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 geologic units. For example, the relationship between an upper bedrock unit and the bedrock surface must be determined. This process provides both the outline and the thickness of the geologic unit.

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. For the upper bedrock aquifer(s) where areas of insufficient data are available from the groundwater database, prepared maps have been masked with a solid brown color to indicate this area. These brown masks have been added to the Lacombe, Haynes and Upper Scollard 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 geologic units are then transferred to the cross-section from the digitally prepared surfaces.

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. Ten cross-sections are presented in Appendix A of this report and as poster-size drawings forwarded with this report; only two (A-A’ and G-G’) are included in the text of this Report. The cross-sections are also included on the CD-ROM; page-size maps of the poster-size cross-sections are included in Appendix D of this report.

4.5 Software

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

- Acrobat 4.0
- ArcView 3.2
- AutoCAD 2000
- CorelDraw! 10.0
- Microsoft Office XP
- Surfer 7.0

5. Aquifers

5.1 Background

An aquifer is a permeable rock that is saturated. In this context, rock refers to subsurface materials, such as sand, gravel, sandstone and coal. If the non-pumping water level is above the top of the rock, this type of aquifer is an artesian aquifer. If the rock is not entirely saturated and the water level is below the top of the rock, this type of aquifer is a water-table aquifer. These types of aquifers occur in one of two general geological settings in the M.D. The first geological setting includes the sediments that overlie the bedrock surface. In this report, these sediments 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 aquifer(s) within different geologic units, and the general chemical quality of the groundwater associated with each setting are reviewed separately.

5.1.1 Surficial Aquifers

Surficial deposits in the M.D. are mainly less than 50 metres thick, except in areas of linear bedrock lows where the thickness of the surficial deposits can exceed 100 metres. The Buried Calgary Valley is the main linear bedrock low in the M.D; a second unnamed buried bedrock valley is present in the northeastern part of the M.D. Other linear bedrock lows are present in the form of meltwater channels (Shetsen, 1987). The south-north cross-section G-G', Figure 8 shown below, passes across the Buried Calgary Valley and shows the surficial deposits being less than 50 metres thick.

