4.4 Maps and Cross-Sections

Once grids for geological surfaces have been prepared, various grids need to be combined to establish the extent and thickness of individual geological units. For example, the relationship between an upper bedrock unit and the bedrock surface must be determined. This process provides both the aquifer outline and the aquifer thickness. The aquifer thickness is used to determine the aquifer transmissivity by multiplying the hydraulic conductivity by the thickness.

Grids must also be combined to allow the calculation of projected long-term yields for individual water wells. The grids related to the elevation of the NPWL and the elevation of the top of the aquifer are combined to determine the available drawdown[7]. The available drawdown data and the transmissivity values are used to calculate values for projected long-term yields for individual water wells, completed in a specific aquifer.

Once the appropriate grids are available, the maps are prepared by contouring the grids. The areal extent of individual parameters is outlined by masks to delineate individual aquifers. Appendix A includes page-size maps from the text, plus additional page-size maps and figures that support the discussion in the text. A list of maps and figures that are included on the CD-ROM is given in Appendix B.

Cross-sections are prepared by first choosing control points from the database along preferred lines of section. Data from these control points are then obtained from the database and placed in an AutoCAD drawing with an appropriate vertical exaggeration. The data placed in the AutoCAD drawing include the geo-referenced lithology, completion intervals and NPWLs. Data from individual geological units are then transferred from the digitally prepared surfaces to the cross-section.

Once the technical details of a cross-section are correct, the drawing file is moved to the software package CorelDRAW! for simplification and presentation in a hard-copy form. These cross-sections are presented in this report and in Appendix A, are included on the CD-ROM, and are in Appendix D in a page-size format.

4.5 Software

The files on the CD-ROM have been generated from the following software:

- Microsoft Professional Office 97
- Surfer 6.04
- ArcView 3.1
- AutoCAD 14.01
- CorelDRAW! 8.0
- Acrobat 3.0

[7] See glossary

5 AQUIFERS

5.1 Background

An aquifer is a porous and permeable rock that is saturated. If the NPWL is above the top of the rock unit, this type of aquifer is an artesian aquifer. If the rock unit is not entirely saturated and the water level is below the top of the unit, this type of aquifer is a water-table aquifer. These types of aquifers occur in one of two general geological settings in the County. The first geological setting is the sediments that overlie the bedrock surface. In this report, these are referred to as the surficial deposits. The second geological setting includes aquifers in the upper bedrock. The geological settings, the nature of the deposits making up the aquifers within each setting, the expected yield of water wells completed in different aquifers, and the general chemical quality of the groundwater associated with each setting are reviewed separately.

5.1.1 Surficial Aquifers

Surficial deposits in the County are mainly less than 40 metres thick, except in areas of linear bedrock lows where the thickness of surficial deposits can exceed 60 metres. The Buried Vegreville and Elk Point valleys are the two main linear bedrock lows in the County. The Buried Vegreville Valley is present in the western third of the County and trends generally from southwest to northeast. The Buried Elk Point Valley is present in the eastern third of the County and also trends from southwest to northeast. Cross-section A-A' passes across both the Buried Vegreville and Elk Point valleys, and shows the thickness of the surficial deposits as being mainly from 40 to 60 metres.

