necessitates creating a representative sample set obtained from the entire data set. If the data set is large enough, it can be treated as a normal population and the removal of extreme values can be done statistically. When data sets are small, the process of data reduction involves a more direct assessment of the quality of individual points. Because of the uneven distribution of the data, all data sets are gridded using the Kriging[6] method.

The final definition of the individual surfaces becomes an iterative process involving the plotting of the surfaces on cross-sections and the adjusting of control points to fit with the surrounding data.

The porous and permeable parts of the individual geological units have been mainly determined from geophysical logs.

4.3 Hydrogeological Parameters

Water well records that indicate the depths to the top and bottom of their completion interval are compared digitally to the spatial distribution of the various geological surfaces. This procedure allows for the determination of the aquifer in which individual water wells are completed. When the completion interval of a water well cannot be established unequivocally, the data from that water well are not used in determining the distribution of hydraulic parameters.

After the water wells are assigned to a specific aquifer, the parameters from the water well records are assigned to the individual aquifers. The parameters include non-pumping (static) water level (NPWL), transmissivity and projected water well yield. The total dissolved solids, chloride and sulfate concentrations from the chemical analysis of the groundwater are also assigned to applicable aquifers.

Once the values for the various parameters of the individual aquifers are established, the spatial distribution of parameters must be determined. The distribution of individual parameters involves the same process as the distribution of geological surfaces. This means establishing a representative data set and then preparing a grid, which is used in contouring the distribution of individual parameters.

4.3.1 Risk Criteria

The main source of groundwater contamination involves activities on or near the land surface. The risk is high when the near-surface materials are porous and permeable and low when the materials are less porous and less permeable. The two sources of data for the risk analysis include (a) a determination of when sand and gravel is or is not present within one metre of the ground surface, and (b) the surficial geology map. The presence or absence of sand and gravel within one metre of the land surface is based on a geological surface prepared from the data supplied on the water well drilling reports. The information available on the surficial geology map is categorized based on relative permeability. The information from these two sources is combined to form the risk assessment map. The criteria used in the classification of risk are given in the table above.

Surface Permeability	Sand or Gravel Present Top Within One Metre Of Ground Surface	Groundwater Contamination Risk
Low	No	Low
Moderate	No	Moderate
High	No	High
Low	Yes	High
Moderate	Yes	High
High	Yes	Very High

Table 1. Risk of Groundwater Contamination Criteria

6 See glossary

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 non-pumping water level 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, wherever the aquifer is present.

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 non-pumping water levels. 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 3.0a
- AutoCAD 14.01
- CorelDRAW! 8.0
- Acrobat 3.0

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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 includes 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 20 metres thick, except in areas of linear bedrock lows where the thickness of surficial deposits can exceed 100 metres. The Buried Beverly Valley is one of the main linear bedrock lows. This linear low is present in the central part of the County and trends southwest to northeast. In the southwest part of the area, the North Saskatchewan River and the Buried Beverly Valley occupy the same linear bedrock low. Cross-section A-A' passes through the Buried Beverly Valley and shows the surficial deposits being up to 100 metres thick within the Valley.

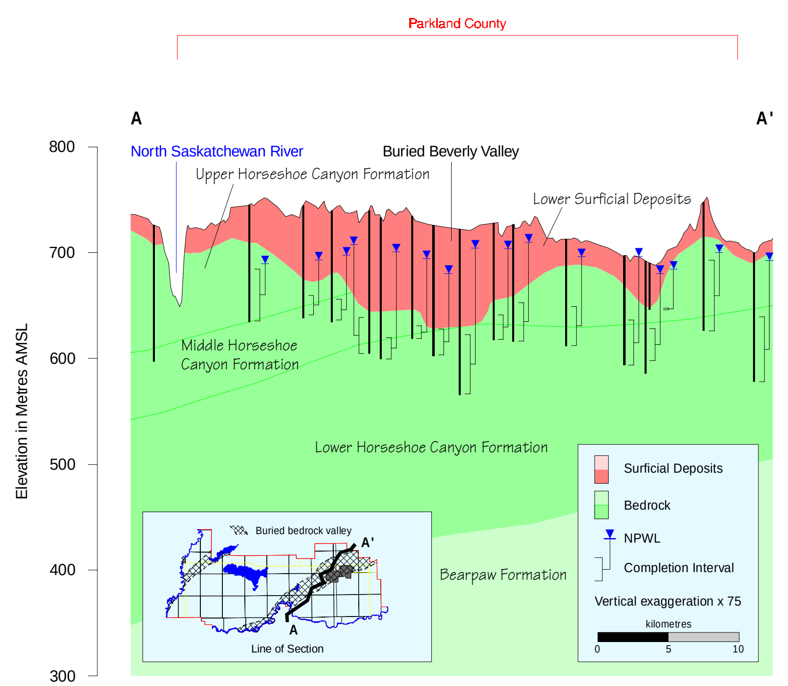

Figure 7. Cross-Section A - A'

