6 GROUNDWATER BUDGET

6.1 Hydrographs

In the County, there are three observation water wells that are part of the AENV regional groundwater monitoring network. These are locations where water levels are being measured and recorded as a function of time: AENV Obs Water Well Ponoka 60-2 (AENV Ponoka Obs WW) in 02-08-043-25 W4M, AENV Obs Water Well Crestomere Lake North Obs No. 1 (AENV Crestomere Lake Obs WW) in 01-34-043-28 W4M and AENV Obs Water Well Gull Lake (AENV Gull Lake Obs WW) in 01-22-042-01 W5M. The water level in AENV Ponoka Obs WW has been measured since January 1964, the water level in AENV Crestomere Lake Obs WW has been measured since December 1990, and the water level in AENV Gull Lake Obs WW has been measured since December 1964 (see page A-57).

The AENV Ponoka Obs WW is completed from 31.4 to 68.0 metres below ground surface mainly in the Upper Scollard Aquifer. The hydrograph shows that the water levels in AENV Ponoka Obs WW have declined in the order of 24 metres since 1973 (see page A-57). The water-level fluctuations in AENV Ponoka Obs WW have been compared to the available monthly precipitation measured at the Ponoka South weather station.

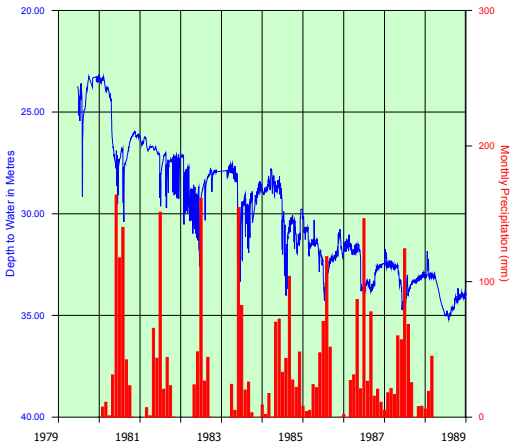

Figure 28. Monthly Precipitation vs Water Levels in AENV Ponoka Obs WW

In an area where there are no pronounced seasonal uses of groundwater, the highest water level will usually occur in late spring/early summer and the lowest water level will be in late winter/early spring. In the adjacent figure, it was noted that the highest water levels occur in late winter/early spring and the lowest water levels are mainly during summer. This situation is a result of increased groundwater use by the Town of Ponoka during the summer months. The Town of Ponoka is authorized to divert more than 4,000 m³/day of groundwater for municipal purposes. The Town of Ponoka diverts groundwater from 11 water supply wells, of which eight are completed in the Upper Scollard Aquifer. The remaining three water supply wells are completed in multiple bedrock aquifers.

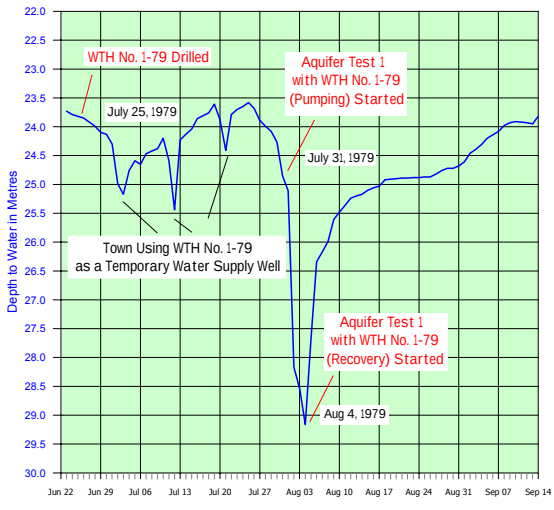

Figure 29. Comparison between AENV Ponoka Obs WW Water Levels and Groundwater Production

In 1979, WTH No. 1-79 was drilled for the Town of Ponoka to augment the Town's water supply. An extended aquifer test commenced on July 31, 1979 and consisted of a 6285-minute pumping interval followed by a 22,800-minute recovery interval. The average pumping rate during the test was 2,070 litres per minute. The water level in AENV Ponoka Obs WW was monitored during the aquifer test. The adjacent figure illustrates the direct hydraulic relationship between the water level in AENV Ponoka Obs WW and the groundwater production from WTH No. 1-79 (HCL, Apr-1980).

