5 AQUIFERS

5.1 Background

An aquifer is a permeable rock unit that is saturated. In this context, rock refers to subsurface materials, such as sand, gravel, sandstone and coal. If the NPWL is above the top of the rock unit, this type of aquifer is a confined or artesian aquifer. If the rock unit is not entirely saturated and the water level is below the top of the rock unit, this type of aquifer is a water-table or unconfined 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 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.

5.2 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[16] and lacustrine[17] deposits. The lacustrine deposits include clay, silt and fine-grained sand. The *upper surficial deposits* include the traditional glacial sediments of till[18] and ice-contact deposits. Pre-glacial materials are expected to be mainly present in association with linear bedrock lows. Meltwater channels are associated with glaciation.

5.2.1 Geological Characteristics of Surficial Deposits

While the surficial deposits are treated as one hydrogeologic unit, they consist of three hydraulic units. 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 9 and to page A-9. While the unsaturated deposits are not technically an aquifer, they are significant as they provide a pathway for soluble 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. Regionally, the bedrock surface varies between 720 and 1,060 metres AMSL. The lowest elevations occur mainly in the northeastern part of the County, as shown on Figure 8 and page A-20.

Over the majority of the County, the surficial deposits are less than 30 metres thick (see CD-ROM). The exceptions are mainly in association with areas where buried bedrock

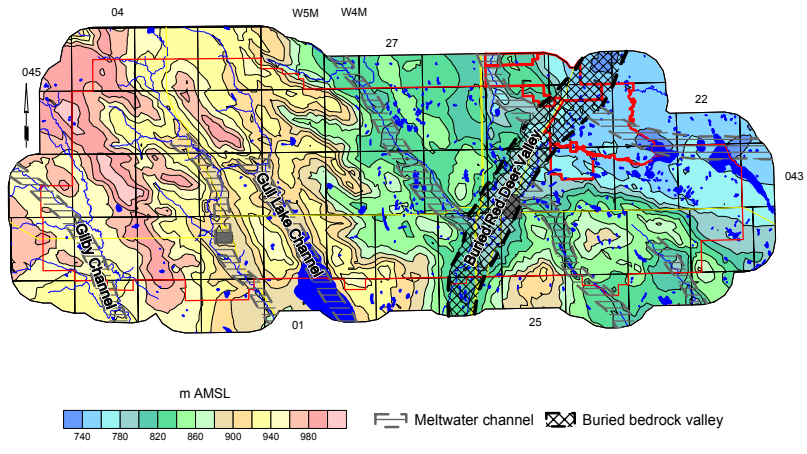

Figure 8. Bedrock Topography

[16] See glossary
[17] See glossary
[18] See glossary

valleys and meltwater channels are present, where the deposits can have a thickness of more than 40 metres. The main southwest-northeast-trending linear bedrock low in the County is the Buried Red Deer Valley.

The Buried Red Deer Valley is present in the east-central part of the County, and extends northeast from the County border through the Town of Ponoka and the Montana, Samson and Ermineskin First Nations lands to the northern County border. The Valley is approximately nine kilometres wide, with local bedrock relief being less than 60 metres. Sand and gravel deposits can be expected in association with the bedrock low, but the thickness of the sand and gravel deposits is expected to be mainly less than ten metres.

The lower surficial deposits are composed mostly of fluvial and lacustrine deposits. Lower surficial deposits occur over of the County, but mainly in linear bedrock lows. The total thickness of the lower surficial deposits is mainly less than 30 metres, but can be more than 35 metres in the linear bedrock lows (see CD-ROM). The lowest part of the lower surficial deposits includes pre-glacial sand and gravel deposits. These deposits would generally overlie the bedrock surface in the Buried Red Deer Valley. The lowest sand and gravel deposits are of fluvial origin, are usually less than five metres thick and may be discontinuous (see CD-ROM).

