5.2.3 Upper Sand and Gravel Aquifer

The Upper Sand and Gravel Aquifer includes saturated sand and gravel deposits in the upper surficial deposits. These aquifers typically occur above an elevation of 580 metres AMSL. Saturated sand and gravel deposits are not continuous but are expected over approximately 80% of the County.

5.2.3.1 Aquifer Thickness

The thickness of the Upper Sand and Gravel Aquifer is in part a function of the elevation of the non-pumping water-level surface associated with the upper surficial deposits and in part a result of the depth to the bedrock surface. Since the non-pumping water-level surface in the surficial deposits tends to be a subdued replica of the bedrock surface, the thickness of the Upper Sand and Gravel Aquifer tends to be directly proportional to the thickness of the surficial deposits.

While the sand and gravel deposits in the upper surficial deposits are not continuous, the Upper Sand and Gravel Aquifer includes all of the aquifers present in the upper surficial deposits. The Upper Sand and Gravel Aquifer can be up to 20 metres thick in a few areas, but over the majority of the County, is less than ten metres thick; over 20% of the County, the Aquifer is absent. Most of the greater thickness in the Upper Sand and Gravel Aquifer occurs in the areas of linear bedrock lows.

5.2.3.2 Apparent Yield

The permeability of the Upper Sand and Gravel Aquifer can be high. The high permeability combined with significant thickness leads to an extrapolation of water wells with high yields. However, because the sand and gravel deposits can occur as hydraulically discontinuous pockets, the long-term yields of the water wells are usually less than 100 m³/day. One exception would be the water well completed in 23-055-11 W4M in the Rannach Pasture. The aquifer test conducted with the water well indicated a long-term yield of 600 m³/day (Hydrogeological Consultants Ltd., January 1996). Where the Upper Sand and Gravel Aquifer is absent and where the yields are low, the development of water wells for the domestic needs of single families may not be possible.

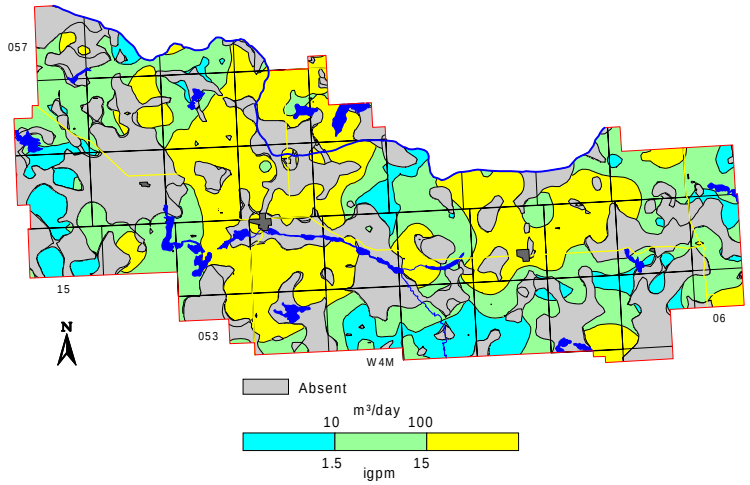

Figure 14. Apparent Yield for Water Wells Completed through Upper Sand and Gravel Aquifer

5.2.4 Lower Sand and Gravel Aquifer

The Lower Sand and Gravel Aquifer is a saturated sand and gravel deposit that occurs at or near the base of the surficial deposits in the deepest part of the pre-glacial linear bedrock lows. The Lower Sand and Gravel Aquifer is not continuous in the Buried Vegreville Valley and the thickness is mostly less than five metres. The Lower Sand and Gravel Aquifer is mainly restricted to parts of the Buried Vegreville and Elk Point valleys. Sand and gravel deposits occur overlying the bedrock surface in the Vermilion Channel below an elevation that coincides with the top of the lower surficial deposits. It is possible that the Vermilion Channel is occupying a pre-glacial valley and that the sand and gravel deposits are of pre-glacial origin. The sand and gravel deposits overlying the bedrock surface within the Vermilion Channel are not identified as lower sand and gravel deposits on the adjacent map.