During the pumping interval of the aquifer test with WTH No. 1-79, the water level in AENV Ponoka Obs WW declined more than four metres. The water level in AENV Ponoka Obs WW recovered to its pre-aquifer-test water level by Aug 17, 1979 (page A-59).

A second example illustrating the impact groundwater production has on water levels is with AENV Crestomere Lake Obs WW in 01-34-043-28 W4M. In SE 23-043-28 W4M, PanCanadian Petroleum Limited is licensed to divert 600 m³/day from two water source wells completed in the Upper Lacombe Aquifer in the Crestomere area. From 1991 to 1999, PanCanadian diverted an average of 345 m³/day from WSW Nos. 1-88 and 1-89 (HCL, Jan-2000). From 1991 to 1999, the water levels were monitored in WSW Nos. 1-88 and 1-89 and ten privately owned water wells in the area that were used as observation water wells by Pan Canadian.

The Engelen SE 18 Stock WW in SE 18-043-27 W4M is one of the observation water wells that was monitored as part of the PanCanadian Petroleum Limited groundwater monitoring program. The Engelen SE 18 Stock WW is completed from 48.8 to 67.1 metres below ground surface in the Upper Lacombe Aquifer and is 3,300 metres southeast of the two water source wells. In order to determine if water-level fluctuations in the Engelen SE 18 Stock WW were in response to the groundwater production from WSW Nos. 1-88 and 1-89, a mathematical simulation using a model aquifer was completed. The model aquifer was used to calculate the water levels in the Engelen SE Stock WW based on the PanCanadian production since 1991, with an aquifer transmissivity of 40 m²/day and a corresponding storativity of 0.0008. The model aquifer has a boundary 500 metres west of the water source wells. The calculations are based on an aquifer that is homogeneous and isotropic. No allowance has been made for aquifer recharge. Therefore, if there were a decrease in recharge to the groundwater, a water-level decline could occur and the simulation would not account for the change. There is a reasonable match between the measured and the calculated water levels in the Engelen SE 18 Stock WW (see page A-60).

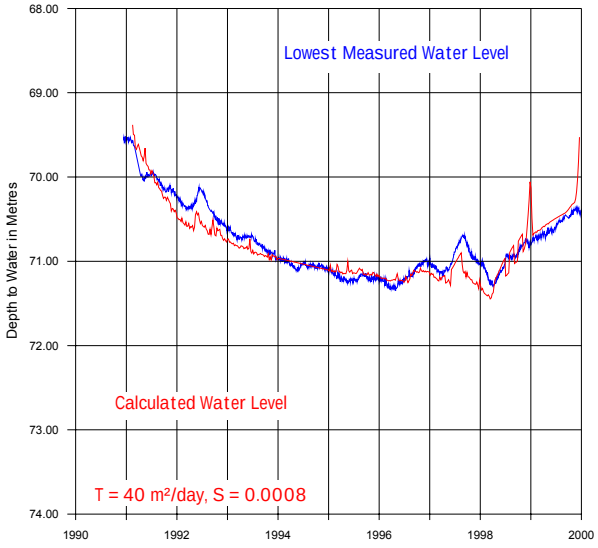

Figure 30. Water-Level Comparison - AENV Crestomere Lake Obs WW

The above parameters were used to calculate the water levels in AENV Crestomere Lake Obs WW, as shown in Figure 30 and page A-61. The AENV Crestomere Lake Obs WW is 3,800 metres northwest of the two PanCanadian water source wells and is completed from 107 to 134.7 metres below ground surface in the Upper Lacombe Aquifer. From the comparison between the calculated water level and the measured water level in AENV Crestomere Lake Obs WW, it can be determined that the groundwater production from WSW Nos. 1-88 and 1-89 has influenced the water-level fluctuations in AENV Crestomere Lake Obs WW.

The flow rate of the Paetkau (Lick) Spring in NW 14-043-28 W4M was measured weekly from 1989 to April 1995 and monthly from May 1995 to 1998 as part of the PanCanadian Petroleum Limited groundwater monitoring program. The measured discharge in the Paekau (Lick) Spring ranged from a low of 63.7 lpm on January 3, 1997 to a high of 563 lpm on January 27, 1992.