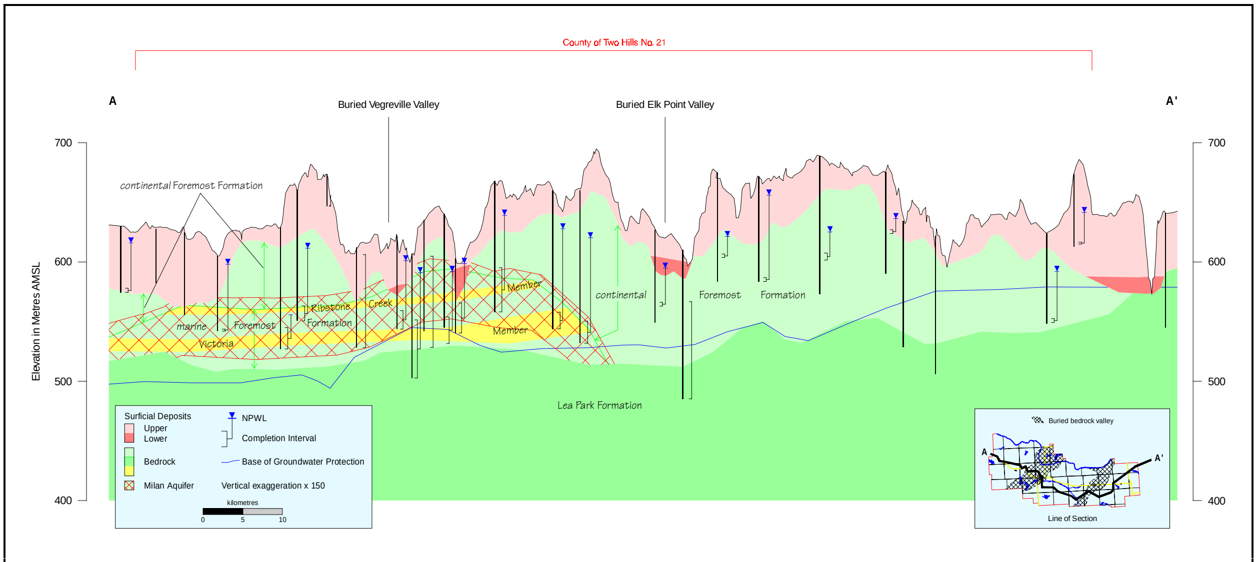

Figure 7. Cross-Section A - A'

The main aquifers in the surficial materials are sand and gravel deposits. In order for a sand and gravel deposit to be an aquifer, it must be saturated; if not saturated, a sand and gravel deposit is not an aquifer. The top of the surficial aquifers has been determined from the NPWL in water wells less than 15 metres deep. The base of the surficial aquifers is the bedrock surface.

For a water well with a small-diameter casing to be effective in surficial deposits and to provide sand-free groundwater, the water well must be completed with a water well screen. Some of the water wells completed in the surficial deposits are completed in low-permeability aquifers and have a large-diameter casing. The large-diameter water wells may have been hand dug or bored and because they are completed in very low permeability aquifers, most of these water wells would not benefit from water well screens. The groundwater from an aquifer in the surficial deposits usually has a chemical hardness of at least a few hundred mg/L and a dissolved iron concentration such that the groundwater must be treated before being used for domestic needs. Within the County, 52% of the water wells completed in the surficial deposits have a casing diameter of greater than 330 millimetres or no reported diameter for the surface casing, and are assumed to be dug or bored water wells.

5.1.2 Bedrock Aquifers

The upper bedrock includes rocks that are less than 200 metres below the bedrock surface. Some of this bedrock contains porous, permeable and saturated rocks that have a structure that is permeable enough for the rock to be an aquifer. Water wells completed in bedrock aquifers usually do not require water well screens, though some of the sandstones are friable[8] and water well screens are a necessity. The groundwater from the bedrock aquifers is usually chemically soft. The data for 692 water wells show that the top of the water well completion interval is below the bedrock surface, indicating that the water wells are completed in at least one bedrock aquifer. Of these 692 water wells, more than 90% have surface casing diameters of less than 220 mm and 25% of these bedrock water wells have been completed with water well screens.

The upper bedrock includes parts of the Belly River Group. The Lea Park Formation underlies the Belly River Group as shown in Figure 8. The Belly River Group has a maximum thickness of 250 metres and includes parts of the Oldman Formation and both the *continental* and *marine* facies[9] of the Foremost Formation. The *marine* Foremost Formation is divided into shale and sandstone members. In the County, the sandstone units include the Ribstone Creek, Victoria and Brosseau members. The upper part of the *marine* Foremost Formation is included in the Milan Aquifer. In the County, the Lea Park Formation is a regional aquitard[10].

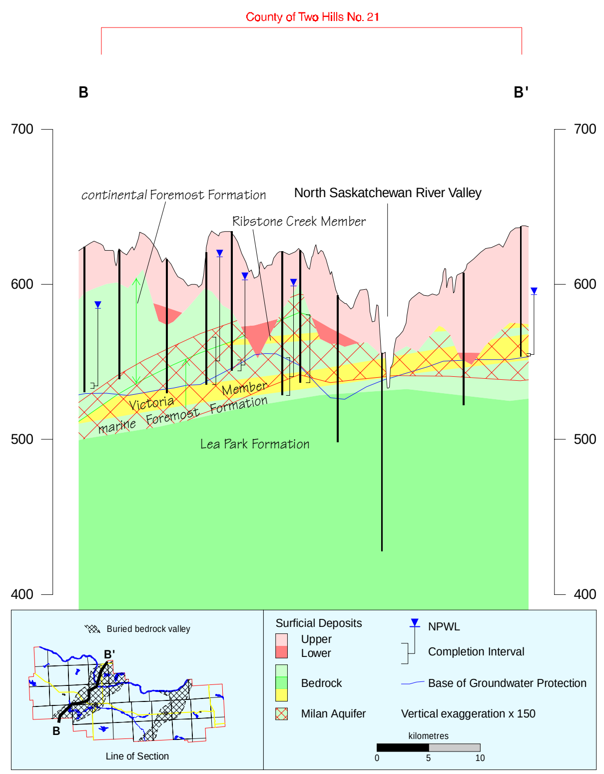

Figure 8. Cross-Section B - B'

