

5.3.4 Upper Lacombe Aquifer

The Upper Lacombe Aquifer comprises the porous and permeable parts of the Upper Lacombe Member that subcrops under the surficial deposits in parts of townships 047 to 049, ranges 01 to 04, W5M in the southwestern part of the County. The thickness of the Upper Lacombe Member is mainly between 20 and 60 metres but varies from less than 20 metres at the northeastern extent to 80 metres in the southwestern part of the County.

5.3.4.1 Depth to Top

The depth to the top of the Upper Lacombe Member is a function of the thickness of the surficial deposits, which ranges from less than 10 metres to more than 20 metres.

5.3.4.2 Apparent Yield

The apparent yields for individual water wells completed through the Upper Lacombe Aquifer are mainly between 10 and 100 m³/day. The adjacent map indicates that apparent yields of more than 100 m³/day are expected mainly in ranges 03 and 04, W5M.

5.3.4.3 Quality

The groundwaters from the Upper Lacombe Aquifer are mainly a sodium-bicarbonate type (see CD-ROM). The TDS concentrations are expected to be mainly less than 500 mg/L, with higher values mainly in townships 047 to 049, ranges 02 to 04, W5M. The sulfate concentrations are generally less than 100 mg/L. The chloride concentrations of the groundwaters from the Upper Lacombe Aquifer range from less than 4 to a high of 13 mg/L.

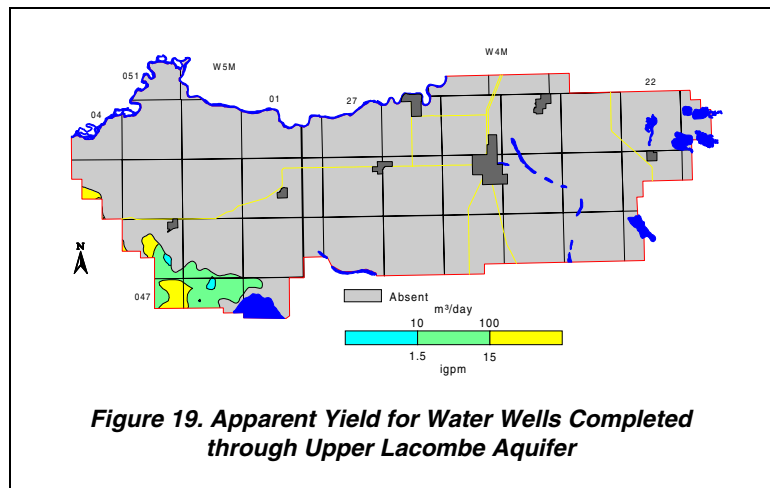


Figure 19. Apparent Yield for Water Wells Completed through Upper Lacombe Aquifer

5.3.5 Lower Lacombe Aquifer

The Lower Lacombe Aquifer comprises the porous and permeable parts of the Lower Lacombe Member. The Lower Lacombe Aquifer subcrops in the southwestern part of the County and underlies the Upper Lacombe Aquifer. The thickness of the Lower Lacombe Member is mainly between 40 and 80 metres.

5.3.5.1 Depth to Top

The depth to the top of the Lower Lacombe Member varies from less than 20 metres below ground level at the northeastern extent of the Member to more than 80 metres in the southwestern part of the County.

5.3.5.2 Apparent Yield

The apparent yields for individual water wells completed through the Lower Lacombe Aquifer are mainly between 10 and 100 m³/day. The adjacent map indicates that apparent yields of more than 100 m³/day are expected at the eastern extent of the Member in township 048, range 02, W5M.

Two Talisman Energy Inc. (Talisman) water source wells in 16-34-047-02 W5M are authorized to divert a total of 360 m³/day (Hydrogeological Consultants Ltd. (HCL), 1999). The water source wells are completed in the Lower Lacombe Aquifer. An extensive aquifer test with the two water source wells in 1989 (HCL, 1989) indicated an effective transmissivity of 25 m²/day and a corresponding storativity of 0.0016.

