6 GROUNDWATER BUDGET

6.1 Hydrographs

There are three observation water wells in the County where water levels are being measured and recorded with time. These observation water wells are part of the AEP groundwater-monitoring network. Two of the observation water wells (AEP Obs WW No. 325 and AEP Obs WW No. 327) are located approximately 10 kilometres northwest of the Town of Stony Plain, and the third (AEP Obs WW No. 377) is located in Enstwistle.

AEP Obs WW No. 325 is completed in the Lower Sand and Gravel Aquifer, just above the bedrock surface. The water level, which was measured from 1980 to 1994, shows a water-level decline of slightly more than 0.10 metres. The water level in the observation water well fluctuates up to 0.16 metres per day, with there being a general 0.10-metre change over a few months. While there has been a general decline over the 15 years of monitoring, there was a rise in water levels from 1990 to 1992.

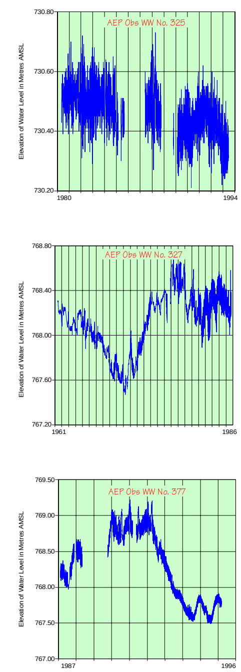

Figure 25. Hydrographs - AEP Observation Water Wells

AEP Obs WW No. 327 is at the same site as AEP Obs WW No. 325, but is completed immediately below the bedrock surface. The water level in AEP Obs WW No. 327 is reported in the AEP Obs WW database to have been 724 metres AMSL in 1961. However, the AEP data show the elevation of the water level in the hydrograph being 45 metres higher. It is assumed that the reference for the hydrograph is in error but that the relative fluctuations are correct.

The present data indicate that AEP Obs WW No. 327 is completed in a sandstone layer near the base of the Upper Horseshoe Canyon Formation. The water-level decline from 1961 to 1971 is believed to be a result of interference from a municipal water supply well. In the mid-1970s, a regional water line was installed and the towns of Stony Plain and Spruce Grove obtained their water supply from the water line. Therefore, the rise in the water level in the observation water well was most likely a result of a switch from a groundwater supply to a water supply from the pipeline. In the 1980s, the water level in the observation water well was above the level measured at the start of monitoring in the early 1960s.

AEP Obs WW No. 377 is completed at a depth of 25.6 metres below ground level in the uppermost part of the bedrock, which is the Paskapoo Formation. The water-level monitoring began in 1987 and data are available to early 1996. Although there are breaks in the water-level record, the water level rose from 1987 to 1990. Throughout 1990 and 1991 the water-level change was less than 0.5 metres. In 1992, 1993 and the first half of 1994, the water level declined 1.5 metres. Between 1994 and 1995, there was no net decline in the water level, although an annual fluctuation is evident. On 26 Feb 92, the Village of Entwistle was authorized to divert up to 226 m³/day from a water supply well in 02-20-053-07 W5M, no more than a few hundred metres from AEP Obs WW No. 377.

The limited amount of data indicates that in the area of the observation water wells there is no depletion of the groundwater resource.

6.2 Groundwater Flow

A direct measurement of groundwater recharge or discharge is not possible from the data that are presently available for the County. One indirect method of measuring recharge is to determine the quantity of groundwater flowing through each individual aquifer. This method assumes that there is sufficient recharge to maintain the flow through the aquifer and the discharge is equal to the recharge. However, even the data that can be used to calculate the quantity of flow must be averaged and estimated. To determine the flow requires a value for the average transmissivity of the aquifer, an average hydraulic gradient and an estimate for the width of the aquifer. For the present program, the flow has been estimated for those parts of the various aquifers within the County.