5.2.4.1 Apparent Yield

Water wells completed in the Lower Sand and Gravel Aquifer are expected to have yields between 10 and 100 m³/day but may have yields in excess of 100 m³/day. The highest yields are expected in the Buried Vegreville and Elk Point valleys.

The Town of Two Hills has completed at least some of its water supply wells in the Lower Sand and Gravel Aquifer associated with the Buried Vegreville Valley. The projected long-term yield from one of the Town of Two Hills water supply wells is in excess of 2,500 m³/day (Geoscience Consulting Ltd., 1980).

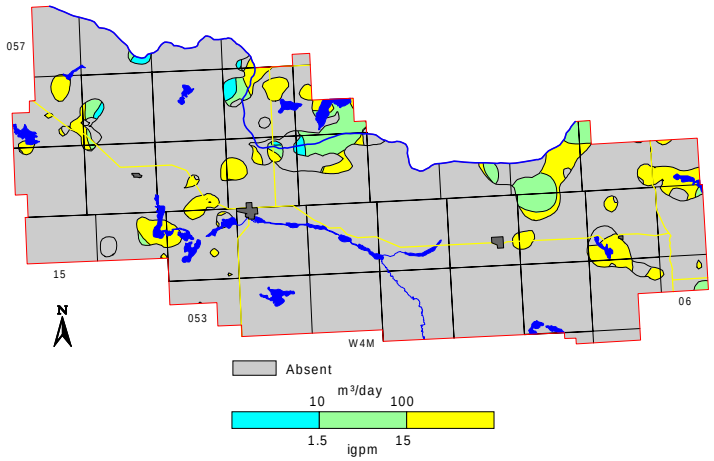

Figure 15. Apparent Yield for Water Wells Completed through Lower Sand and Gravel Aquifer

The Lower Sand and Gravel Aquifer was encountered by a water test hole drilled for Highland Feeders. An extensive aquifer test with the water test hole showed that the short-term yield from the water test hole would be in the order of 250 m³/day. However, the Lower Sand and Gravel Aquifer at this location is of limited areal extent and the projected long-term yield from the water test hole is 35 m³/day (Hydrogeological Consultants Ltd., 1998 [in progress]).

Extensive aquifer testing has been conducted with water test holes drilled for Alberta Agri-Ethanol Co. Ltd. east of the Town of Two Hills. Fifteen of sixteen water test holes encountered sand and gravel deposits that are associated with a linear bedrock low that is referred to as the Vermilion Channel. At this time, it is not known if these are Lower Sand and Gravel deposits that were reworked by meltwater processes or are meltwater deposits associated with the upper surficial deposits. Extensive aquifer tests with water test holes completed in the sand and gravel aquifer indicated a long-term supply of approximately 500 m³/day (Hydrogeological Consultants Ltd., 1996 [in progress]).

5.3 Bedrock

5.3.1 Geological Characteristics

The upper bedrock in the County includes parts of the Belly River Group. The Lea Park Formation underlies the Belly River Group.

The Belly River Group in the County has a maximum thickness of 150 metres, and includes parts of the Oldman Formation and both the *continental* and *marine* facies of the Foremost Formation.