5.3.5.3 Quality

The groundwaters from the Lower Lacombe Aquifer are mainly a sodium-bicarbonate type (see CD-ROM). The TDS concentrations are mostly between 500 and 750 mg/L. The higher values are in the southwestern corner of the County. The sulfate concentrations are generally less than 100 mg/L. Chloride concentrations in the groundwaters from the Lower Lacombe Aquifer range from less than 4 to more than 10 mg/L.

The groundwaters from the Talisman water source wells are sodium-bicarbonate-types. Between 1970 and 1997, five groundwater samples were collected from the two water source wells in the Lower Lacombe Member (HCL, May 1998). The TDS concentrations ranged from 500 to 800 mg/L, sulfate concentrations ranged from below the detection limit to 5 mg/L, and chloride concentrations ranged from 15 to 47 mg/L.

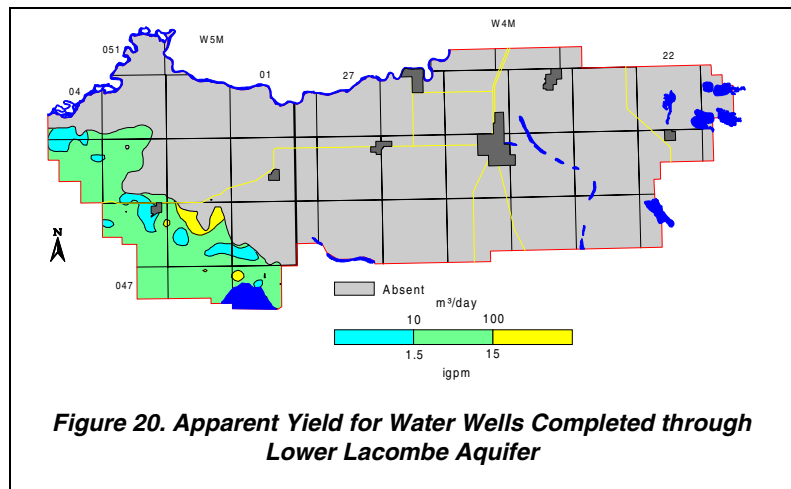


Figure 20. Apparent Yield for Water Wells Completed through Lower Lacombe Aquifer

5.3.6 Haynes Aquifer

The Haynes Aquifer comprises the porous and permeable parts of the Haynes Member. The Haynes Member underlies the Lower Lacombe Member and subcrops under the surficial deposits in the western part of the County. The thickness of the Haynes Member is mainly between 30 and 50 metres but varies from less than 10 metres at the northeastern extent to 60 metres in the southwestern part of the County.

5.3.6.1 Depth to Top

The depth to the top of the Haynes Member is variable, ranging from less than 20 metres at the northeastern extent to more than 140 metres in the southwestern part of the County.

5.3.6.2 Apparent Yield

The apparent yields for individual water wells completed through the Haynes Aquifer range from less than 10 to more than 100 m³/day. The areas where water wells with higher yields are expected are mainly where the Haynes Member subcrops under the surficial deposits and would be most subjected to weathering processes.

An aquifer test conducted with the Fred Kostyk Lawn Water Well completed in the Haynes Aquifer and drilled in NE 23-048-02 W5M in 1981 (HCL, January 1998) indicated a long-term yield in excess of 11.5 m³/day based on a transmissivity of 19.2 m²/day and a pumping rate of 8 litres per minute.

Additional data for the Haynes Aquifer are available for a water source well in the Alder Flats area, southwest of the County, in 01-17-045-07 W5M (HCL, 1995). An extended aquifer test indicated a long-term yield of 45 m³/day based on an effective transmissivity of 0.25 m²/day.