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 that are less than 15 metres deep. The base of the surficial deposits 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 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, 12% of the water wells completed in the surficial deposits have a casing diameter of greater than 180 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 and saturated rocks that have a structure that is permeable enough to be an aquifer. Water wells completed in bedrock aquifers usually do not require water well screens and the groundwater is usually chemically soft. The data for 1,617 water wells indicate 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 1,617 water wells in the database, 1,555 have values for surface casing diameter. Of the 1,555 water wells, 99% have casing diameters of less than 180 millimetres and fewer than 6% of these water wells have been completed with water well screens.

The upper bedrock includes parts of the Paskapoo, Scollard, and Horseshoe Canyon formations. The Bearpaw Formation underlies the Lower Horseshoe Canyon Formation and is a regional aquitard[8]. The Bearpaw Formation is not considered part of the upper bedrock in the Parkland area, although in some areas it is less than 200 metres below the bedrock surface. The present-day Pembina River has eroded into the Paskapoo Formation in the western part of the County.

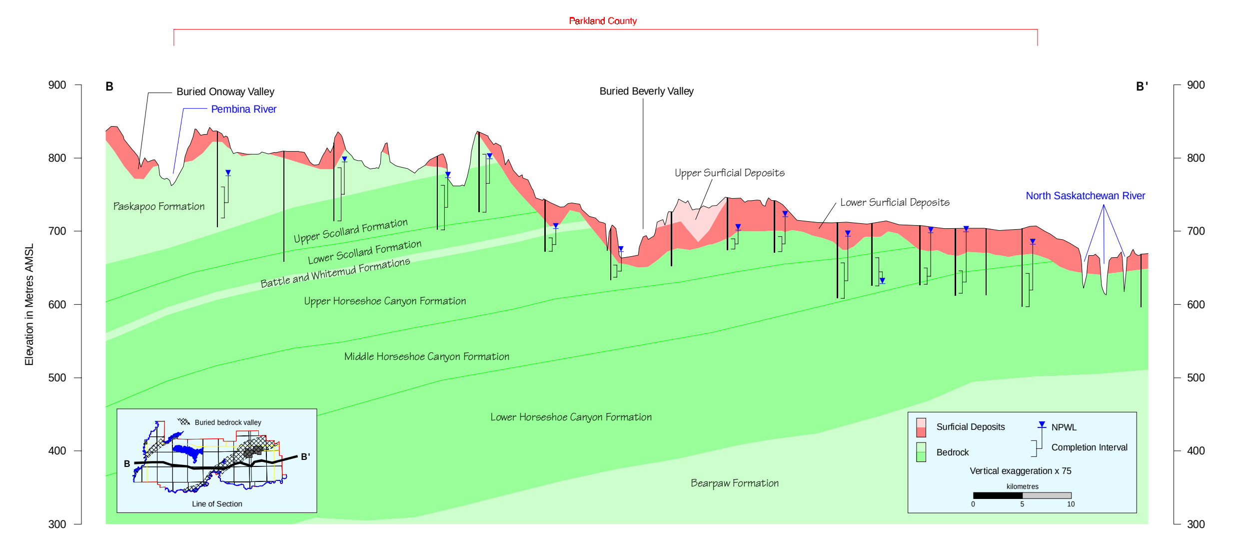

Figure 8. Cross-Section B - B'

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[8] 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[9] and lacustrine[10] deposits. The lacustrine deposits include clay, silt, fine-grained sand and coal. The upper surficial deposits include the more traditional glacial deposits of till and meltwater deposits.

5.2.1 Geological Characteristics of Surficial Deposits

While the surficial deposits are treated as one hydrogeological unit, they can 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 third is the sand and gravel close to ground level, of which some can be unsaturated. The sand and gravel deposits close to the ground surface 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”.

