5.3.8 Foremost Aquifer

The Foremost Aquifer comprises the permeable parts of the Foremost Formation. The Foremost Formation is present under all of the County and subcrops mainly along the Bow River Valley and the South Saskatchewan River Valley in the west-central part of the County. The thickness of the Foremost Formation is mostly less than 150 metres. Groundwater flow in the Foremost Aquifer is both downdip and toward the Buried Medicine Hat Valley (see CD-ROM).

5.3.8.1 Depth to Top

The depth to the top of the Foremost Formation is variable, ranging from less than 50 metres where it subcrops to more than 700 metres below the Cypress Hills (page A-48).

5.3.8.2 Apparent Yield

There are 106 water well records in the database with sufficient information to calculate apparent yields for individual water wells completed through the Foremost Aquifer; these water wells are located mainly in the vicinity of Medicine Hat. Of the 106 water well records, 61 have apparent yields that range from 10 to 100 and 42 are greater than 100 m³/day. There are four records that indicate dry, or abandoned with “insufficient water”.

A water test hole was completed from 155 to 180 metres below ground surface in the Foremost Aquifer in 16-36-015-07 W4M; however, because a suitable aquifer was not encountered (less than 200 m³/day was required), the water test hole was reclaimed (HCL, 1998). This test hole is located in an area where yields of greater than 300 m³/day are expected.

In the County, there are two licensed water wells that are completed in the Foremost Aquifer. The highest allocation is 54 m^3/day for a Petro-Canada Resources water source well used for commercial purposes in 10-10-015-10 W4M. Both of the licensed water wells completed through the Foremost Aquifer could be linked to a water well in the AENV groundwater database.

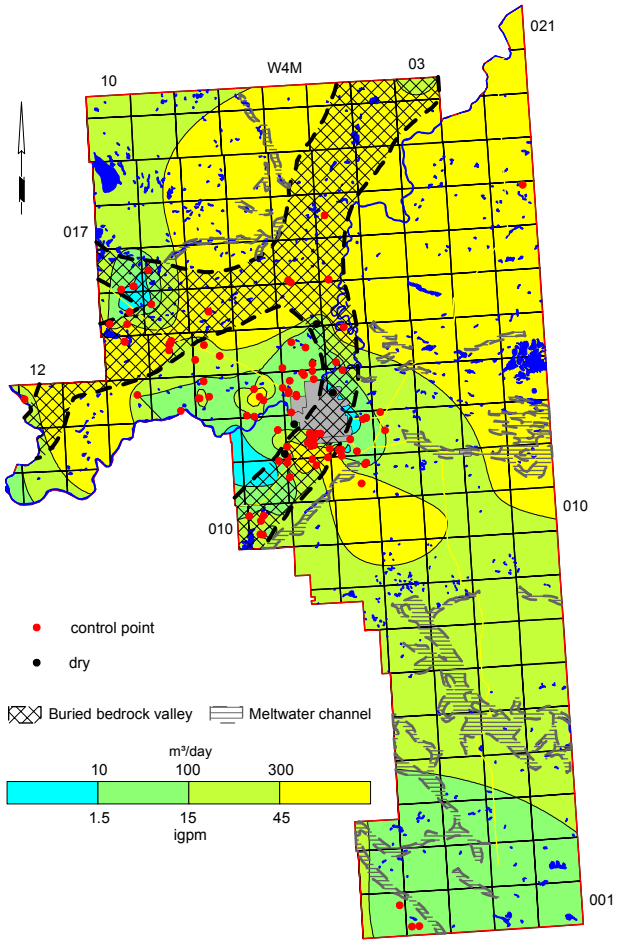

Figure 25. Apparent Yield for Water Wells Completed through the Foremost Aquifer

5.3.8.3 Quality

The groundwaters from the Foremost Aquifer are mainly a sodium-bicarbonate or sulfate type (see Piper diagram on CD-ROM). Total dissolved solids concentrations are mainly greater than 1,000 mg/L. Most of the 241 TDS control points available for the Foremost Aquifer are in the vicinity of Medicine Hat (see page A-50). The sulfate concentrations are mainly below 1,000 mg/L. The indications are that chloride concentrations in the Foremost Aquifer are expected to be mainly less than 100 mg/L. There are six out of 105 analyses where fluoride concentrations exceed 1.5 mg/L.

