V. Aquifers

A. 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 Special Areas and the M.D. 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 aquifer(s) within different geological units, and the general chemical quality of the groundwater associated with each setting are reviewed separately.

1) Surficial Aquifers

Surficial deposits in Special Areas and 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 east-west-trending linear bedrock low in Special Areas and the M.D. The Red Deer River and the Buried Calgary Valley occupy the same linear bedrock low at the southern border of Special Area 3 and the M.D. of Acadia (buried bedrock valley extents overlay in report pocket). Cross-section A-A' is west to east along the Buried Calgary Valley, and shows the thickness of the surficial deposits varying from less than ten to more than 100 metres.

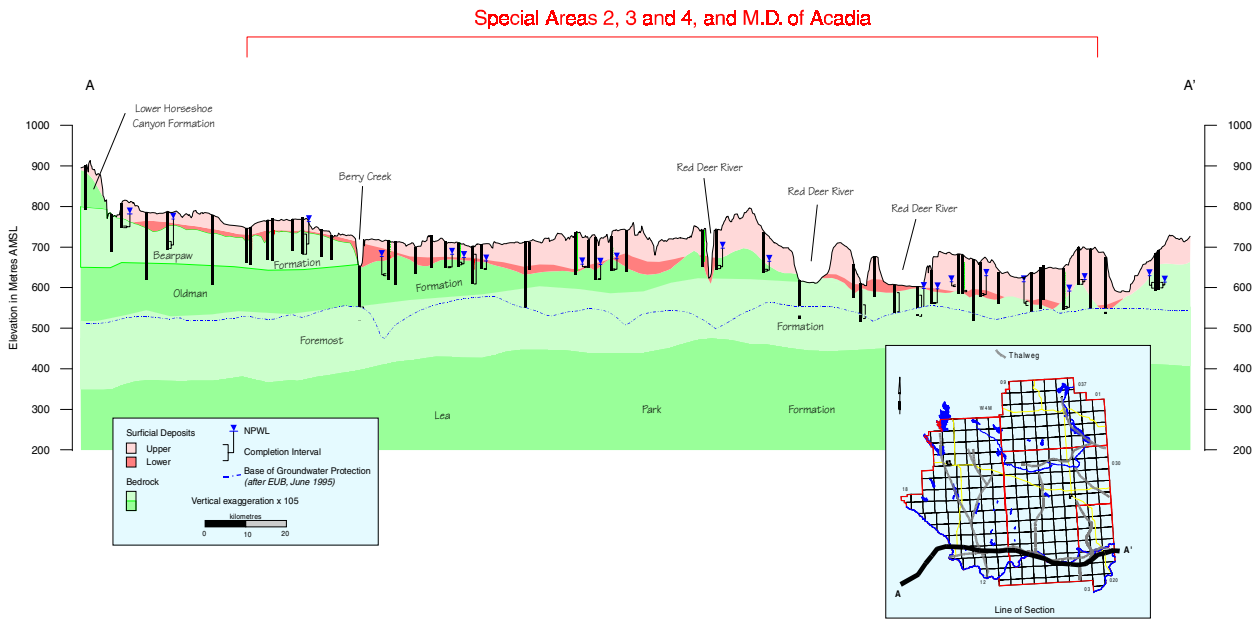

Figure 7. Cross-Section A - A'

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 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 project area, casing-diameter information is available for 647 of the 1,080 water wells completed in the surficial deposits; 251 of these have a casing diameter of more than 300 millimetres, and are assumed to be bored or dug water wells.

2) Bedrock Aquifers

The upper bedrock includes rocks that are less than 200 metres below the bedrock surface and above the Lea Park Formation. Some of this bedrock contains saturated rocks with sufficient permeability 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 are friable[11] and water well screens are a necessity. The groundwater from the bedrock aquifers is usually chemically soft.