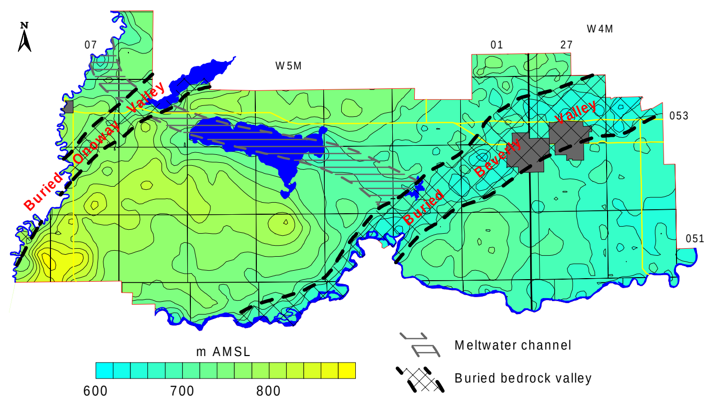

Figure 9. Bedrock Topography

Over the majority of the County, the surficial deposits are less than 20 metres thick. The exceptions are mainly in association with the linear bedrock lows where the deposits can have a thickness of up to 100 metres. The main linear bedrock low in the County has been designated as the Buried Beverly Valley, as shown on the adjacent map. This Valley trends from southwest to northeast from the North Saskatchewan River and underlies most of the towns of Stony Plain and Spruce Grove. The Buried Beverly Valley is approximately 6 to 9 kilometres wide, with local bedrock relief being less than 60 metres. Sand and gravel deposits can be expected 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 Town of Stony Plain, Forest Green Subdivision has an extensive dewatering system that was established in 1976 (Hydrogeological Consultants Ltd., 1976). Three dewatering wells were completed in the sand and gravel aquifer associated with the Buried Beverly Valley.

A second linear bedrock low, the Buried Onoway Valley, trends from southwest to northeast and is present in the northwest part of the County, southeast of the Town of Entwistle. The Buried Onoway Valley is approximately 4 kilometres wide, with local relief being less than 40 metres. Sand and gravel deposits associated with the linear bedrock low can be expected to be less than 30 metres thick.

9 See glossary
10 See glossary

In addition to the Buried Beverly and Onoway valleys, there is a low in the bedrock surface in the southeastern part of the County. The edges of this broad bedrock low are poorly defined but the bedrock low does have a regional northwest-southeast trend and is present from the Town of Spruce Grove to the North Saskatchewan River near Devon. Sand and gravel deposits with a thickness of less than 30 metres can be expected to be present in association with this bedrock low. The Devonian Botanical Gardens uses a water well completed in the sand and gravel deposits associated with this bedrock low (Hydrogeological Consultants Ltd., 1987).

There is also a minor linear bedrock low that is believed to be associated with a meltwater channel. This meltwater channel is noted on the bedrock topography map and is between the Buried Onoway Valley and the Buried Beverly Valley, passing below Lake Wabamun.

The lower surficial deposits are composed mostly of fluvial and lacustrine deposits. The total thickness of the lower surficial deposits is mainly less than 20 metres in the western part of the County, but ranges mostly between 20 and 80 metres in the eastern part of the County. 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 Beverly and Onoway valleys. The lowest sand and gravel deposits are of fluvial origin and are usually no more than a few metres thick.

The upper surficial deposits are either directly or indirectly a result of glacial activity. The deposits include till, with minor sand and gravel deposits of meltwater origin, which occur as isolated pockets. The thickness of the upper surficial deposits can exceed 100 metres. The greatest thickness of upper surficial deposits occurs in the areas of the buried bedrock valleys; there are several areas in the County where these deposits are not present.

Sand and gravel deposits can occur throughout the entire unconsolidated section. The total thickness of sand and gravel deposits is generally less than 10 metres in the western part of the County but can be more than 30 metres in the eastern part of the County. The greatest thickness of sand and gravel deposits occurs in the areas of the buried bedrock lows and meltwater channels. 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 30% of the western part of the County, the sand and gravel deposits are more than 50% of the total thickness of the surficial deposits. The areas where the sand and gravel percentages are more than 50% in the eastern half of the County are associated with the Buried Beverly Valley and the bedrock low in the southeastern part of the County.

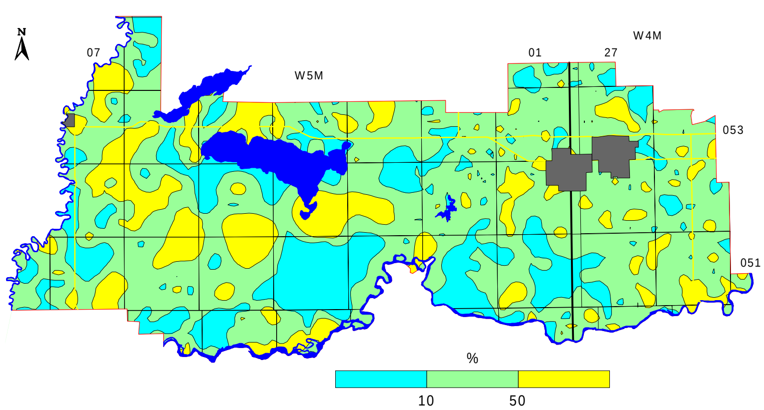

Figure 10. Amount of Sand and Gravel in Surficial Deposits