5.3.9 Milk River Aquifer

The Milk River Aquifer comprises the permeable parts of the Milk River Formation and underlies all of the County. The thickness of the Milk River Formation is mostly less than 100 metres. The main regional groundwater flow in the Milk River Aquifer is downdip and toward the South Saskatchewan River (see CD-ROM).

5.3.9.1 Depth to Top

The depth to the top of the Milk River Formation is variable, ranging from less than 150 metres to more than 1,000 metres in the Cypress Hills area (page A-52).

5.3.9.2 Apparent Yield

In the County, there are three water well records in the database with sufficient information to calculate apparent yields for individual water wells completed through the Milk River Aquifer. In the buffer area, west of the County, there are an additional 160 apparent yield values for the Milk River Aquifer. But with limited data available within the County, the summary results of drill stem tests (DSTs) available from the EUB database were also used. The DST summaries often provide a description of fluid obtained and interval tested during the DST. Therefore, the DST summaries can be used to determine an apparent yield and the quality of fluid available from the Milk River Aquifer.

There was sufficient information to allow for the calculation of an apparent yield from 150 DSTs (County plus buffer area) where at least some part of the fluid type is water. The data from the DSTs combined with the 163 apparent yield values available from individual water wells completed in the Milk River Aquifer have been used to prepare the adjacent figure.

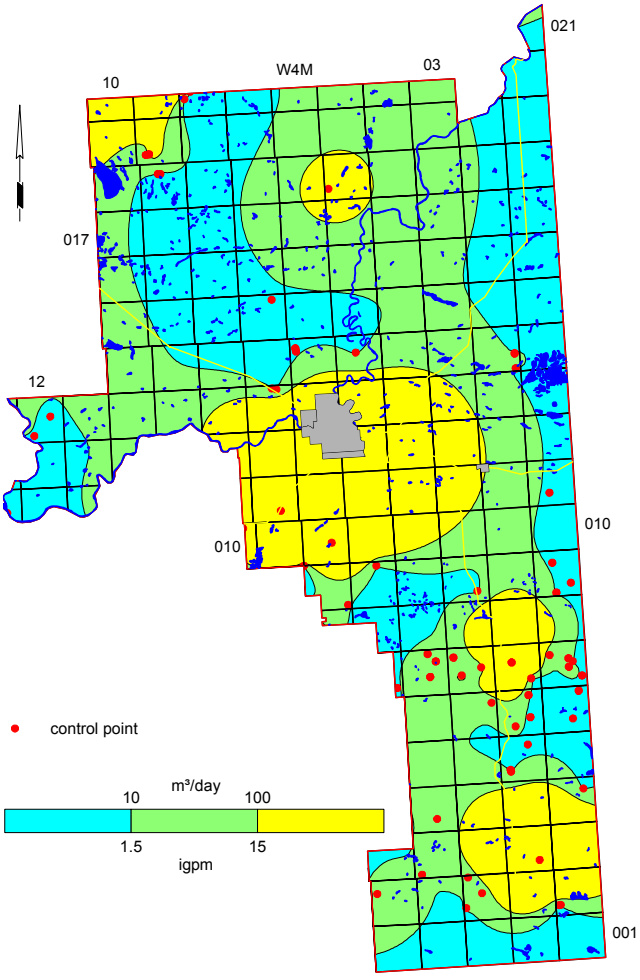

Figure 26. Apparent Yield for Water Wells Completed through the Milk River Aquifer

A water well drilled for inventory purposes in --07-018-05 W4M has an anticipated yield of 165 m³/day (PFRA, 1978). This water well was completed from 298.7 to 304.8 metres below ground level in the Milk River Aquifer.