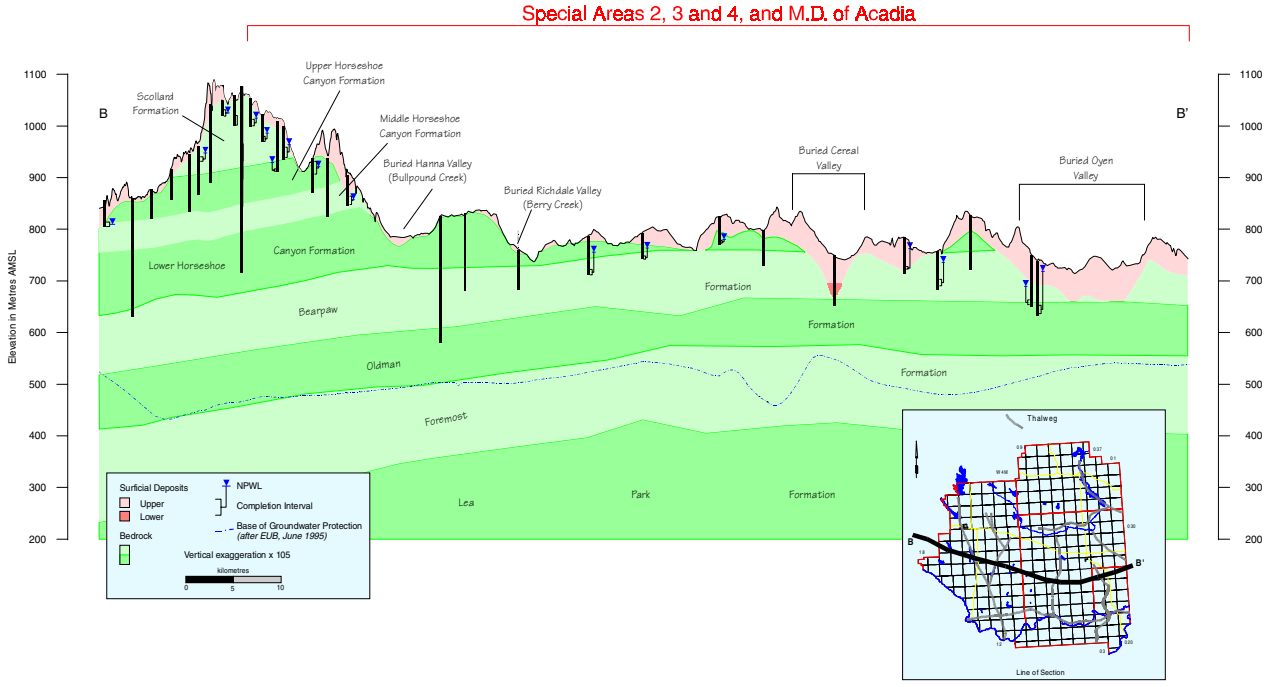

Figure 8. Cross-Section B - B'

The data for 1,432 water wells show that the top of the water well completion interval is below the top of bedrock, indicating that the water wells are completed in at least one bedrock aquifer. Within the project area, casing-diameter information is available for 1,220 of the 1,432 water wells completed below the top of bedrock. Of these 1,220 water wells, 98% have surface-casing diameters of less than 300 mm and these bedrock water wells have been mainly completed with either a screen or as open hole.

[11] See glossary

The upper bedrock includes the lower part of the Paskapoo Formation, the Edmonton Group, the Bearpaw Formation and the Belly River Group (page A-8). The Lea Park Formation underlies the Belly River Group and is a regional aquitard[12].

B. 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[13] and lacustrine[14] deposits. The lacustrine deposits include clay, silt and fine-grained sand. The *upper surficial deposits* include the more traditional glacial deposits of till[15] and meltwater deposits.

1) Geological Characteristics

While the surficial deposits are treated as one hydrogeological unit, they consist of three individual units. When present, the sand and gravel deposits of the lower surficial deposits are the first unit; these deposits are mainly saturated. The second and third 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 unit is the saturated part of these sand and gravel deposits; the third unit is the unsaturated part of these deposits. (See Figure 5 for a graphical depiction of the above description). 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. Because of the significance of the shallow sand and gravel deposits, they have been mapped where the tops of these deposits are present within one metre of the ground surface; these shallow deposits are referred to as the “first sand and gravel”.

The base of the surficial deposits is the bedrock surface, represented by the bedrock topography as shown on the adjacent map. There are numerous linear bedrock lows shown on the bedrock topography map. The lowest elevation of the linear bedrock low is the thalweg; the thalwegs for the linear bedrock lows in the present report are named mainly as per Carlson, 1969.

Over the majority of the project area, the upper surficial deposits are less than 30 metres thick (page A-11). The exceptions are mainly in association with the linear bedrock lows where the deposits can have a thickness of more than 50 metres. The main linear bedrock low in the project area has been designated as the Buried Calgary Valley, as shown on the adjacent bedrock topography map. This Valley trends east while occupying the present-day Red Deer River Valley. The Buried Calgary Valley is approximately 15 to 40 kilometres wide, with local relief being up to 100 metres.