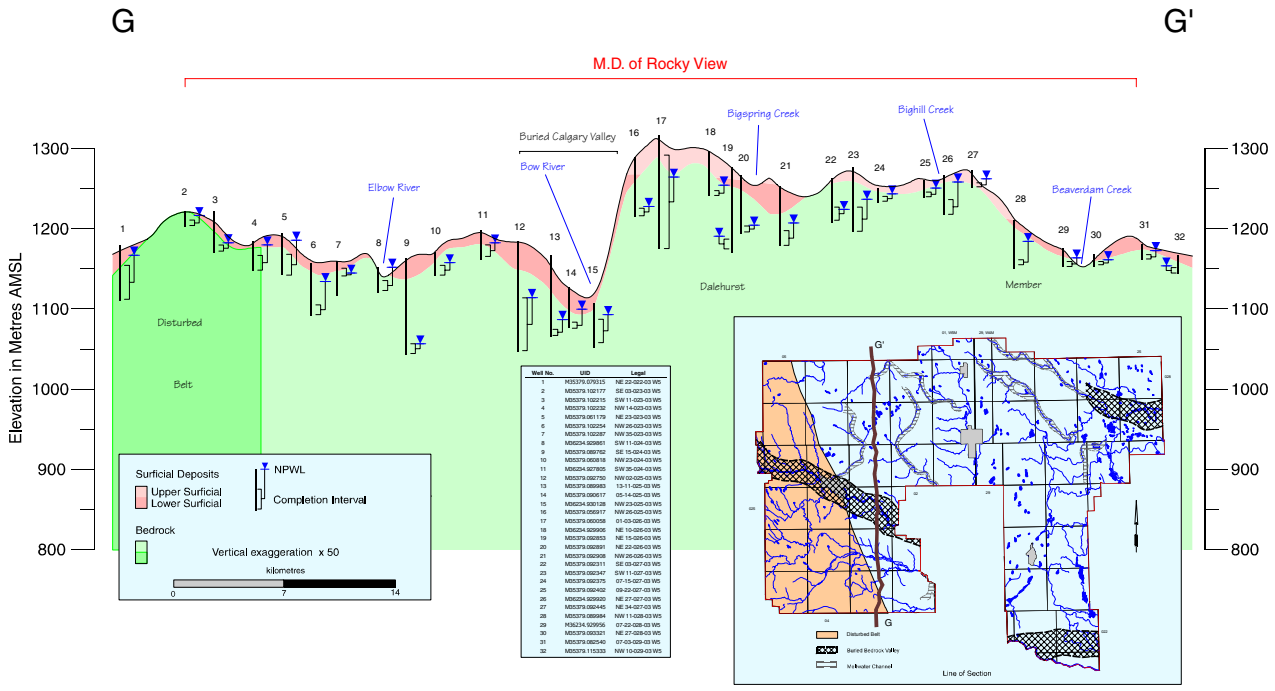

Figure 8. Cross-Section G - G'

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 non-pumping water level in water wells that are less than 20 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 M.D., casing-diameter information is available for 202 of the 222 water wells completed in the surficial deposits; only one water well has a casing diameter of more than 275 millimetres, and is assumed to be a bored or dug water well.

5.1.2 Bedrock Aquifers

In the M.D., the upper bedrock includes the Disturbed Belt along the western edge of the M.D., the Paskapoo and the Upper Scollard formations. Cross-section A-A' (Figure 9) shows that the aquifers in which water wells are completed are mainly within 200 metres of the ground surface. Some of this bedrock contains saturated rocks that are permeable enough to transmit groundwater for a specific need. Water wells completed in bedrock aquifers usually do not require water well screens, although some of the sandstones may be friable[13] and water well screens are a necessity. The groundwater from the bedrock aquifers is usually chemically soft.

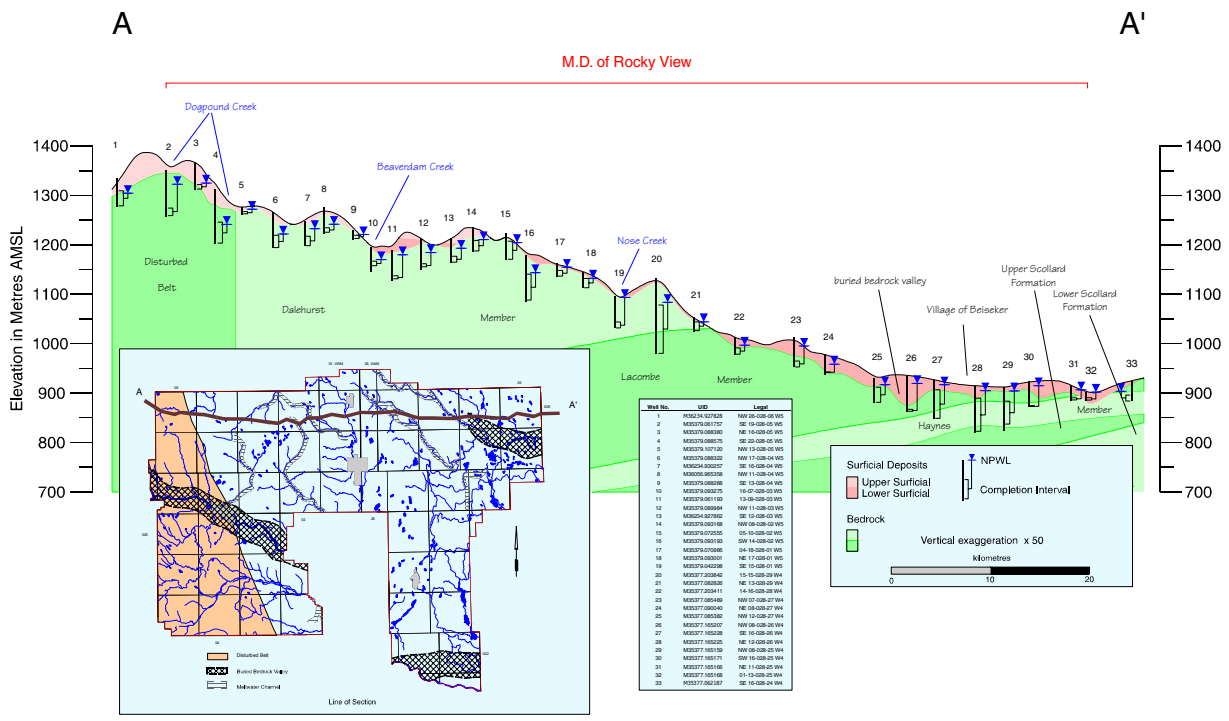

Figure 9. Cross-Section A - A'

In the M.D., the Base of Groundwater Protection extends below the Upper Scollard Formation. A map showing the depth to the Base of Groundwater Protection is given on page 7 of this report, in Appendix A, and on the CD-ROM.