Following the completion of a water supply well in SW 15-002-04 W4M at a depth of 335 metres below ground level in the Milk River Aquifer, “it was noted that this unit is generally very fine grained and well screens and low pumping rates are required to avoid bringing fine grained sediment into the completed wells” (PFRA, 1997 Memorandum Communication).

In the County, there are four licensed water wells in township 001, range 02, W4M that are completed in the Milk River Aquifer. The four water wells are licensed to Kusler Ranches Ltd. for agricultural purposes and have a combined authorized total of 81 m^3/day. All four of the licensed water wells completed through the Milk River Aquifer could be linked to a water well in the AENV groundwater database.

5.3.9.3 Quality

In the County, there are two water wells completed in the Milk River Aquifer with groundwater quality data. Three samples have been collected from a water well in 08-31-001-01 W4M from 1966 to 1982. Total dissolved solids concentrations from this water well are in the order of 3,500 mg/L, sulfates are less than 15 mg/L and chloride concentrations average 1,720 mg/L.

The groundwater from the water supply well in SW 15-002-04 W4M has a TDS concentration of 1,064 mg/L, a sulfate concentration of 3 mg/L, and a chloride concentration of 127 mg/L (PFRA, 1997 Memorandum Communication).

6. Groundwater Budget

6.1 Hydrographs

There are sixteen locations in the County where water levels are being or have been measured and recorded with time, as shown on the adjacent figure. However, of the sixteen observation water wells that are part of the AENV regional groundwater-monitoring network, only five are currently active; the remaining eleven are either inactive or have been reclaimed. There are no active AENV Obs WWs north of Medicine Hat. Water-level measurements are available for 14 of the 16 AENV Obs WWs, but five are of limited use, and are not presented in the report. One additional water well site that is being monitored over time by Mow-Tech Ltd. is also discussed in the text below.

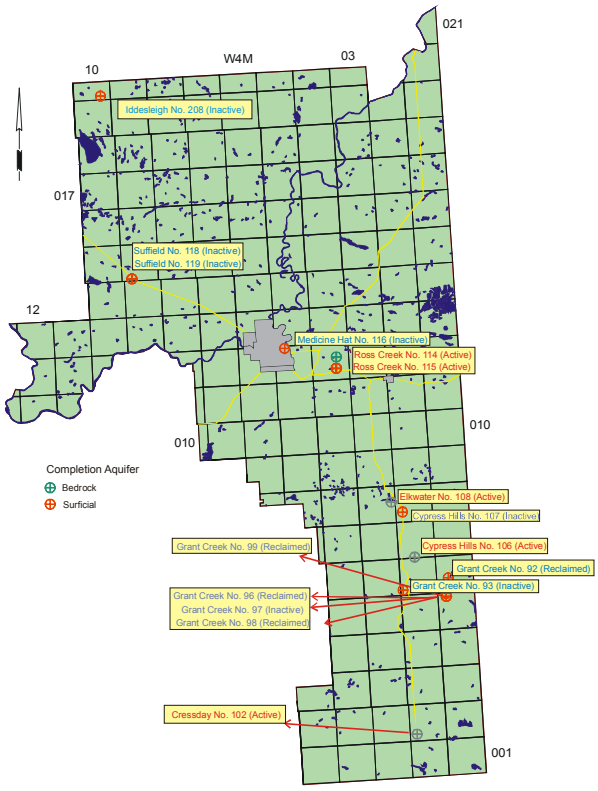

Figure 27. Location of AENV Obs WWs

Two AENV Obs WWs, Nos. 114 and 115, in 16-10-012-04 W4M, are used by AENV as an indicator of drought (AEP, 1998 Fax Communication). AENV Obs WW No. 114 is completed at a depth of 73.8 metres below ground level in the Oldman Aquifer and AENV Obs WW No. 115 is completed at a depth of 36.0 metres below ground level in the Lower Sand and Gravel Aquifer. Both hydrographs show similar water-level fluctuations, but because AENV Obs WW No. 114 has a more complete record, the water-level fluctuations in No. 114 have been compared to the annual precipitation measured at the Medicine Hat weather station from 1984 to 1998. There appears to be no correlation between precipitation and water level (page A-57).