5.3.6.3 Quality

The groundwaters from the Haynes Aquifer are mainly a bicarbonate type (see CD-ROM). The TDS concentrations are mostly between 500 and 750 mg/L. The sulfate concentrations are generally less than 100 mg/L. Chloride concentrations in the groundwaters from the Haynes Aquifer are mainly less than 10 mg/L. Groundwater from the Fred Kostyk Lawn Water Well (HCL, January 1998) is a sodium-bicarbonate-type, has a TDS concentration of 627 mg/L, a sulfate concentration of 53 mg/L and a chloride concentration of 3.4 mg/L. Groundwater from the Alder Flats area water source well (HCL, 1995), which is completed in the Haynes Aquifer, has a TDS concentration of 1,245 mg/L, a sulfate concentration of 1 mg/L and a chloride concentration of 360 mg/L; the Alder Flats water source well is 382 metres deep.

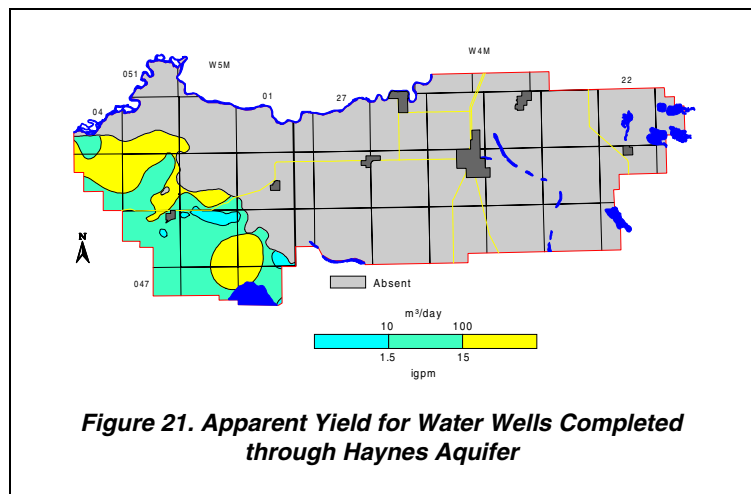


Figure 21. Apparent Yield for Water Wells Completed through Haynes Aquifer

5.3.7 Upper Scollard Aquifer

The Upper Scollard Aquifer comprises the porous and permeable parts of the upper part of the Scollard Formation that underlies the Haynes Member in the westernmost part of the County, and subcrops under the surficial deposits where the Haynes Member has been eroded. The thickness of the Upper Scollard Formation increases to the southwest and can reach 80 metres in the southwestern part of the County.

5.3.7.1 Depth to Top

The depth to the top of the Upper Scollard is variable, ranging from less than 20 metres at the northeastern extent to more than 200 metres in the southwestern corner of the County.

5.3.7.2 Apparent Yield

The apparent yields for water wells completed through the Upper Scollard Aquifer range from less than 10 to more than 100 m³/day, with 17% of the values being between 200 and 700 m³/day.

5.3.7.3 Quality

The groundwaters from the Upper Scollard Aquifer are mainly a sodium-bicarbonate type. The TDS concentrations in groundwaters from the Upper Scollard Aquifer are mainly less than 1,000 mg/L. The sulfate concentrations are mainly less than 100 mg/L. Chloride concentrations in the groundwaters from the Upper Scollard Aquifer range from less than 4 to more than 10 mg/L.