The flow through each aquifer assumes that by taking a large area, an aquifer can be considered as homogeneous, that the average gradient can be estimated from the non-pumping water-level surface, and that flow takes place through the entire width of the aquifer. Based on these assumptions, the estimated groundwater flow through the individual aquifers can be summarized as follows:

Aquifer Designation	Transmissivity (m^2/day)	Gradient (m/m)	Width (km)	Main Direction of Flow	Quantity (m^3/day)
Surficial Deposits	14.4	0.003	30	Southeast	1296
Buried Beverly Valley	12.6	0.0045	8	Northeast	454
Paskapoo	25.2	0.005	40	Northwest/Southeast	5040
Upper Scollard	8.4	0.002	60	Northwest/Southeast	1008
Upper Horseshoe Canyon	5.6	0.002	60	Northwest/Southeast	672
Middle Horseshoe Canyon	3.8	0.003	60	Northwest/Southeast	684
Lower Horseshoe Canyon	1	0.003	60	Northwest/Southeast	180

The recharge to these aquifers would be mainly restricted to Parkland County. This means that there would not be a significant inflow of groundwater into the County from the surrounding areas.

6.2.1 Quantity of Groundwater

An estimate of the volume of groundwater stored in the sand and gravel aquifers in the surficial deposits is 0.7 to 4.0 cubic kilometres. This volume is based on an areal extent of 2,700 square kilometres and a saturated sand and gravel thickness of five metres. The variation in the total volume is based on the value of porosity that is used for the sand and gravel. One estimate of porosity is 5%, which gives the low value of the total volume. The high estimate is based on a porosity of 30% (Ozoray, Dubord and Cowen, 1990).

The adjacent water-level map has been prepared by considering water wells completed in aquifers in the surficial deposits. The map shows the highest level of groundwater in surficial deposits, and this level was used for the calculation of saturated surficial deposits and for calculations of recharge/discharge areas.

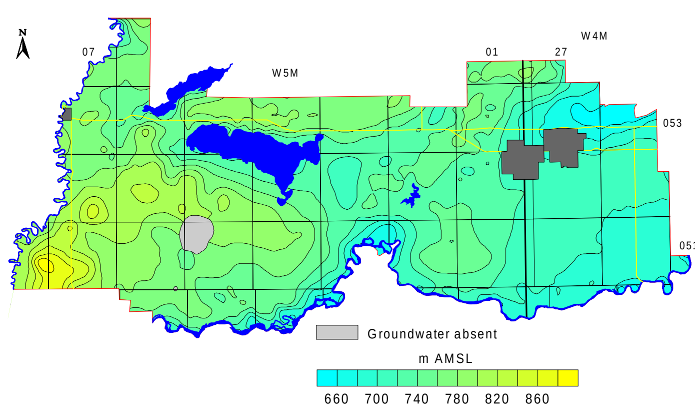

Figure 26. Non-Pumping Water-Level Surface in Water Wells Completed in Surficial Aquifer(s)

6.2.2 Recharge/Discharge

The hydraulic relationship between the groundwater in the surficial deposits and the groundwater in the bedrock aquifers is given by the non-pumping water-level surface associated with each of the hydraulic units. Where the water level in the surficial deposits is at a higher elevation than the water level in the bedrock aquifers, there is the opportunity for groundwater to move from the surficial deposits into the bedrock aquifers. This condition would be considered as an area of recharge to the bedrock aquifers and an area of discharge from the surficial deposits. The amount of groundwater that would move from the surficial deposits to the bedrock aquifers is directly related to the vertical permeability of the sediments separating the two aquifers.

When the hydraulic gradient is from the bedrock aquifers to the surficial deposits, the condition is a discharge area, relative to the bedrock aquifers.

6.2.2.1 Surficial Deposits/Bedrock Aquifers

The hydraulic gradient between the surficial deposits and the bedrock aquifers has been determined by subtracting the elevation of the non-pumping water-level surface associated with all water wells completed in the bedrock aquifers from the elevation of the non-pumping water-level surface, determined for all water wells in the surficial deposits. The recharge classification on the adjacent map includes those areas where the water level in the surficial deposits is more than five metres above the water level in the upper bedrock aquifer(s). The discharge areas are where the water level in the surficial deposits is more than five metres lower than the water level in the bedrock. When the elevation of the water level in the surficial deposits is between five metres above and five metres below the elevation of the water level in the bedrock, the area is classified as a transition.