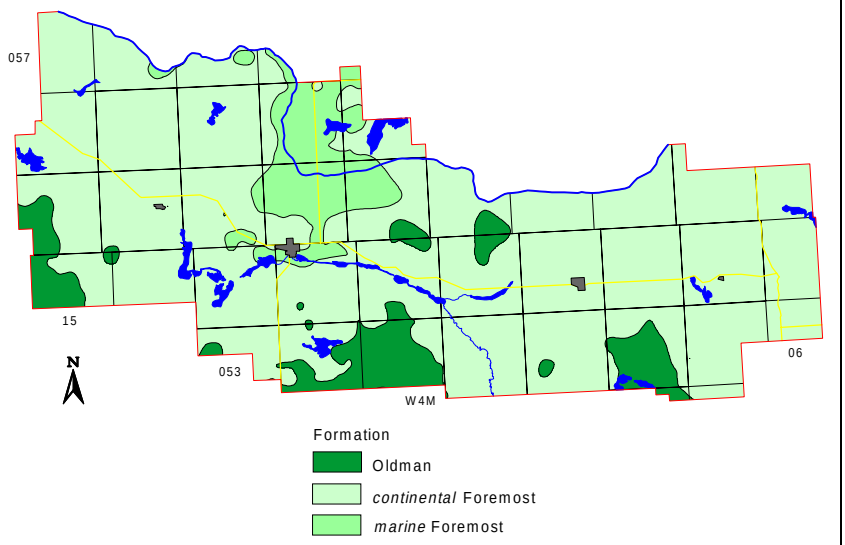

Figure 16. Bedrock Geology

The uppermost part of the Belly River Group is the Oldman Formation. Within the County only the lower part of the Oldman Formation is present and it forms the upper bedrock in a few areas in the southern part of the County. The Oldman Formation within the County has a maximum thickness of 30 metres and is composed of sandstone, siltstone, shale, and coal deposits of the Comrey and Upper Siltstone members.

The *continental* Foremost Formation underlies the Oldman Formation and subcrops under the surficial deposits in the majority of the County; it has a maximum thickness of 140 metres within the County. The *continental* Foremost Formation, a backshore deposit, consists mainly of shale deposits with minor amounts of sandstone present. Coal zones occur within the *continental* Foremost Formation, with the main ones referred to as the McKay and the Taber coal zones. There are also minor amounts of ironstone, a chemical deposit, in the *continental* Foremost Formation. Where the *continental* Foremost Formation is close to the bedrock surface, it can be fractured or weathered and can have significant local permeability.

The *marine* Foremost Formation has a maximum thickness of 80 metres within the County and underlies the *continental* Foremost Formation in the western half of the County. The *marine* Foremost Formation subcrops as the upper bedrock in the north-central part of the County, mainly in townships 055 and 056, ranges 11 and 12, W4M.

In parts of eastern Alberta the *marine* Foremost Formation can be separated into individual sandstone and shale members. However, close to the upper part of the *marine* Foremost Formation, and particularly toward the western extent, the sandstones making up the *marine* Foremost Formation cannot always be separated into individual members. This situation occurs because the sandstone members of the *marine* Foremost Formation thicken and the intervening shale layers thin toward the top and the

western extent of the marine facies. Even though the individual members cannot be distinguished, the sandstone occurrence can be a significant aquifer and has been designated the “Milan Aquifer”. The top of the Milan Aquifer extends up to ten metres into the overlying *continental* Foremost Formation and can occupy the upper 40 metres of the *marine* Foremost Formation. The westward extent of the Milan Aquifer coincides with the position where the Basal Belly River Sand can be distinguished. The Milan Aquifer is present in the western half of the County under the *continental* Foremost Formation but does not subcrop anywhere in the County.

In the County of Two Hills, the Milan Aquifer occupies almost the entire *marine* Foremost facies. The Ribstone Creek and Victoria members have been shown on the cross-sections (Figures 7 and 8) and maps have been prepared for the two members. The maps are presented on the CD-ROM. Also, there is a discussion for the Ribstone Creek and Victoria members. However, the main discussion for these members in this report is included in the section for the Milan Aquifer. In the query, the Ribstone Creek and Victoria members are only identified when outside the area of the Milan Aquifer.

The Lea Park Formation is mostly composed of shale, with only minor amounts of bentonitic sandstone present in some areas. Regionally, the Lea Park Formation is an aquitard.