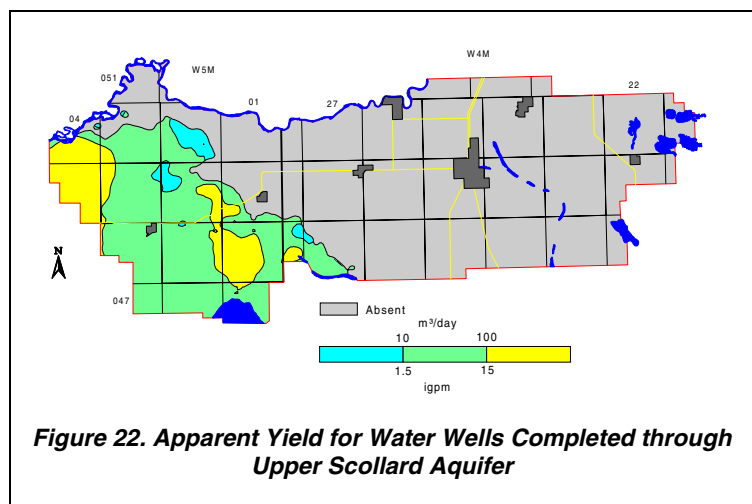


Figure 22. Apparent Yield for Water Wells Completed through Upper Scollard Aquifer

5.3.8 Lower Scollard Aquifer

The Lower Scollard Aquifer comprises the porous and permeable parts of the lower part of the Scollard Formation that underlies the Upper Scollard Aquifer, and subcrops under the surficial deposits in the western part of the County. The thickness of the lower part of the Scollard Formation is mainly between 30 and 40 metres but varies from less than 10 metres at the northeastern extent to more than 40 metres in the southwestern part of the County.

5.3.8.1 Depth to Top

The depth to the top of the Lower Scollard is variable, ranging from less than 20 metres at the northeastern extent to more than 280 metres in the southwestern part of the County.

5.3.8.2 Apparent Yield

The apparent yields for water wells completed through the Lower Scollard Aquifer are significantly less than the yield of water wells completed through the Upper Scollard Aquifer. Fifty-seven percent of the values for apparent yield for the water wells completed in the Lower Scollard Aquifer are less than 10 m³/day. The adjacent map shows the higher yields toward the western edge of the County. However, these values are a result of the gridding procedure used to process a limited number of data points. The number of data points is limited in the western part of the County, due to the increased depth of burial. It is expected that the yields for water wells completed in the Lower Scollard Aquifer in the western part of the County will be less than 50 m³/day.

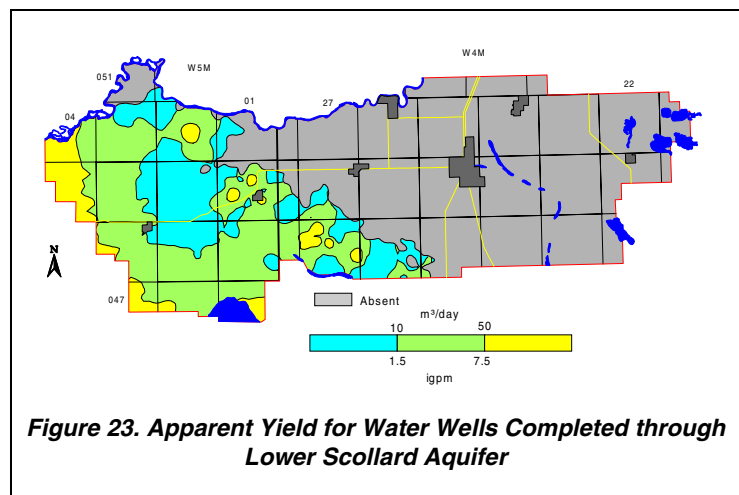


Figure 23. Apparent Yield for Water Wells Completed through Lower Scollard Aquifer

5.3.8.3 Quality

There are two water well records in the database with sufficient information to determine the chemical type of groundwaters from the Lower Scollard Aquifer. The groundwaters from the Lower Scollard Aquifer are a sodium-bicarbonate-type. There are 12 water well records in the database that have TDS, chloride and sulfate values for water wells completed through the Lower Scollard Aquifer. The TDS concentrations in groundwater from the Lower Scollard Aquifer range from less than 750 to more than 1,000 mg/L. The higher TDS values are in the southwestern part of the County. The sulfate concentrations in the groundwaters from the Lower Scollard Aquifer are mainly less than 100 mg/L. The two small areas on the map (see CD-ROM) that indicate sulfate concentrations of more than 100 mg/L are a result of the gridding procedure used to process data from adjacent counties. The chloride concentrations in the groundwaters from the Lower Scollard Aquifer range from less than 4 to more than 10 mg/L.