In the County, there are numerous linear bedrock lows that trend mainly northwest to southeast and are indicated as being of meltwater origin. Because sediments associated with the lower surficial deposits are indicated as being present in parts of the meltwater channels, it is possible that the meltwater channels were originally tributaries to the Buried Red Deer Valley (see CD-ROM). The three significant surface-water bodies in the County, Gull Lake, Samson Lake and Red Deer Lake, appear to be associated with meltwater channels.

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. The thickness of the upper surficial deposits is mainly less than 25 metres. Upper surficial deposits are present mainly in the western part of the County and are absent from the buried bedrock valleys (see CD-ROM). 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 upper sand and gravel deposits are usually less than two metres thick (see CD-ROM). Upper sand and gravel deposits are present mainly in the southwestern part of the County and are absent from the buried bedrock valleys (see CD-ROM).

The west-east cross-section G-G', Figure 9 shown below and page A-18, passes across the Buried Red Deer Valley and shows the surficial deposits being in the order of 30 to 60 metres thick (locally up to 100 metres) in the Buried Red Deer Valley and east to the County border.

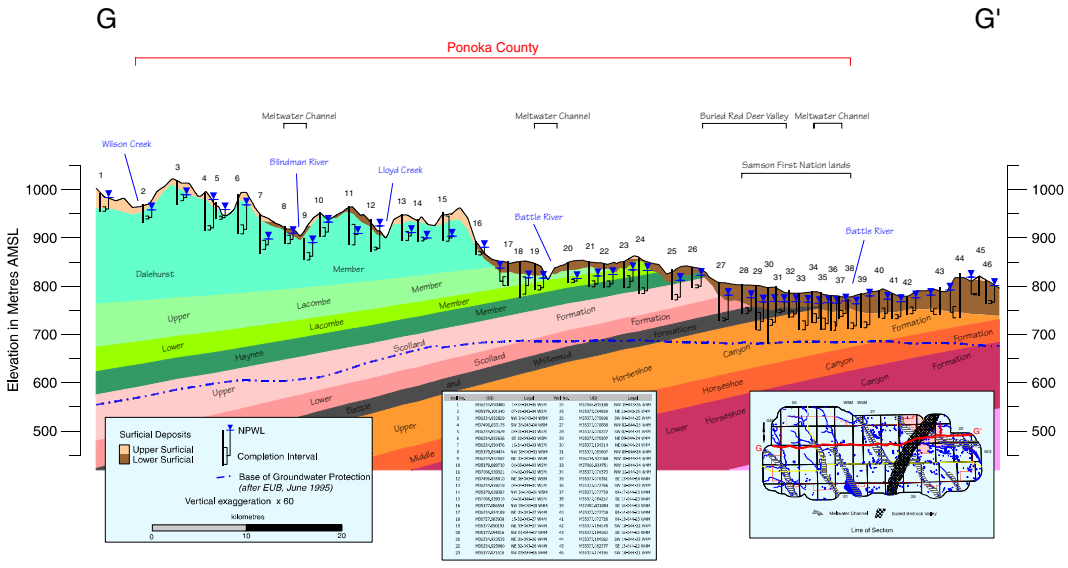

Figure 9. Cross-Section G - G'

Sand and gravel deposits (Figure 10) can occur throughout the surficial deposits. The total thickness of sand and gravel deposits is generally less than two metres but can be more than five metres in association with the linear bedrock lows.