The changes in flow rates measured from 1989 to 1998 were compared to precipitation measured at the Dakota West weather station. The comparison shows that the flow-rate fluctuations of the Paetkau (Lick) Spring reflect the changes in precipitation. For example, from June 10 to June 12, 1990, a total of 88 millimetres of precipitation was measured, and in response, the flow rate increased from 230 to 260 litres per minute. Following this major recharge event, 141 mm of precipitation was measured on July 2, 1990. This single-day precipitation is the highest amount that was recorded during the 1989 to 1998 monitoring program. In response, the flow rate measured at the Paetkau (Lick) Spring increased to 379 lpm.

In addition to precipitation, the flow rate measured at the Paetkau (Lick) Spring is influenced by changes in ambient temperature. The adjacent graph shows that in every year when the mean monthly temperature recorded at the Dakota West weather station rose above zero, mainly in April, the flow rate at the Paetkau (Lick) Spring increased. After this initial increase in flow rate in April, the flow rate would decrease until May. In order for the flow rate in the Paetkau (Lick) Spring to continue to increase during seasonal recharge, the June precipitation would need to be in the order of at least 115 mm as shown during the years of 1990, 1991 and 1997 in the adjacent figure. If the June precipitation was below 115 mm, the flow rate generally declined throughout the remainder of the year as shown during the years from 1992 to 1996. The exception that occurred in 1998 may be a result of the day during the month of July when the flow rate was measured at the Paetkau (Lick) Spring (page A-62).

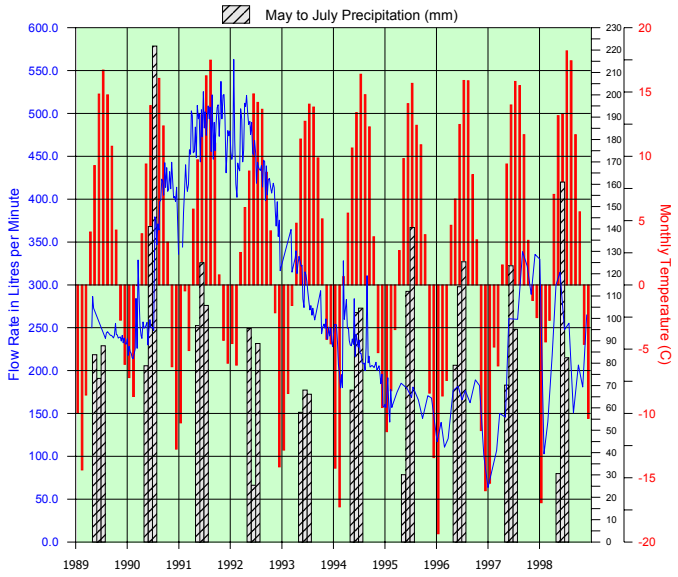

Figure 31. Monthly Temperature and May to July Precipitation vs Flow Rate in Paetkau (Lick) Spring

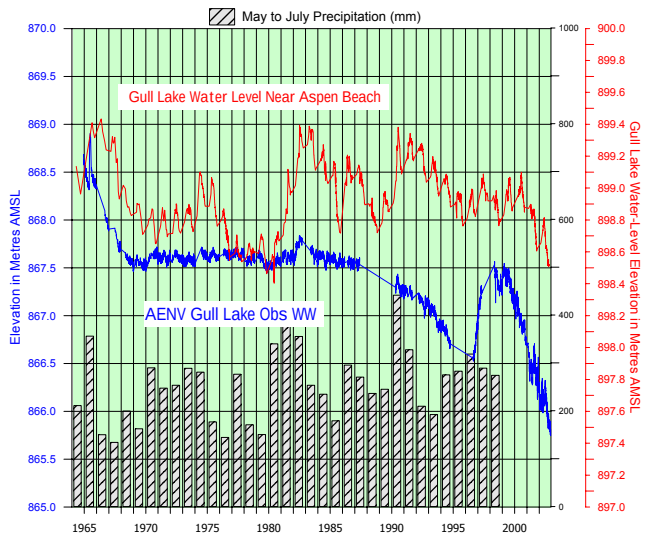

Figure 32. Comparison of Water Levels in AENV Gull Lake Obs WW to Precipitation and Gull Lake Water Level

AENV Gull Lake Obs WW in 01-22-042-01 W5M is completed open hole from 91.4 to 223.5 metres below ground surface in multiple bedrock aquifers.