5.3.9 Upper Horseshoe Canyon Aquifer

The Upper Horseshoe Canyon Aquifer comprises the porous and permeable parts of the Upper Horseshoe Canyon Formation that underlies the Scollard Formation, and subcrops under the surficial deposits in 40% of the County. The thickness of the Upper Horseshoe Canyon Formation increases to the southwest and can reach more than 100 metres in the western part of the County.

5.3.9.1 Depth to Top

The depth to the top of the Upper Horseshoe Canyon Formation is variable, ranging from less than 20 metres at the eastern extent to more than 300 metres in the extreme southwestern corner of the County.

5.3.9.2 Apparent Yield

The apparent yields for water wells completed through the Upper Horseshoe Canyon Aquifer range from less than 10 to more than 100 m³/day; sixty-nine percent of the apparent yield values that are available are between 10 and 50 m³/day. The lower yields presented in the western part of the County, and shown on the adjacent map, could be a result of the gridding procedure used to process a very limited number of data points due to the depth of burial. The areas where water wells with higher yields are expected are mainly where the Upper Horseshoe Canyon Formation subcrops under the surficial deposits and would be most subjected to weathering processes.

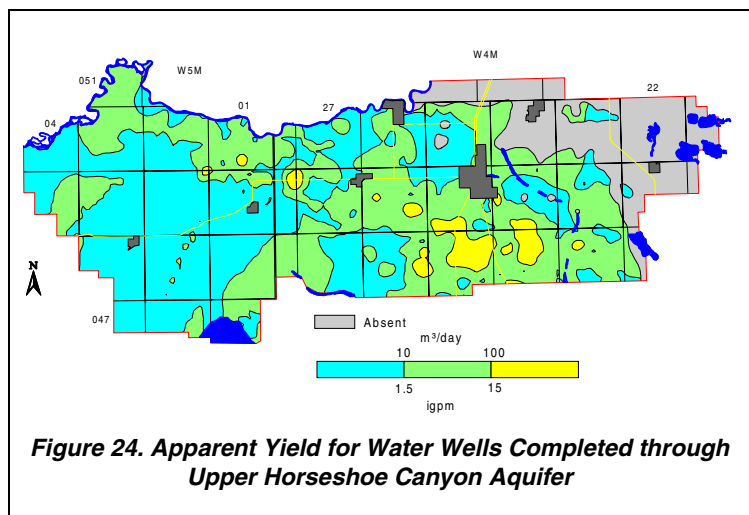


Figure 24. Apparent Yield for Water Wells Completed through Upper Horseshoe Canyon Aquifer

An extended aquifer test conducted with the Village of Calmar's Water Test Hole 80-6, drilled in 07-25-049-07 W5M and completed in the Upper Horseshoe Canyon Aquifer (MLM, 1980), indicated a long-term yield of more than 100 m³/day based on a transmissivity of 85 m²/day.

5.3.9.3 Quality

The groundwaters from the Upper Horseshoe Canyon Aquifer are mainly sodium-bicarbonate or sodium-sulfate types. The TDS concentrations in groundwaters from the Upper Horseshoe Canyon Aquifer are mainly less than 1,500 mg/L. The higher TDS values are in ranges 23 and 24, W4M. The sulfate concentrations are mainly less than 500 mg/L. Chloride concentrations in the groundwaters from the Upper Horseshoe Canyon Aquifer are mainly less than 250 mg/L.

Chemistry data were not available for the Village of Calmar water test hole completed in the Upper Horseshoe Canyon Aquifer.