5.3.2 Aquifers

Of the 3,629 water wells in the database, 692 were defined as being completed in bedrock aquifers. This designation is based on the top of the completion interval being below the bedrock surface. The completion depth is available for the majority of water wells. In order to make use of additional information within the groundwater database, it was statistically determined that water wells typically have completion intervals equivalent to one quarter of their completed depth. This relationship was used to increase the number of water wells identified as completed in bedrock aquifers to 1,812 from 692. With the use of geological surfaces that were determined from the interpretation of geophysical logs, it has been possible to assign the water wells completed in bedrock aquifers to specific aquifers based on their completion intervals. Of the 1,812 bedrock water wells, 1,674 could be assigned a specific aquifer. The bedrock water wells are mainly completed in the *continental* Foremost Aquifer, as shown in the table above. The total of 50 given for the number of water wells completed in the *marine* Foremost Aquifer does not include water wells completed in the individual members of the *marine* Foremost Aquifer; however, the 50 water wells do include water wells completed through more than one member. The discussions related to specific aquifers, later in this report, do not include the *marine* Foremost Aquifer or the Lea Park Aquitard due to the paucity of data available for these geological units in the County. However, maps associated with these geological units are included on the CD-ROM.

Bedrock Aquifer	No. of Water Wells
Oldman	40
continental Foremost	1217
Milan	212
marine Foremost	50
Ribstone Creek Member	55
Victoria Member	76
Lea Park	24

Table 3. Completion Aquifer

There are 338 records for bedrock water wells that have apparent yield values. In the County, water well yields can be expected to be mainly less than 100 m³/day. The areas of higher yields that are indicated on the adjacent figure are mainly in the central part of the County. These higher yields may be a result of increased permeability that has resulted from the weathering process in association with the Buried Vegreville and Elk Point valleys.

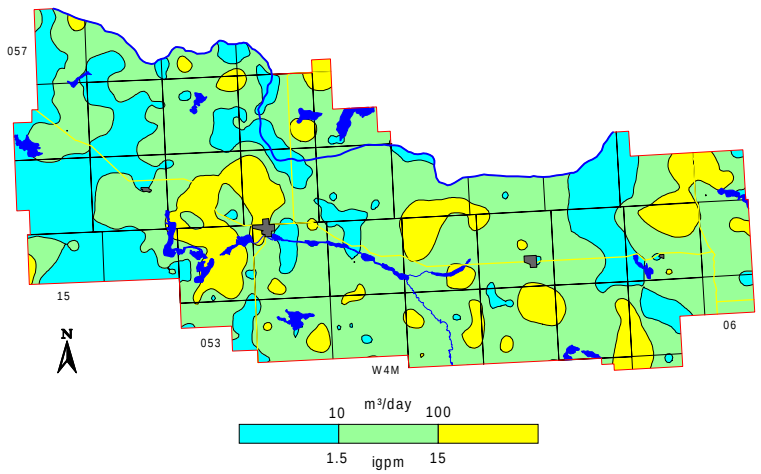

Figure 17. Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)

There are 335 apparent yield values that can be assigned to a specific bedrock aquifer. The majority of the water wells completed in the bedrock aquifers have apparent yields that range from 10 to 100 m³/day, as shown in the table below.

Aquifer	No. of Water Wells with Apparent Yields	Number of Water Wells with Apparent Yields <10 m³/day	10 to 100 m³/day	>100 m³/day
Oldman	4	2	1	1
continental Foremost	268	67	133	68
Milan	11	4	4	3
marine Foremost	1	0	0	1
Ribstone	18	9	7	2
Victoria	33	9	20	4
Totals	335	91	165	79

Table 4. Apparent Yields of Bedrock Aquifers

5.3.3 Chemical Quality of Groundwater

The TDS concentrations in the groundwaters from the upper bedrock aquifer(s) range from less than 500 to more than 2,000 mg/L. In more than 60% of the area, TDS values are less than 1,000 mg/L, with a few areas having TDS concentrations of less than 500 mg/L. The higher values are expected in the western 20% of the County, as can be seen on the adjacent figure.