[13] See glossary

5.2 Aquifers in Surficial Deposits

The surficial deposits are the sediments above the bedrock surface. These include pre-glacial materials, which were deposited before glaciation, and materials deposited directly or indirectly as a result of glaciation. The *lower surficial deposits* include pre-glacial fluvial[14] and lacustrine[15] deposits. The lacustrine deposits include clay, silt and fine-grained sand. The *upper surficial deposits* include the more traditional glacial deposits of till[16] and meltwater deposits. Pre-glacial materials are expected to be mainly present in the eastern two-thirds of the M.D., and in association with the buried bedrock valleys. The glacial meltwater channels (Shetsen, 1987) are primarily in the northern half of the M.D.

5.2.1 Geological Characteristics of Surficial Deposits

While the surficial deposits are treated as one hydrogeologic unit, they consist of three hydraulic parts. The first unit is the sand and gravel deposits of the lower surficial deposits, when present. These deposits are mainly saturated. The second and third hydraulic units are associated with the sand and gravel deposits in the upper surficial deposits. The sand and gravel deposits in the upper surficial deposits occur mainly as pockets. The second hydraulic unit is the saturated part of these sand and gravel deposits; the third hydraulic unit is the unsaturated part of these deposits. For a graphical depiction of the above description, please refer to Figure 5, page 8. While the unsaturated deposits are not technically an aquifer, they are significant as they provide a pathway for liquid contaminants to move downward into the groundwater.

The base of the surficial deposits is the bedrock surface, represented by the bedrock topography as shown on the adjacent map.

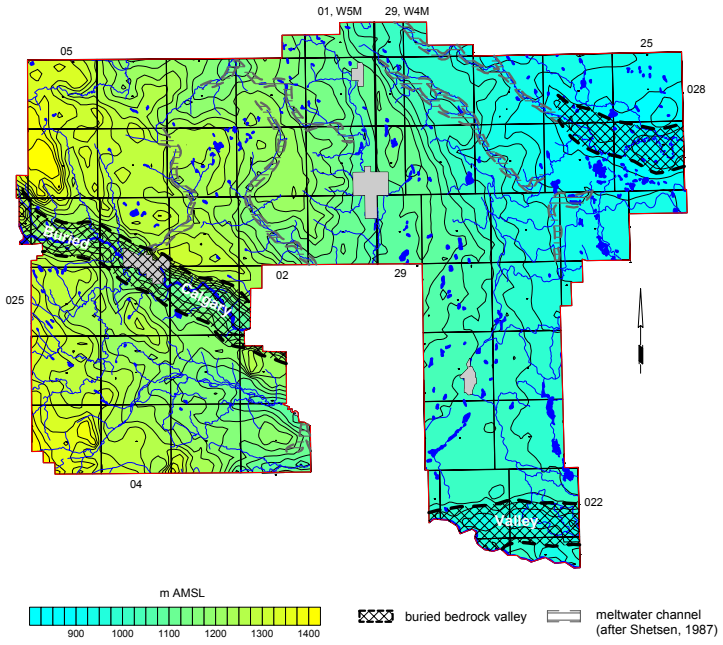

Figure 10. Bedrock Topography

Over the majority of the M.D., the surficial deposits are less than 50 metres thick (page A-22). The exceptions are mainly in association with areas where buried bedrock valleys are present, where the deposits can have a maximum thickness of more than 50 metres. The main linear bedrock low in the M.D. is northwest-southeast-trending and has been designated as the Buried Calgary Valley; the unnamed buried bedrock valley in the northeastern part of the M.D. is a tributary valley to the Buried Calgary Valley in Special Areas 2.