5.3.10 Middle Horseshoe Canyon Aquifer

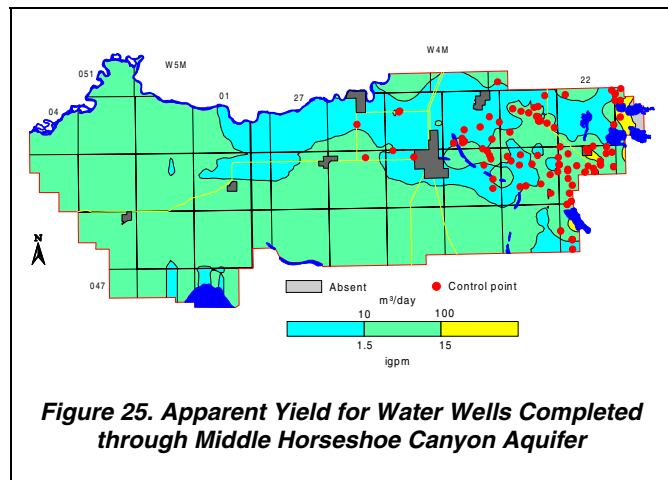
The Middle Horseshoe Canyon Aquifer comprises the porous and permeable parts of the Middle Horseshoe Canyon Formation which subcrops under the surficial deposits in the northeastern part of the County. The thickness of the Middle Horseshoe Canyon Formation increases to the west and can reach more than 70 metres in the western part of the County. In general terms, the permeability of the Middle Horseshoe Canyon Aquifer is very low. Higher local permeability can be expected when the depth of burial is less than 100 metres and weathering processes have occurred.

5.3.10.1 Depth to Top

The depth to the top of the Middle Horseshoe Canyon Formation is variable, ranging from less than 50 metres in the eastern part of the County to more than 350 metres in the southwestern part of the County.

5.3.10.2 Apparent Yield

The apparent yields for water wells completed through the Middle Horseshoe Canyon Aquifer range from less than 10 to more than 100 m³/day. However, 82% of the values for apparent yield are less than 50 m³/day. The lower yields presented in the north-central third of the County could be a result of the gridding procedure used to process a very limited number of data points due to the depth to the top of the Formation. The areas where water wells with higher yields are expected are mainly at the eastern extent of the Aquifer where the Middle Horseshoe Canyon Formation subcrops under the surficial deposits and would be most subjected to weathering processes.



An extended aquifer test was conducted with the Village of New Sarepta's Water Test Hole (WTH) No. 6-81 in SW 34-049-22 W4M was completed in the Middle Horseshoe Canyon Aquifer (Tokarsky, 1981). The long-term yield for this water test hole is more than 300 m³/day. The high projected long-term yield may be a result of the weathering processes, increasing the local transmissivity of the Aquifer.

5.3.10.3 Quality

The groundwaters from the Middle Horseshoe Canyon Aquifer are mainly sodium-bicarbonate or sodium-sulfate types, with TDS mainly between 1,000 and 1,500 mg/L. The sulfate concentrations are generally less than 500 mg/L and chloride concentrations are mainly less than 100 mg/L. The groundwaters from WTH No. 6-81 are a sodium-bicarbonate type. Two groundwater samples from Water Test Hole 6-81 while completed in the Middle Horseshoe Canyon Aquifer (Tokarsky, 1981) had TDS concentrations of 757 and 826 mg/L, sulfate concentrations of 68 and 73 mg/L and chloride concentrations of 3 and 4 mg/L.

All of the chemical parameter maps exhibit lower values in the western part of the County as a result of the gridding process using limited data control.

5.3.11 Lower Horseshoe Canyon Aquifer

The Lower Horseshoe Canyon Aquifer comprises the porous and permeable parts of the Lower Horseshoe Canyon Formation which subcrops under the surficial deposits in a small area in the extreme northeastern part of the County. The thickness of the Lower Horseshoe Canyon Formation increases to the west and can reach more than 160 metres in the western part of the County. In general terms, the permeability of the Lower Horseshoe Canyon Aquifer is very low. Higher local permeability can be expected when the depth of burial is less than 100 metres and weathering processes have occurred. In the eastern two-thirds of the County, the Lower Horseshoe Canyon Formation is above the Base of Groundwater Protection.