8 See glossary
9 See glossary
10 See glossary

5.2 Aquifers in Surficial Deposits

The surficial deposits are the sediments above the bedrock surface. This includes pre-glacial materials, which were deposited before glaciation, and materials deposited directly or indirectly by glaciation. The lower surficial deposits include pre-glacial fluvial[11] and lacustrine[12] deposits. The lacustrine deposits include clay, silt and fine-grained sand. The upper surficial deposits include the more traditional glacial deposits of till and meltwater deposits. In the County, pre-glacial material would be expected to be mainly present in association with the Buried Vegreville and Elk Point valleys.

5.2.1 Geological Characteristics of Surficial Deposits

While the surficial deposits are treated as one hydrogeological unit, they consist of three hydraulic parts. The first is the sand and gravel deposits of the lower surficial deposits, the second is the saturated sand and gravel deposits of the upper surficial deposits and the third is the sand and gravel close to ground level, which is usually unsaturated. The sand and gravel deposits in the upper part of the surficial deposits can extend above the upper limit of the saturation zone and because they are not saturated, they are not an aquifer. However, these sand and gravel deposits are significant since they provide a pathway for liquid contaminants to move downward into the groundwater. Because of the significance of the shallow sand and gravel deposits, they have been mapped where they are present within one metre of the ground surface and are referred to as the “first sand and gravel”.

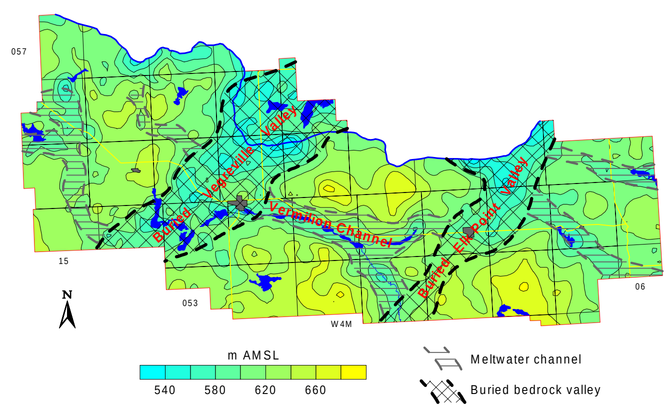

Figure 9. Bedrock Topography

Over the majority of the County, the surficial deposits are less than 40 metres thick. The exceptions are mainly in association with the linear bedrock lows where the deposits can have a thickness of more than 60 metres. The two most significant linear bedrock lows in the County have been designated as the Buried Vegreville Valley and the Buried Elk Point Valley. The Buried Vegreville Valley is in the western third of the County as shown on the adjacent map. The Buried Vegreville Valley trends from southwest to northeast, is approximately 8 to 16 kilometres wide within the County and has a local bedrock relief of less than 60 metres. Sand and gravel deposits can be expected to be present in association with this bedrock low, but the thickness of the sand and gravel deposits is expected to be mainly less than 30 metres. The Two Hills Lions Club is licensed to use 274 m³/day of groundwater from a water supply well completed in the Lower Sand and Gravel Aquifer associated with the Buried Vegreville Valley.

The second linear bedrock low, the Buried Elk Point Valley, trends from southwest to northeast in the eastern third of the County. The Buried Elk Point Valley is approximately four to ten kilometres wide, with local relief being less than 60 metres. Sand and gravel deposits can be expected to be present in association with this bedrock low, with the thickness of the deposits expected to be less than 30 metres.

[11] See glossary
[12] See glossary

There are other linear bedrock lows shown on the bedrock topography map. The majority of these lows trend northwest to southeast in the County and are indicated as being of meltwater origin. The Vermilion Channel is one of these linear bedrock lows. However, there are indications that the Lower Sand and Gravel deposits occupy at least parts of this linear bedrock low. If they are Lower Sand and Gravel deposits, it is possible that the meltwater channel occupies a pre-glacial channel.