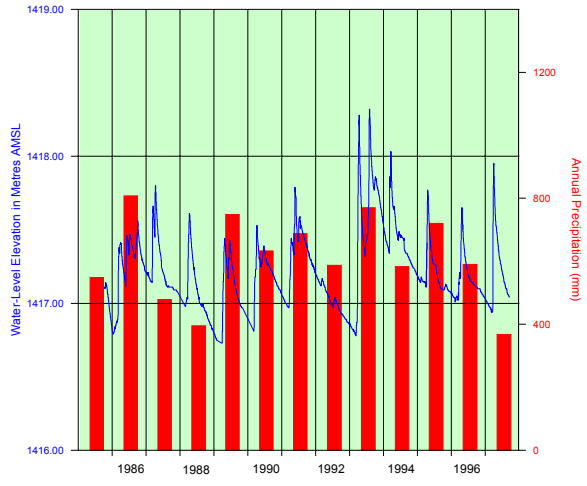

Figure 28. Annual Precipitation vs Water Levels in AENV Obs WW No. 107

There are three AENV Obs WWs in the Cypress Hills/Elkwater area, of which two are currently active. Of the three AENV Obs WWs, one is completed in the Lower Sand and Gravel Aquifer (107), one in the Horseshoe Canyon Aquifer (108), and one in the Bearpaw Aquifer (106). All three hydrographs show at least one peak during the year. The water-level fluctuations in AENV Obs WW No. 107 (12-08-008-02 W4M) show at least two peaks in 1986, 1987, and from 1989 to 1993. The first peak in a given year would be associated with recharge when the frost leaves the ground and the second peak coincides with the end of the growing season. In order to determine if the water-level fluctuations correspond to precipitation, several scenarios of spring, summer and annual precipitation measured at the Cypress Hills, Saskatchewan weather station were applied. Overall, there appeared to be an inconsistent correlation, with the best relationship occurring between annual precipitation and the water levels in AENV Obs WW No. 107 (Figure 28).

In a further attempt to find the closest relationship with water levels and climatic factors in AENV Obs WW No. 107, water levels were compared to monthly temperatures measured at the Cypress Hills, Saskatchewan weather station. In nearly every year, when temperatures rose above 0°C, water levels also rose. The exception that occurred in 1992 was because there was below-average winter precipitation. As a result of the below-average winter precipitation, in 1992 there was no recharge to the Sand and Gravel Aquifer in which AENV Obs WW No. 107 is completed, as shown on the adjacent figure. This water-level decline from 1991 to 1992 is also evident in AENV Obs WW Nos. 106 and 108, both of which are completed in bedrock aquifers (page A-56).

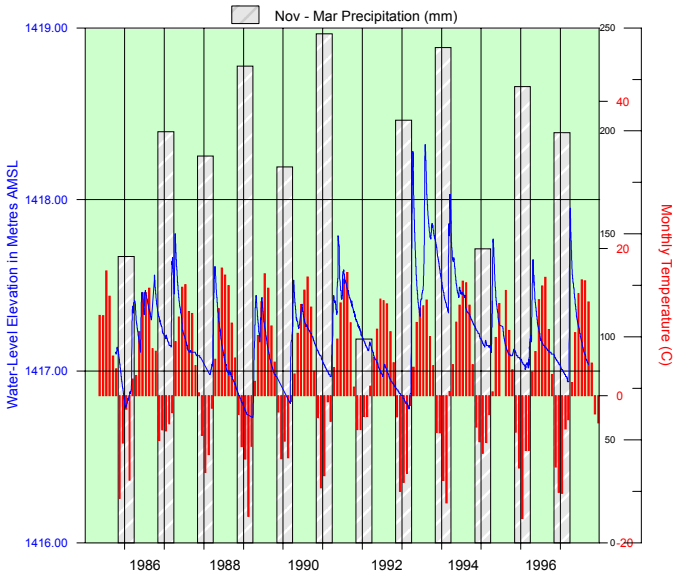

Figure 29. Monthly Temperature and Winter Precipitation vs. Water Levels in AENV Obs WW No. 107

Another example where there appears to be a relationship between water levels, ambient temperature and the November to March precipitation is in the Grant Creek AENV Obs WW No. 93 in 14-06-006-02 W4M (page A-60). A longer record would be necessary to establish this relationship. There have been as many as six AENV observation water wells in the Grant Creek area, with the longest record being from 1994 to 1996. Of the six Grant Creek AENV Obs WWs, four have been reclaimed, and two are inactive. AENV Obs WW No. 93 is completed in the Lower Sand and Gravel Aquifer and was active from 1994 to 1996.

