation followed by fieldwork. Previously mapped deposits were transferred onto 1:20 000-scale township photomosaics (1995 orthophotos). The township mosaics were used as a base on which to compile aggregate information from several sources:

1) active pit locations – Mines Branch quarry database
2) quarry lease and withdrawn locations – Mines Branch plat books
3) Crown vs. private ownership – Manitoba Crown Lands Branch database
4) pit and sample locations – Geological Survey Pleistocene database
5) pit and sample locations – Department of Highways block files.

Gravel pits, road cuts and natural exposures were examined during the first part of the field season. Pits were examined for the type of material, degree of depletion and active/inactive/depleted status. Unopened portions of deposits were inspected and land uses that would limit aggregate extraction noted. Site locations were taken by GPS using UTM coordinates, as well as by section-township-range notation.

Aggregate samples were processed in two stages. In the field, samples that weighed between 75 and 100 kg were passed through 6 in. (15.2 cm), 3 in. (7.5 cm), 1½ in. (3.8 cm) and ¾ in. (1.9 cm) screens. The weights of the 3 in., 1½ in., ¾ in. and <¾ in. fractions were recorded and the relative abundance of the >6 in. material, as well as deleterious material such as shale or concretions, was noted. Pebble counts on the 1½ in. to 3 in. fraction were done in the field. A representative sample of the <¾ in. fraction was taken for processing by the Material and Research Branch of the Department of Transportation and Government Services (Highways) under a cooperative agreement initiated in 1998.

Aggregate deposits

R.M. of Riverside

There are only three active pits in the municipality and all are associated with the Pembina spillway.

The largest pit in the municipality is in a terrace deposit along the north wall of the spillway, immediately east of the Souris Gorge. The pit, in SE-11-6-18-W1, has been active for a minimum of twenty-five years. The material in the pit is coarse pebble gravel, with minor shale. The gravel contains a higher percentage of carbonate clasts than other deposits in the area. The currently active parts of the pit are 2 to 4 m deep, although Conley (1986) reported a 10 m depth in the then active part of the deposit and Highways testing in 1980 estimated the deposit depth to be greater than 8 m. The deposit extends into sections 1 and 2 of 6-18-W1 but has been largely depleted in these areas.

There is a small active pit in SE-2-6-18-W1, also within the spillway. The pit exposes approximately 2 m of very fine sand.

In 2004, there was a report of gravel being removed in NE-6-6-18-W1. Examinations this year found a pit in the section but it appears to be depleted and rehabilitated. It is possible that there may be another pit in the section that was not seen.

There is a large terrace deposit in 8-6-18-W1. The majority of the deposit is in the Souris River Bend WMA. The terrace was mined for traffic gravel in 1972. The pit at that time was 4 m deep and contained coarse gravel. There is no record of the lithology of the gravel. There has not been any excavation since 1972. A request to backhoe test the deposit in 1996 was refused by the Wildlife Branch due to the presence of unbroken, mixed grass prairie. The mineral rights were withdrawn in 2000 to preserve the natural area. Possible indicators of the subsurface material were found when heavy rains this summer eroded ruts in an old trail as it sloped down from one terrace level to another. Petrified wood, agates and jaspers, typical of the Souris gravel and sand, were present on the surface. However no holes were dug to determine the extent of the material.

Shale is commonly exposed along the spillway walls and there are some old extraction sites (e.g., SW-24-5-17-W1, NW-5-6-18-W1) but none have been in use recently.

R.M. of Turtle Mountain

Glaciofluvial deposits are the primary source of aggregate production in the municipality. Bedrock is rarely utilized.

There is one small bedrock quarry located on the side of a meltwater channel in SW-6-3-18-W1. The rock is shale from the Odanah Member and has been fractured and faulted by glacial action. The pit is small and about 2.5 m deep. There are only minor amounts of shale being removed.

One esker deposit was active in 2002. The ridge height varies up to 3.5 m. The pit in NE-6-2-16-W1 is about 2.5 m deep and in some places till has been encountered in the pit floor. Shale content is moderate and there is a good amount of crushable material in the 5 to 8 cm range. The pit has not been used recently and is beginning to revegetate.