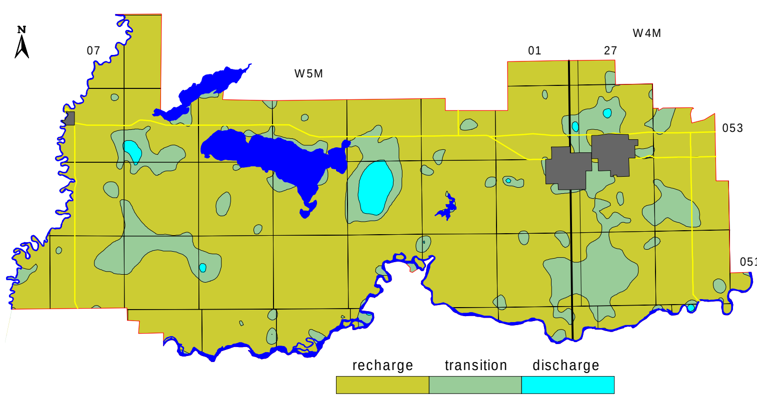

Figure 27. Recharge/Discharge Areas between Surficial Deposits and Upper Bedrock Aquifer(s)

The adjacent map shows that in more than 85% of the County there is a downward hydraulic gradient between the surficial deposits and the upper bedrock aquifer(s). Areas where there is an upward hydraulic gradient, discharge from the bedrock, are very few. One of the main areas of discharge from the bedrock is in Tp 052, R 03, W5M, east of Wabamun Lake. The remaining parts of the County are areas where there is a transition condition. One of the main areas of transitional flow trends north-south and is on the east side of the Fifth Meridian, passing beneath the towns of Stony Plain and Spruce Grove. The other main areas of transitional flow occur in range 06, W5M. The extensive areas of transition conditions may be a result of the topographic relief and/or the limited amount of data for both aquifer conditions generally and specifically for the surficial deposits.

Because of the paucity of data, a calculation of the volumes of groundwater entering and leaving the surficial deposits has not been attempted.

Previous work associated with the Town of Stony Plain has shown that with the diversion of 2,500 m^3/day (Hydrogeological Consultants Ltd., 1998) there has been no appreciable lowering of the water level in the Lower Sand and Gravel Aquifer after 20 years of diversion. Based on the regional results, the estimated flow through the Lower Sand and Gravel Aquifer associated with the Buried Beverly Valley is 454 m^3/day. The lower value based on the regional data may be a result of the data being mainly from domestic water wells and from the method of calculating apparent transmissivity. In order to support a flow of 2,500 m^3/day through the Aquifer and all other conditions remaining constant, the transmissivity of the aquifer would need to be 70 m^2/day. This value of transmissivity is less than the 800 m^2/day determined from the aquifer tests with the original dewatering wells (Hydrogeological Consultants Ltd., 1976).

Based on the water-level map for the surficial deposits, the area that could be expected to contribute recharge to the Lower Sand and Gravel Aquifer associated with the Buried Beverly Valley near Stony Plain would be approximately one township, 92 square kilometres. With an average annual precipitation of 533 mm in the area, slightly less than 2% of the precipitation would be needed to maintain a flow of 2,500 m^3/day through the Aquifer.

6.3 Bedrock Aquifers

Recharge to the bedrock aquifers within the County takes place mainly from the overlying surficial deposits. The amount of flow from outside the County is considered to be minimal. The recharge/discharge maps show that generally for most of the County, there is a downward hydraulic gradient from the surficial deposits to the bedrock. On a regional basis, calculating the quantity of water involved is not possible because of the complexity of the geological setting and the limited amount of data. However, because of the generally low permeability of the upper bedrock materials, the volume of water is expected to be small.

The hydraulic relationship between the surficial deposits and the Paskapoo Aquifer indicates that in 80% of the County where the Paskapoo is present, there is a downward hydraulic gradient. The main discharge occurs at the edge of the Paskapoo Formation south and west of Wabamun Lake. There is also an extensive transition flow area that extends northwest from the North Saskatchewan River in townships 050 and 051, ranges 05 and 06, W5M. Because both the Pembina and North Saskatchewan rivers are deeply incised into the bedrock, there would be little or no groundwater flow into the County in the Paskapoo Formation.

The hydraulic relationship between the surficial deposits and the Upper and Lower Scollard Aquifer indicates that in 95% of the County where the Aquifer is present, there is a downward hydraulic gradient. Discharge or transition areas are present mainly along the eastern edges of the Scollard Formation.