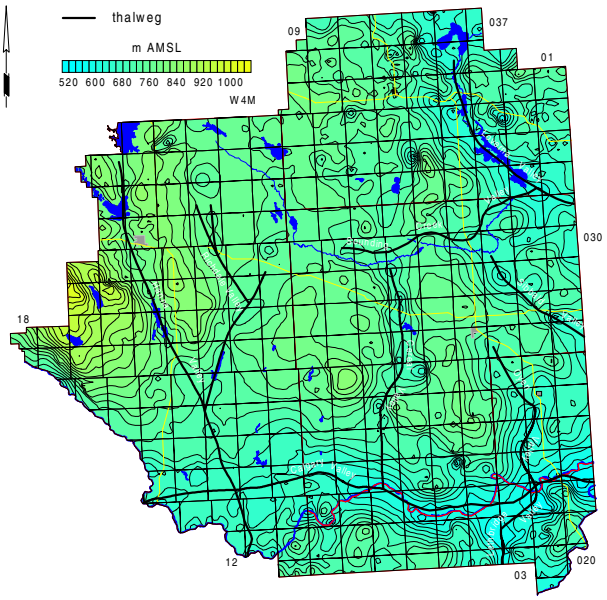

Figure 9. Bedrock Topography

12 See glossary
13 See glossary
14 See glossary
15 See glossary

The lower surficial deposits are composed mostly of fluvial and lacustrine deposits. Lower surficial deposits occur over more than 15% of the project area, in association with linear bedrock lows. The total thickness of the lower surficial deposits is mainly less than 20 metres, but can be up to 50 metres in the areas of linear bedrock lows. 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 Calgary Valley. The lower sand and gravel deposits are of fluvial origin, are usually less than five metres thick and may be discontinuous.

The upper surficial deposits are either directly or indirectly a result of glacial activity. The deposits include till, with minor sand and gravel deposits, which are expected to occur mainly as isolated pockets. The greatest thickness of the upper surficial deposits is mainly in association with the linear bedrock lows; there are several areas in the project area where the upper surficial deposits are not present.

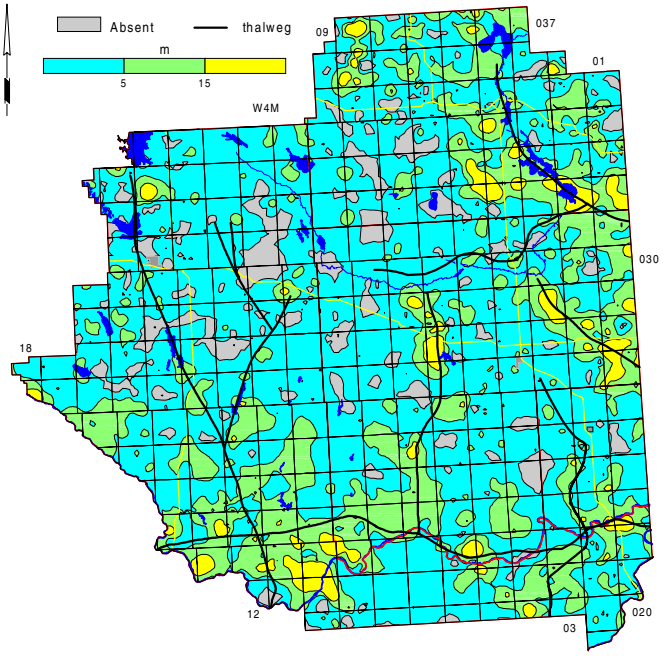

Figure 10. Thickness of Sand and Gravel Deposits

Sand and gravel deposits can be present anywhere in the surficial deposits. The total thickness of sand and gravel deposits is generally less than five metres but can be more than 15 metres in the areas of the linear bedrock lows.

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 project area, the sand and gravel deposits are more than 50% of the total thickness of the surficial deposits. One area where the sand and gravel percentages are higher is in association with the Buried Calgary Valley. The other areas where sand and gravel deposits constitute more than 50% of the total thickness of the surficial deposits may be in areas where linear bedrock lows exist but have not been identified due to a shortage of accurate bedrock control points.