5.3.11.1 Depth to Top

The depth to the top of the Lower Horseshoe Canyon Formation is variable, ranging from less than 50 metres in the northeastern part of the County to more than 550 metres in the southwestern part of the County.

5.3.11.2 Apparent Yield

There are 14 values available for the apparent yields for water wells completed in the Lower Horseshoe Canyon Aquifer. Of these 14 values, three are from drill stem tests, which are the westernmost control points on the adjacent figure. The control points in Tp 050, R 21, W4M all have apparent yields of greater than 100 m³/day.

In general terms, the yields from the Lower Horseshoe Canyon Aquifer can be more than 1,000 m³/day where the aquifer has been subjected to weathering processes, to less than 10 m³/day where the depth of burial is significant and less weathering has occurred.

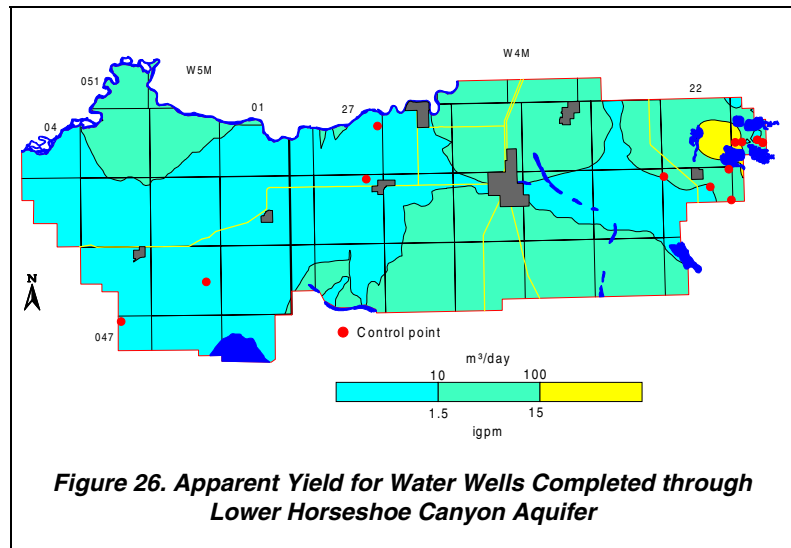


Figure 26. Apparent Yield for Water Wells Completed through Lower Horseshoe Canyon Aquifer

5.3.11.3 Quality

The groundwaters from the Lower Horseshoe Canyon Aquifer are sodium-bicarbonate or sodium-sulfate types, based on the information provided on five water well records in the database. From these and the few partial chemical analyses results available, the concentrations of TDS are mainly less than 1,500 but range from 500 to more than 2,000 mg/L, the sulfate values are mainly between 100 and 500 mg/L and the chloride concentrations are mainly less than 250 mg/L.

All of the chemical parameter maps exhibit lower values west of range 24, W4M (see CD-ROM) as a result of the gridding process using limited data control.

6 GROUNDWATER BUDGET

6.1 Hydrographs

There are sixteen locations in the County where water levels are being measured and recorded with time. These sites are observation water wells (Obs WWs) that are part of the AEP regional groundwater-monitoring network. These sixteen Obs WWs are in four main areas of the County. Of the sixteen Obs WWs, thirteen are in the vicinity of the Village of Warburg (six in 12-10-048-03 W5M, seven in 14-04-048-02 W5M), and the remaining three are in 02-18-049-23 W4M (Rollyview), 10-26-049-25 W4M (Leduc) and 08-36-050-26 W4M (Devon). Water-level measurements are available for the Rollyview Obs WW but are of limited use, and are not presented in the report.