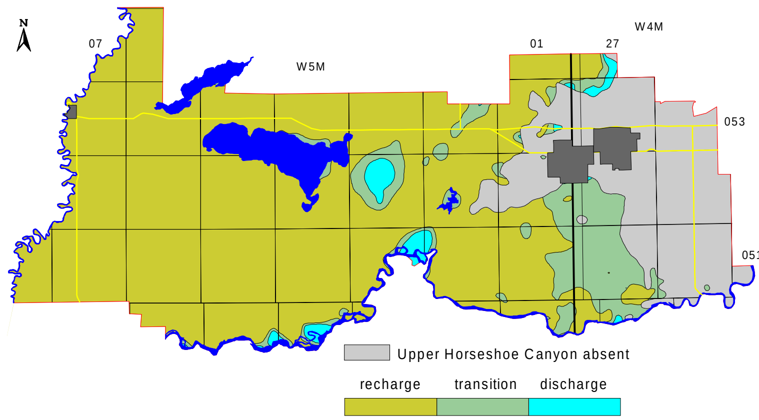

Figure 28. Recharge/Discharge Areas between Surficial Deposits and Upper Horseshoe Canyon Aquifer

The recharge/discharge configuration for each of the Upper, Middle and Lower Horseshoe Canyon formations and the surficial deposits shows that, generally, discharge from the bedrock occurs over an area of less than 10% of the County. The discharge from the Lower Horseshoe Canyon Aquifer is mainly along the North Saskatchewan River in the south-central part of the County. Discharge from the Middle Horseshoe Canyon Aquifer is minimal but the areas of transitional flow are associated with the Buried Beverly Valley and an area southeast of the towns of Stony Plain and Spruce Grove. One of the main transitional zones for the Upper Horseshoe Canyon Aquifer is along the eastern edge of the Formation south of the towns of Stony Plain and Spruce Grove.

The recharge/discharge maps generally support the idea that there is flow through the aquifers from west to east, with there being discharge from the individual units only when there cannot be any more flow through the aquifers because they have been eroded.

7 POTENTIAL FOR GROUNDWATER CONTAMINATION

The most common sources of contaminants that can impact groundwater originate on or near the ground surface. The contaminant sources can include leachate from landfills, effluent from leaking lagoons or from septic fields, and petroleum products from storage tanks or pipeline breaks. The agricultural activities that generate contaminants include spreading of fertilizers, pesticides, herbicides and manure. The spreading of highway salt can also degrade groundwater quality.

When activities occur that do or can produce a liquid which could contaminate groundwater, it is prudent (from a hydrogeological point of view) to locate the activities where the risk of groundwater contamination is minimal. Alternatively, if the activities must be located in an area where groundwater can be more easily contaminated, the necessary action must be taken to minimize the risk of groundwater contamination.

The potential for groundwater contamination is based on the concept that the easier it is for a liquid contaminant to move downward, the easier it is for the groundwater to become contaminated. In areas where there is groundwater discharge, liquid contaminants cannot enter the groundwater flow systems to be distributed throughout the area. When there are groundwater recharge areas, low-permeability materials impede the movement of liquid contaminants downward. Therefore, if the soils develop on a low-permeability parent material of till or clay, the downward migration of a contaminant is slower relative to a high-permeability parent material such as sand and gravel of fluvial origin. Once a liquid contaminant enters the subsurface, the possibility for groundwater contamination increases if it coincides with a higher permeability material within one metre of the land surface.

To determine the nature of the materials on the land surface, the surficial geology map prepared by the Alberta Research Council (Shetsen, 1990) has been reclassified based on the relative permeability. The classification of materials is as follows:

1. high permeability - sand and gravel;
2. moderate permeability - silt, sand with clay, gravel with clay, and bedrock; and
3. low permeability - clay and till.

To identify the areas where sand and gravel can be expected within one metre of the ground surface, all groundwater database records with lithologies were reviewed. From a total of 2,563 records in the area of the County with lithology descriptions, 608 have sand and gravel within one metre of ground surface. In the remaining 1,955 records, the first sand and gravel is deeper or not present. This information was gridded to prepare a distribution of where the first sand and gravel deposit could be expected within one metre of ground level.