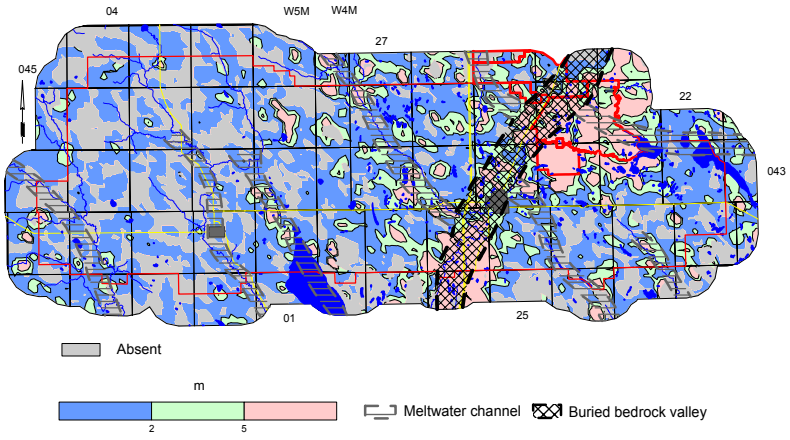

Figure 10. Thickness of Sand and Gravel Deposits

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 5% of the County 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-23). The areas where sand and gravel deposits constitute more than 30% of the total thickness of the surficial deposits are mainly associated with linear bedrock lows.

5.2.2 Sand and Gravel Aquifer(s)

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.

Since the Sand and Gravel Aquifer(s) are not present everywhere, the actual aquifer that is developed at a given location is usually dictated by the aquifer that is present. Over approximately 40% of the County, the sand and gravel deposits are not present, or if present, are not saturated; these areas are designated as grey on the adjacent map. In the County, the thickness of the Sand and Gravel Aquifer(s) is generally less than five metres, but can be more than five metres mainly in areas of, or near, linear bedrock lows, as shown in Figure 11, in Appendix A and on the CD-ROM.

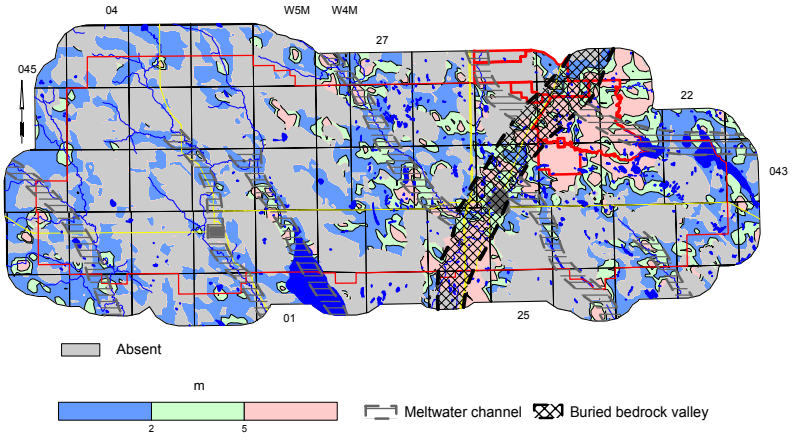

Figure 11. Thickness of Sand and Gravel Aquifer(s)

Of the 7,839 water wells in the database, 135 were defined as being completed in surficial aquifers, based on lithologic information and water well completion details. From the present hydrogeological analysis, 541 water wells are completed in aquifers in the surficial deposits. Of the 541 water wells, 25 are completed in aquifers in the upper surficial deposits, 223 are completed in aquifers in the lower surficial deposits, and 293 water wells are completed in multiple surficial aquifers. This number of water wells (541) is four times the number (135) 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.

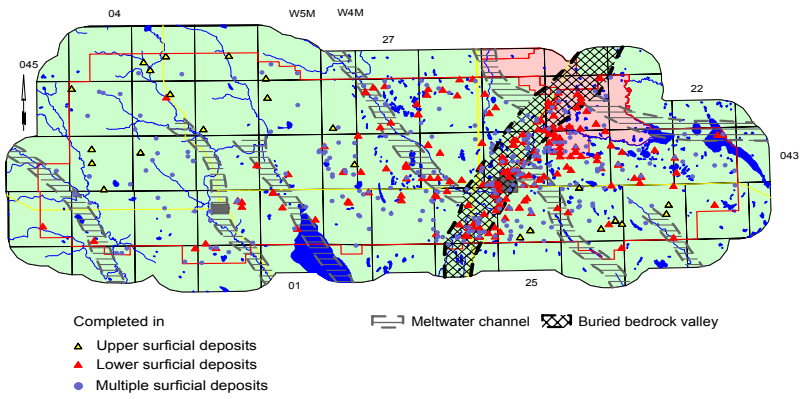

Figure 12. Water Wells Completed Surficial Deposits

Water wells completed in the upper surficial deposits are mainly not in association with linear bedrock lows, as shown on Figure 12. A large number of water wells completed in the lower surficial deposits are located along the Buried Red Deer Valley.