The Buried Calgary Valley is present in the southern part of the M.D., and is coincidental with the present-day Bow River. The Valley is six to nine kilometres wide within the M.D., with local bedrock relief being up to 75 metres. Sand and gravel deposits can be expected in association with this bedrock low, with the sand and gravel deposits expected to be mainly less than 15 metres thick.

The buried bedrock valley present in the northeastern part of the M.D. mainly parallels the stretch of present-day Rosebud River between the villages of Beiseker and Irricana. The Valley is less than nine kilometres wide within

[14] See glossary
[15] See glossary
[16] See glossary

the M.D., with local bedrock relief being up to 40 metres. Sand and gravel deposits can be expected in association with this bedrock low, with the thickness of the sand and gravel deposits being mainly less than 15 metres.

The lower surficial deposits are composed mostly of fluvial and lacustrine deposits. Lower surficial deposits occur mainly in the linear bedrock lows and in the eastern two-thirds of the M.D. The total thickness of the lower surficial deposits is mainly less than 30 metres, but can be more than 50 metres in the buried bedrock 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 bedrock valleys. The lowest sand and gravel deposits are of fluvial origin, are usually less than five metres thick and may be discontinuous.

In the M.D., several meltwater channels mainly overlie linear bedrock lows. Because sediments associated with the lower surficial deposits are indicated as being present in many of these linear bedrock lows, it is possible that the bedrock lows were originally tributaries to the buried bedrock valleys as shown in the bedrock topography map on Figure 10.

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 are expected to occur mainly as isolated pockets. Because the meltwater channels are mainly an erosional feature, the sand and gravel deposits associated with these features are considered not to be significant aquifers. The major meltwater channels in the M.D. have been outlined by Shetsen (1987). The thickness of the upper surficial deposits is mainly less than 30 metres, but can be more than 30 metres in the northwestern and southwestern parts of the M.D. Upper surficial deposits are mainly absent from the buried bedrock valleys (see CD-ROM).

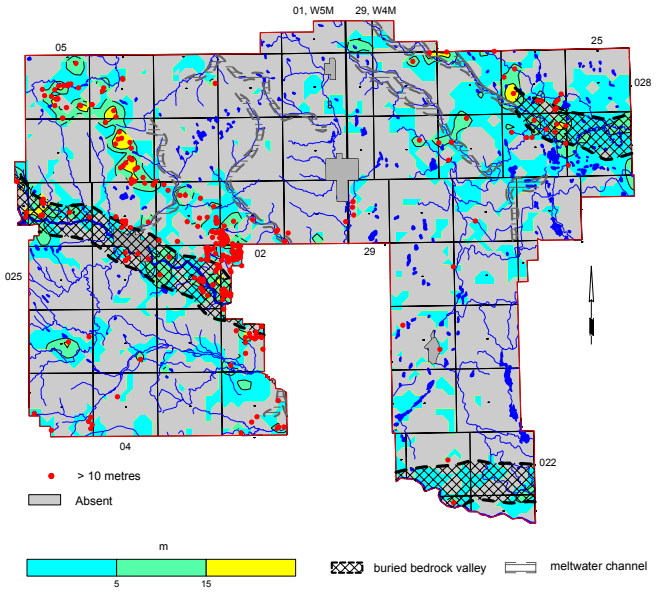

Figure 11. Thickness of Sand and Gravel Deposits

Sand or gravel deposits (Figure 11) are reported in association with the Buried Calgary Valley and the unnamed bedrock low that occurs in the northeastern part of the M.D. In addition to the major bedrock lows, sand or gravel deposits are reported at a few other locations in the M.D. The main occurrence of sand or gravel in the M.D. not associated with linear bedrock lows occurs along a line from the northwestern corner of the City of Calgary to the northwestern corner of the M.D. This sand or gravel deposit occurs along a topographically high area and is indicated as being an “ice contact deposit”. Within this area, sand or gravel deposits are up to 20 metres thick and have a lateral extent of approximately eight kilometres.

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 40% of the M.D. where sand and gravel deposits are present, the sand and gravel deposits are more than 30% of the total thickness of the surficial deposits (page A-25). The areas where sand and gravel deposits constitute more than 30% of the total thickness of the surficial deposits are mainly in the areas associated with the buried bedrock valleys and along a line from the northwestern corner of the City of Calgary to the northwestern corner of the M.D.