There is one alluvial fan deposit which is currently being mined. A portion of the deposit was backhoe tested in 1996. The testholes showed that the gravel was deposited over an undulating till surface. The gravel is 0.5 to 2.5 m thick and overlies clay or till. The pits in the rest of the deposit are generally up to 2.5 m deep. Shale content is low to moderate and clasts range up to cobble size (20 cm). There are three active gravel pits in the deposit. The pit in the SE and SW quarter sections of 19-1-18-W1 is owned and operated by the R.M. of Turtle Mountain. It has greatly expanded since 2002. The pit in NE-19-1-18-W1 is also still active. The pit in NE-18-1-18-W1 is under quarry lease and was mined last year. The pit in Wakopa WMA in NW-18-1-18-W1 has been rehabilitated and returned to its natural wildlife habitat. The mineral rights in the WMA have been withdrawn to prevent future aggregate removal as part of the Area of Special Interest program.

The other pits in the municipality occur in outwash sediments. While these sediments are found along most of the creeks and along some of the old watercourses, most of the gravel extraction has been from the deposits adjacent to the Pembina and Long rivers. There are numerous old pits and several active pits along the length of these channels. The pits range from 1.5 to >4 m deep, are usually till floored, and contain variable amounts of shale and ironstone concretions. The material is generally sandy pebble gravel. Unlike other areas of the province, where outwash deposits often contain a large coarse fraction, cobble- and boulder-size material is a minor component of the deposits. However, most of the deposits contain enough of the 4 to 8 cm fraction to provide adequate material for crushing.

In 2005, there were seven active pits in outwash deposits, most of which were in small deposits along the east side of the municipality. The gravel is privately owned in all of the pits. Due to the high amount of rainfall this year, many of the pits were flooded.

The pit in NW-25-1-16-W1 is about 1.5 m deep and the material is very sandy fine pebble gravel with a moderate amount of shale. The pit was flooded this year, so true depths aren't known. The R.M. of Roblin, as well as private companies, has extracted gravel from here. The R.M. of Roblin is located immediately adjacent to this locality in 1-15-W1.

The pit in SE-20-2-16-W1 is very active and used by several operators. The gravel was deposited on an undulating till surface and pit depth varies up to 4 m. In some areas, the till floor is exposed and there are many boulders on the site.

The two pits in NE-24-2-16-W1 are both shallow (approximately 1 to 1.5 m deep) but water on the pit floor may have concealed the true depth. The gravel is very fine and sandy with a fair amount of shale and ironstone concretions. The material is being used to make traffic gravel and there are very large, new stockpiles on site. The R.M. of Roblin, as well as other operators, is extracting gravel from this deposit.

The small pit in NW-33-3-16-W1 was being dewatered during the 2005 visit. The pit is active; it is very shallow with about 1 to 1.5 m of gravel over a till base. The R.M. of Turtle Mountain extracts material from this pit.

There are two large, active pits in 12-4-16-W1. The pit in the southwest quarter is active at the west end where it is about 2.5 to 3 m deep and contains sandy pebble gravel. There are large stockpiles of traffic gravel on site. Both the R.M. of Turtle Mountain and R.M. of Strathcona remove aggregate from this site. A pit in the northwest quarter is more than 4 m deep and is primarily sandy coarse pebble gravel. The R.M. of Strathcona also removes gravel from here.

Economic considerations

Aggregate is a high bulk, low value commodity so the haulage cost is often an important factor in the final aggregate cost of a project. As a rule of thumb, the average haulage rate is $0.07/t/km. In general, the value of aggregate reserves in any specific area depends on the abundance of the resources and on the demand. Due to the haulage factor, the fewer the resources or the greater the demand, the more important it is to protect those resources from activities that would prevent them being utilized. The haulage factor is the reason the R.M. of Strathcona and R.M. of Roblin, to the east of the study area, are producing some of their traffic gravel from pits in the R.M. of Turtle Mountain.

The R.M. of Riverside has only one major deposit. It is large and of good quality but it has been in use for many years. While not near depletion, it is a finite reserve. It is essential to protect the deposit from conflicting land uses. The R.M. of Turtle Mountain, in comparison, has more sources of aggregate but many of the remaining ones are thin and do not contain a large volume of material. These too should be protected until the resources have been depleted.

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