From 1964 to 2002, the water level in AENV Gull Lake Obs WW has declined 2.5 metres. In order to determine if there is a hydraulic relationship with Gull Lake, the water levels in AENV Gull Lake Obs WW were compared to the total May to July precipitation measured at the Dakota West weather station and to the Gull Lake surface water level recorded near Aspen Beach from 1964 to 2002.

In the mid-1960s, there appears to be a relationship between the water level in AENV Gull Lake Obs WW, the Gull Lake surface water level and the precipitation measured at the Dakota West weather station. However, in subsequent years there are not sufficient AENV Gull Lake Obs WW monitoring data to establish a consistent relationship. The apparent relationship between the lake surface water levels and the AENV Gull Lake Obs WW in the mid-1960s may be because the Obs WW is completed in multiple bedrock aquifers and it took five years for the groundwater elevation to reach a new equilibrium.

Within a 5,000-metre radius of AENV Gull Lake Obs WW, there are a total of 32 authorized non-exempt water wells, the closest being 1,000 metres from AENV Gull Lake Obs WW, which is authorized to divert 0.7 m³/day. The highest authorization is for a water well in 16-08-042-28 W4M, licensed to divert 16.9 m³/day for agricultural purposes. It does not appear that groundwater diversion from authorized non-exempt water wells is having an effect on the water-level fluctuations in AENV Gull Lake Obs WW.

6.2 Estimated Groundwater Use in Ponoka County

An estimate of the quantity of groundwater removed from each geologic unit in Ponoka County must include both the authorized non-exempt and the exempt groundwater diversions. As stated previously on page 6 of this report, the daily water requirement for livestock for the County based on the 2001 census is estimated to be 29,945 cubic metres. As of January 2003, AENV has licensed the use of 6,998 m³/day for livestock, which includes both surface water (based on consumptive use) and groundwater. To obtain an estimate of the quantity of groundwater being diverted from the individual geologic units, it has been assumed that the remaining 22,947 m³/day of water required for livestock watering is obtained from unauthorized groundwater use.

In the groundwater database for the County, there are records for domestic (4,227), domestic/stock (1,277) and stock (1,125) purposes.

Groundwater for household use requires a non-exempt authorization if the use is more than 1,250 m³/year. Under the *Water Act*, a residence is protected for up to 3.4 m³/day. However, the standard groundwater use for household purposes (a family of four) is 1.1 m³/day. Since there are 5,504 domestic water wells in Ponoka County serving a population of 8,852, the domestic use per water well is 0.4 m^3/day.

To obtain an estimate of the groundwater from each geologic unit, there are three possibilities for a water well. A summary of the possibilities and the quantity of water for each use is as follows:

Domestic	0.4 m³/day
Stock	14.3 m³/day
Domestic/stock	14.7 m³/day

Because of the limitations of the data, no attempt has been made to compensate for dugouts, springs or inactive water wells.

Based on using all available domestic, domestic/stock, and stock water wells and corresponding calculations, the following table was prepared. Table 14 shows a breakdown of the 6,629 unauthorized and authorized non-exempt water wells used for domestic, stock, or domestic/stock purposes by the geologic unit in which each water well is completed. The final column in the table equals the total amount of unlicensed groundwater that is being used for both domestic and stock purposes. The data provided in Table 14 indicate that most of the 29,742 m³/day, estimated to be diverted from unlicensed domestic, stock, or domestic/stock water wells, is from the Dalehurst Aquifer or multiple bedrock completions.