5.2.2 Sand and Gravel Aquifer(s)

One source of groundwater in the M.D. 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. In the M.D., the thickness of the sand and gravel aquifer(s) is generally less than five metres, but can be more than 15 metres in the area northwest of Calgary (page A-26).

From the present hydrogeological analysis, 295 water wells are completed in aquifers in the surficial deposits. Of the 295 water wells, 118 are completed in aquifers in the upper surficial deposits and 177 are completed in aquifers in the lower surficial deposits. This number of water wells is slightly more than the number (222) determined to be completed in aquifers in the surficial deposits, based on lithologies given on the water well drilling reports. The larger number is obtained by comparing the elevation of the reported depth of a water well to the elevation of the bedrock surface at the same location. For example, if only the depth of a water well is known, the elevation of the completed depth can be calculated. If the elevation of the completed depth is above the elevation of the bedrock surface determined from the gridded bedrock topographic surface at the same location, then the water well is considered to be completed in an aquifer in the surficial deposits.

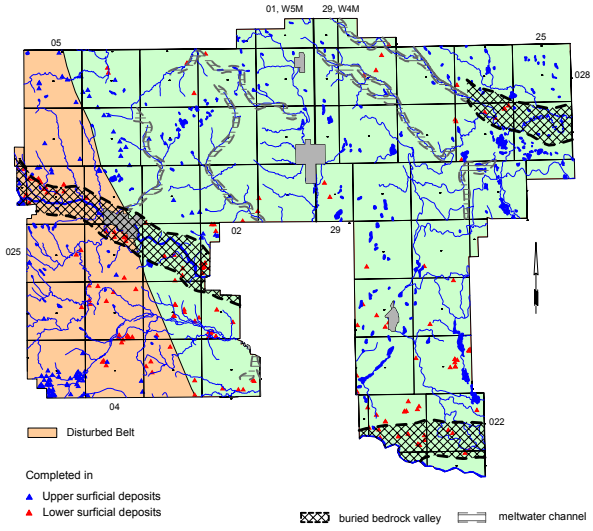

Figure 12. Water Wells Completed in Surficial Deposits

Water wells completed in the upper surficial deposits occur mainly near or within the Disturbed Belt area and in the southwestern part of the M.D. Water wells completed in the lower surficial deposits occur mainly in the vicinity of streams and linear bedrock lows (Figure 12).

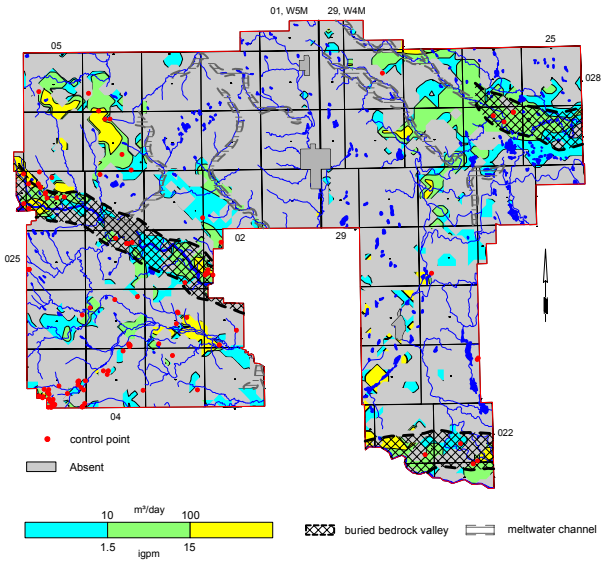

Figure 13. Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)

The adjacent map shows expected yields for water wells completed in sand and gravel aquifers(s). Over approximately 70% of the M.D., the sand and gravel deposits are not present, or if present, are not saturated; these areas are designated as grey on the map.

Based on the aquifers that have been developed by existing water wells, these data show that water wells with yields of less than 100 m³/day from sand and gravel aquifer(s) can be expected in most of the M.D. The most notable areas where yields of more than 100 m³/day are expected are mainly in association with the buried bedrock valleys, but can also occur in the northwestern part of the M.D. In the M.D., there are approximately 110 records for surficial water wells with apparent yield data.