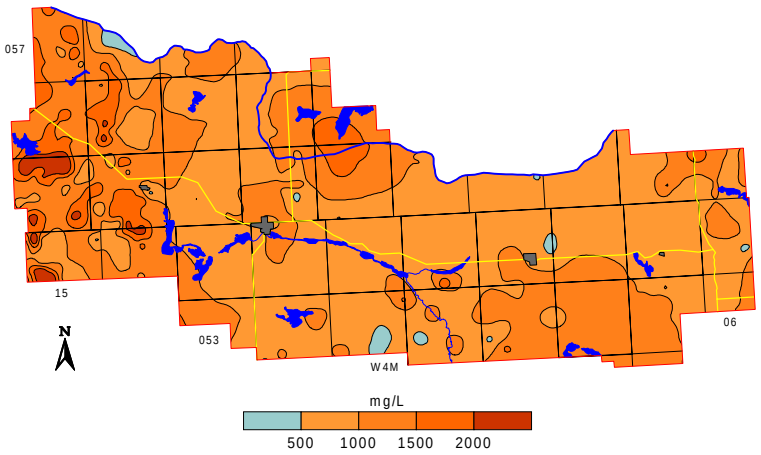

Figure 18. Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)

The relationship between TDS and sulfate concentrations shows that when TDS values in the upper bedrock aquifer(s) exceed 1,200 mg/L, the sulfate concentration exceeds 400 mg/L. The majority of the sulfate concentrations are less than 500 mg/L. The higher values are expected mainly in the central and western parts of the County. The chloride concentration in groundwater from the upper bedrock aquifer(s) is less than 100 mg/L in 20% of the County.

In 95% of the County, the fluoride ion concentration in the groundwater from the upper bedrock aquifer(s) is less than 1.0 mg/L.

The Piper tri-linear diagram (see Appendix A and CD-ROM) shows that all chemical types of groundwater occur in the upper bedrock aquifer(s). However, the majority of the groundwaters are sodium-bicarbonate types.

5.3.4 Oldman Aquifer

The Oldman Aquifer comprises the porous and permeable parts of the Oldman Formation and underlies less than 200 square kilometres, mainly in the southern part of the County. The thickness of the Oldman Aquifer in the County is mainly less than 30 metres.

5.3.4.1 Depth to Top

The depth to the top of the Oldman Formation is mainly between 10 and 30 metres except in the southern part of the County, where it can be greater than 30 metres.

5.3.4.2 Apparent Yield

The apparent yields for individual water wells completed in the Oldman Aquifer are mainly less than 100 m³/day. The adjacent map includes four values within the County. Three of the four values are less than 20 m³/day and the fourth value is more than 350 m³/day.

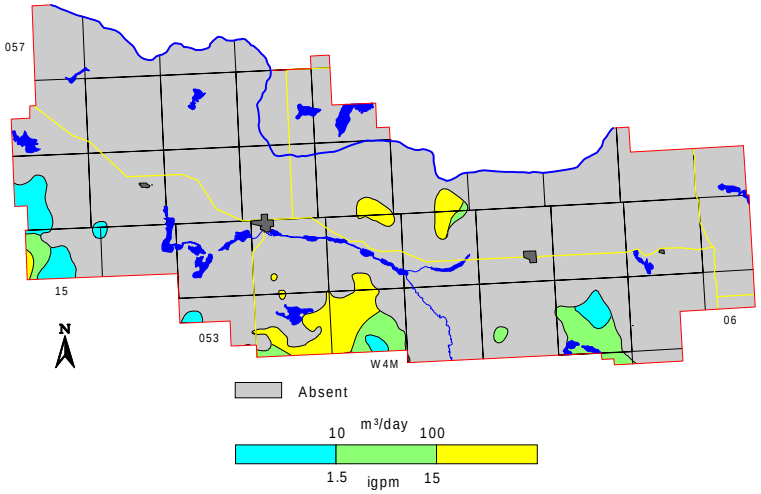

Figure 19. Apparent Yield for Water Wells Completed through Oldman Aquifer

5.3.4.3 Quality

There are seven water well records in the database with sufficient information to determine the chemical type of groundwaters from the Oldman Aquifer. The groundwaters are mainly a sodium-sulfate type. TDS concentrations are expected to be mainly less than 1,000 mg/L. The sulfate concentrations are mainly less than 500 mg/L except in the western part of the County where the sulfate concentrations are expected to exceed 500 mg/L. Chloride concentrations in the groundwater from the Oldman Aquifer are mainly between 10 and 100 mg/L.