	Unauthorized and Authorized Non-Exempt Groundwater Diversions							*Authorized Non-Exempt Groundwater Diversions*	*Unauthorized Groundwater Diversions*
Aquifer Designation	Number of Domestic	Daily Use (0.4 m³/day)	Number of Stock	Daily Use (14.3 m³/day)	Number of Domestic and Stock	Daily Use (14.7 m³/day)	Totals m³/day	Totals (m³/day)	Totals m³/day
Multiple Surficial Completions	132	53	52	743	58	852	1649	3	1646
Upper Sand/Gravel	8	3	7	100	8	118	221	5	216
Lower Sand/Gravel	92	37	30	429	33	485	951	81	870
Multiple Bedrock Completions	738	297	214	3,058	211	3,100	6,456	1,006	5,450
Dalehurst	1,440	579	516	7375	528	7758	15,712	2,533	13,179
Upper Lacombe	80	32	66	943	53	779	1,754	639	1,115
Lower Lacombe	31	12	28	400	23	338	751	228	523
Haynes	170	68	57	815	69	1,014	1,897	755	1,142
Upper Scollard	211	85	69	986	114	1675	2,746	900	1,846
Lower Scollard	59	24	24	343	37	544	910	181	729
Battle and Whitemud	14	6	5	71	7	103	180	13	167
Upper Horseshoe Canyon	703	283	49	700	97	1,425	2,408	268	2,140
Unknown	549	221	8	114	39	573	908	189	719
Totals [1]	4,227	1,700	1,125	16,079	1,277	18,764	36,543	6,801	29,742

[1] The values given in the table have been rounded and, therefore, the columns and rows may not add up equally

Table 14. Total Groundwater Diversions by Aquifer

By assigning 0.4 m³/day for domestic use, 14.3 m³/day for stock use and 14.7 m³/day for domestic/stock use, and using the total maximum authorized diversion associated with any non-exempt water well, a map has been prepared that shows the estimated groundwater use in terms of volume per section per day for the County (not including springs).

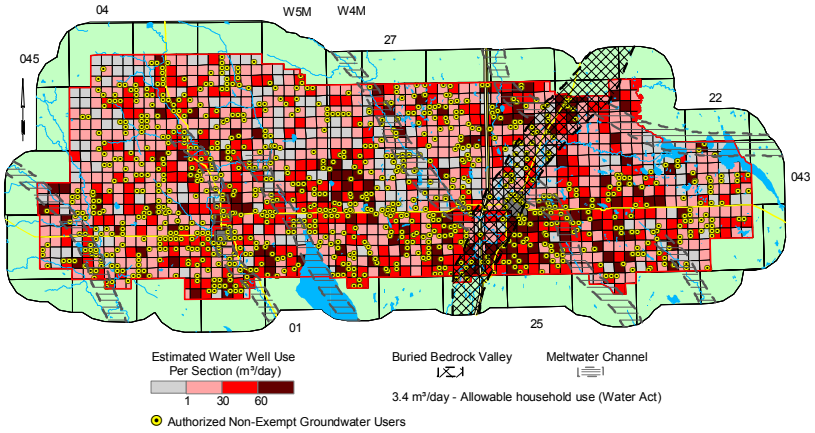

Figure 33. Estimated Water Well Use Per Section

There are 1,274 sections in the County. In 15% (197) of the sections in the County, there is no domestic, stock or authorized non-exempt groundwater user. The range in groundwater use for the remaining 1,077 sections is from 0.2 m³/day to 1,065 m³/day (municipal), with an average use per section of 38 m³/day (5.8 igpm). The estimated water well use per section can be more than 60 m³/day in 157 of the 1,274 sections. There are 317 of the total 1,270 authorized non-exempt groundwater users in areas of greater than 60 m³/day. The most notable areas where water well use of more than 60 m³/day is expected to occur is in township 043, range 28, W4M; township 044, range 25, W4M; and the Town of Ponoka and the areas south of the Town in range 25, W4M, as shown on Figure 33.

Groundwater Use within Ponoka County (m³/day)		%
Domestic/Stock (including agriculture and registrations)	35,887	74
Municipal (licensed)	7,180	15
Commercial/Dewatering/Industrial et al (licensed)	5,669	12
Total	48,736	100

Table 15. Total Groundwater Diversions

In summary, the estimated total groundwater use within Ponoka County is 48,736 m³/day, with the breakdown as shown in the adjacent table. An estimated 48,238 m³/day is being withdrawn from a specific aquifer. The remaining 498 m³/day or 1% is being withdrawn from unknown aquifer units. Of the 48,736 m³/day, 96% is being diverted from bedrock aquifers and 3% from surficial aquifers. Approximately 40% of the total estimated groundwater use is from authorized non-exempt water wells.