The lower surficial deposits are composed mainly of fluvial and lacustrine deposits. Lower surficial deposits occur over approximately 20% of the County, in association with linear bedrock lows. The total thickness of the lower surficial deposits is mainly less than 20 metres, but ranges from less than 10 to more than 30 metres in parts of the Buried Vegreville and Elk Point valleys. The lowest part of the lower surficial deposits includes pre-glacial sand and gravel deposits. These deposits would generally be expected to directly overlie the bedrock surface in the Buried Vegreville and Elk Point valleys. The lowest sand and gravel deposits are of fluvial origin and are usually less than 10 metres thick.

The upper surficial deposits are either directly or indirectly a result of glacial activity. The deposits include till plus sand and gravel deposits of meltwater origin. The thickness of the upper surficial deposits is mainly less than 30 metres. The greatest thickness of upper surficial deposits occurs mainly in association with the Buried Vegreville Valley.

Sand and gravel deposits can occur throughout the entire unconsolidated section. The total thickness of sand and gravel deposits is generally less than ten metres but can be more than 20 metres in the areas of the buried bedrock lows and meltwater channels.

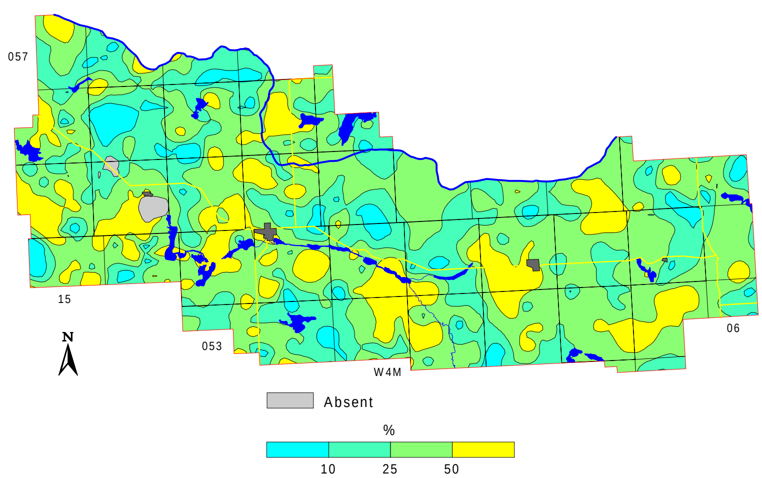

Figure 10. Amount of Sand and Gravel in Surficial Deposits

The combined thickness of all sand and gravel deposits has been determined as a function of the total thickness of the surficial deposits. Over approximately 25% of the County, the sand and gravel deposits are more than 50% of the total thickness of the surficial deposits.

5.2.2 Sand and Gravel Aquifer(s)

One source of groundwater in the County includes aquifers in the surficial deposits. Since the sand and gravel aquifer(s) are not everywhere, the actual aquifer that is developed at a given location is usually dictated by the aquifer that is present. From the present hydrogeological analysis, 204 water wells are completed in aquifers in the lower surficial deposits and 1,711 are completed in aquifers in the upper surficial deposits. This number of 1,915 water wells completed in aquifers in the surficial deposits is nearly three times the number of water wells determined to be completed in aquifers in the surficial deposits based on lithologies given on the water well drilling reports.

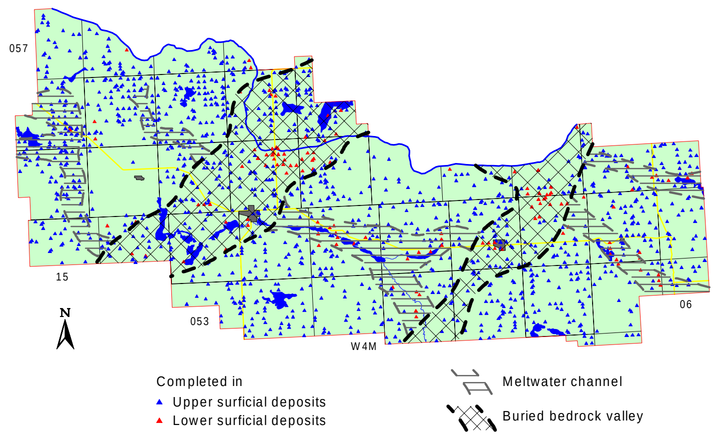

Figure 11. Water Wells Completed in Surficial Deposits

The water wells completed in the upper surficial deposits are located throughout the County, as shown in Figure 11. The majority of the water wells completed in the lower surficial deposits are located along the Buried Vegreville and Elk Point valleys and bedrock lows of meltwater origin.