In the County, there are 84 records for surficial water wells with apparent yield data, which is 16% of the 541 surficial water wells. Of the 84 water well records with apparent yield values, 35 have been assigned to aquifers associated with specific geologic units. Twenty percent (17) of the 84 water wells completed in the Sand and Gravel Aquifer(s) have apparent yields that are less than ten m³/day, 48% (40) have apparent yield values that range from 10 to 100 m³/day, and 32% (27) have apparent yields that are greater than 100 m³/day, as shown in Table 3. In addition to the 84 records for surficial water wells, there are eight records that indicate that the water well is dry. In order to depict a more accurate yield map, an apparent yield of 0.1 m³/day was assigned to each of the eight dry holes prior to gridding. All of the dry holes are in multiple surficial completions.

Aquifer	No. of Water Wells with Values for Apparent Yield (*)	Number of Water Wells with Apparent Yields <10 m³/day	10 to 100 m³/day	>100 m³/day
Upper Surficial	3	0	2	1
Lower Surficial	32	9	12	11
Multiple Completions	49	8	26	15
Totals	84	17	40	27

Table 3. Apparent Yields of Sand and Gravel Aquifer(s)

The adjacent map shows expected yields for water wells completed in Sand and Gravel Aquifer(s).

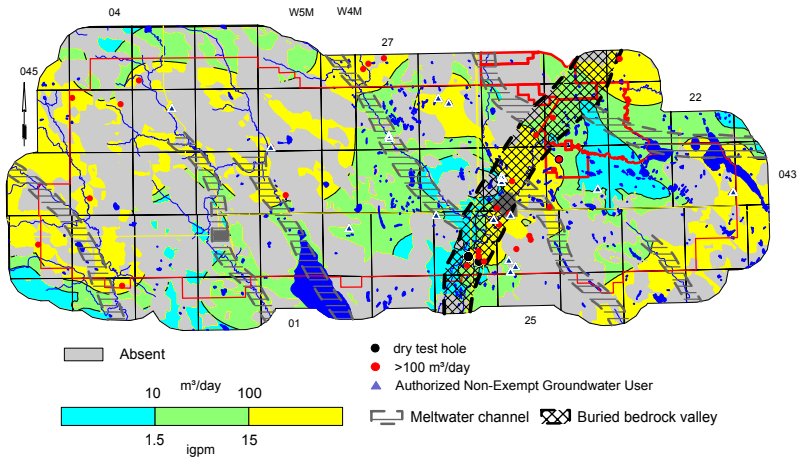

Figure 13. Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)

Based on the aquifers that have been developed by existing water wells, these data show that water wells with yields of more than 100 m³/day from the Sand and Gravel Aquifer(s) can be expected in 60% of the County where the Sand and Gravel Aquifer(s) are present. The most notable areas where yields of more than 100 m³/day are expected are in association with the Buried Red Deer Valley and the Gilby and Gull Lake meltwater channels. The higher yields in the extreme eastern part of the County could be a result of the gridding procedure used to process a limited number of data points.

In the County, there are eighteen authorized non-exempt water wells that are completed in the Sand and Gravel Aquifer(s), for a total authorized diversion of 174 m^3/day (Table 1, page 6). Five of the eighteen water wells are in the vicinity of the Town of Ponoka and are completed in the sand and gravel deposits in association with the Buried Red Deer Valley, as shown above in Figure 13. The highest allocation is for the Ponoka Golf Course, which is authorized to divert 74 m³/day for irrigation purposes.