The water-level fluctuations in AEP Obs No. 320 in 14-04-048-02 W5M have been compared to the summer precipitation measured at the Calmar weather station; the comparison is shown in the adjacent graph. The observation water well is 9.1 metres deep and is completed in the Upper Lacombe Aquifer. The summer precipitation includes the total precipitation measured in May, June, July and August of each year. The comparison shows that the water-level fluctuation reflects the changes in summer precipitation. The highest peaks in water level occur in 1986, 1990 and 1991. These peaks correspond to three of the four highest years of summer precipitation. The water-level fluctuations show two water peaks for most years. The first peak would be associated with recharge when the frost leaves the ground and the second coincides with the end of the growing season. The low water level at the start of each year is a result of no recharge to the groundwater flow system during the time of ground frost.

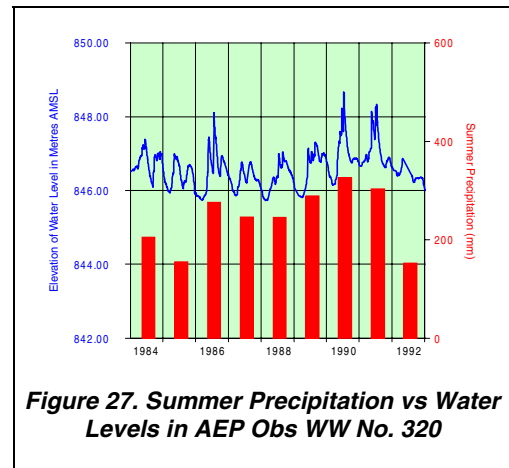


Figure 27. Summer Precipitation vs Water Levels in AEP Obs WW No. 320

There are six other AEP Obs WWs in 14-04-048-02 W5M, completed in aquifers ranging from the Lower Lacombe to the Upper Horseshoe Canyon. The water-level measurements for AEP Obs WW No. 344, completed at a depth of 244 metres below ground level in the Upper Horseshoe Canyon Aquifer, are available from 1983 to 1988 but are of limited use. However, the schematic drawing of the drilling log for Obs WW No. 344 was used to show the completion intervals for six of the seven AEP Obs WWs in 14-04-048-02 W5M (see Appendix A). The hydrographs for AEP Obs WW Nos. 315, 319 and 317 completed in the Lower Lacombe Aquifer also show water-level peaks that can be related to the precipitation peaks in 1986, 1990 and 1991. However, the water level in AEP Obs WW No. 316, completed at a depth of 125 metres in the Haynes Aquifer, shows no relationship to the precipitation peaks.

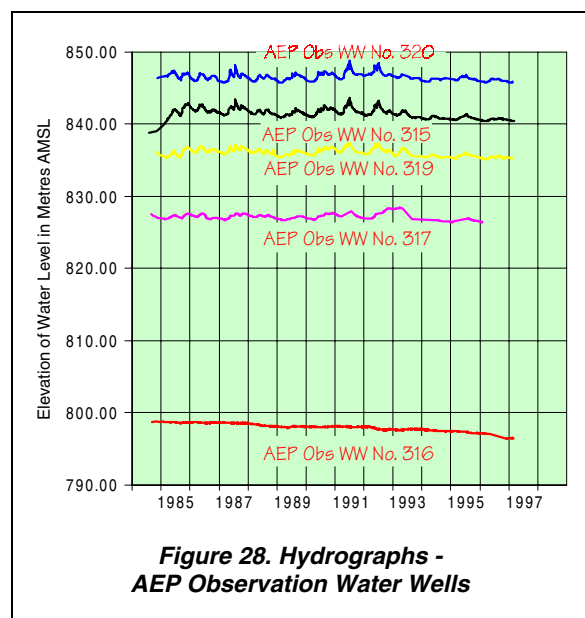


Figure 28. Hydrographs - AEP Observation Water Wells