The adjacent map shows water well yields that are expected in the County, based on surficial aquifers that have been developed by existing water wells. These data show that water wells with yields of more than 100 m³/day from sand and gravel aquifer(s) can be expected in more than 30% of the County. The most notable areas where yields of more than 100 m³/day are expected are mainly in the Buried Vegreville Valley. Over the majority of the County, water wells completed in the sand and gravel aquifer(s) would be expected to mainly have long-term yields of from 10 to 100 m³/day.

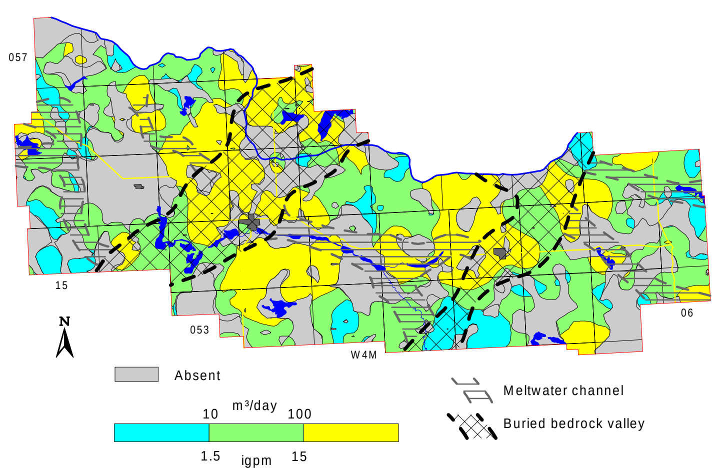

Figure 12. Apparent Yield for Water Wells Completed through Sand and Gravel Aquifer(s)

5.2.2.1 Chemical Quality of Groundwater from Surficial Deposits

The chemical analysis results of groundwaters from the surficial deposits have not been differentiated based on aquifers in the upper or lower surficial deposits. The main reason for not separating the chemical analysis results into the different aquifers is the lack of control. Because of the limited areal extent of the lower surficial deposits, almost all of the analysis results are from the upper surficial deposits.

The other justification for not separating the analyses was that there appeared to be no major chemical difference between groundwaters from the upper or lower sand and gravel aquifers. The groundwaters from these aquifers are generally chemically hard and high in dissolved iron.

The groundwaters from the surficial deposits are mainly calcium-magnesium-bicarbonate-type waters, with 80% of groundwaters having a TDS concentration of less than 1,000 mg/L. The groundwaters with a TDS of more than 1,500 mg/L occur in the western part of the County. Groundwaters from the surficial deposits are expected to have concentrations of dissolved iron that are greater than 1.0 mg/L. Groundwater from a water test hole completed in the Lower Sand and Gravel Aquifer associated with the Vermilion Channel has a TDS of 531 mg/L, a dissolved iron concentration of 1.0 mg/L and a hardness of 416 mg/L. Chloride concentrations were below 0.7 mg/L (Hydrogeological Consultants Ltd., 1996 [in progress]).

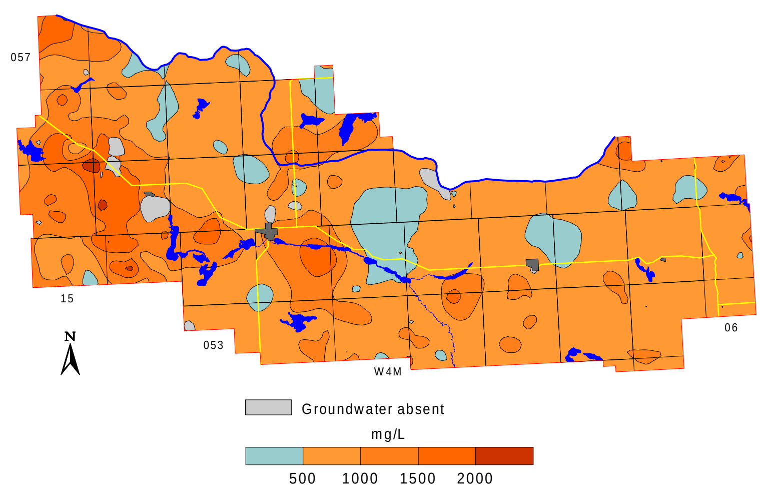

Figure 13. Total Dissolved Solids in Groundwater from Surficial Deposits

Although the majority of the groundwaters are calcium-magnesium-bicarbonate-type waters, there are groundwaters from the surficial deposits with sodium as the main cation; there are also groundwaters with significant concentrations of the sulfate ion. The groundwaters with elevated levels of sulfate occur in areas where there are elevated levels of total dissolved solids. There are very few groundwaters from the surficial deposits with appreciable concentrations of the chloride ion and in most of the County, the chloride ion concentration is less than 100 mg/L.