There are two inactive AENV Obs WWs in 07-05-015-09 W4M completed in the surficial deposits. AENV Obs WW No. 118 is completed in the Lower Sand and Gravel Aquifer associated with the Buried Lethbridge Valley and AENV Obs WW No. 119 is completed in the Upper Sand and Gravel Aquifer. AENV Obs WW No. 118 has a water-level record from 1985 to 1992 and AENV Obs WW No. 119 has a water-level record from 1985 to 1995. Only the hydrograph from AENV Obs WW No. 119 is shown in Appendix A and has been included on the CD-ROM. The water level in AENV Obs WW No. 119 has declined in the order of 1.8 metres, with the decline occurring from 1986 to 1990, and from 1993 to 1995. The closest licensed groundwater user to the Obs WW is a water source well completed in the Lower Sand and Gravel Aquifer in NW 13-015-09 W4M, licensed in 1985 to National Defence for commercial purposes. Whether this water source well had an impact on the water level in the two inactive observation water wells cannot be determined without additional groundwater data.

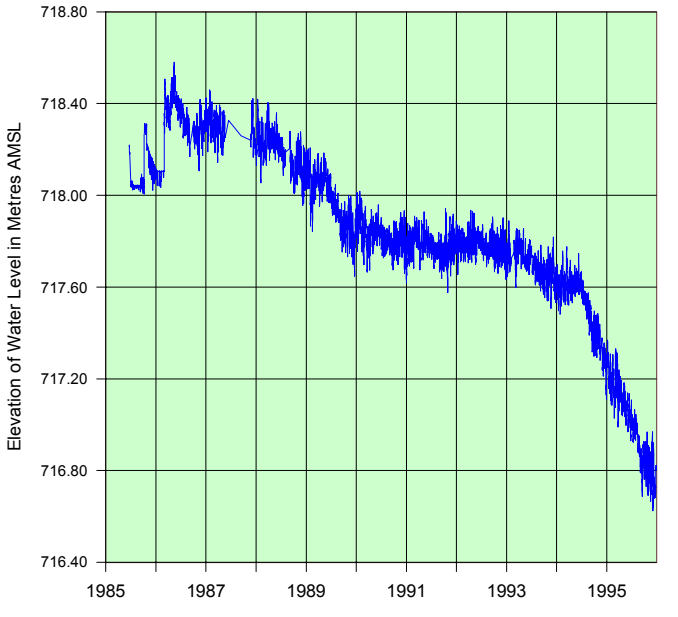

Figure 30. Hydrograph - AENV Obs WW No. 119

In the vicinity of Medicine Hat, there are a large number of water wells completed in the Lower Sand and Gravel Aquifer plus there are nine groundwater users licensed to divert a total of more than 8,000 m³/day from the Lower Sand and Gravel Aquifer. AENV Obs WW No. 116, also inactive and completed in the Lower Sand and Gravel Aquifer, is located in 10-32-012-05 W4M in the Medicine Hat area. The hydrograph for this Obs WW shows an overall water-level decline of approximately 0.5 metres. This water-level decline may be the result of heavy groundwater usage.

The only AENV Obs WW hydrograph that shows an overall water-level rise is in AENV Obs WW No. 102 (page A-56). This observation water well is located in 04-08-002-02 W4M and is completed in the Oldman Aquifer. From 1989 to 1999, there was a water-level rise of approximately 0.4 metres. This active observation water well is used by AENV for international/interprovincial purposes (AEP, 1998 Fax Communication).

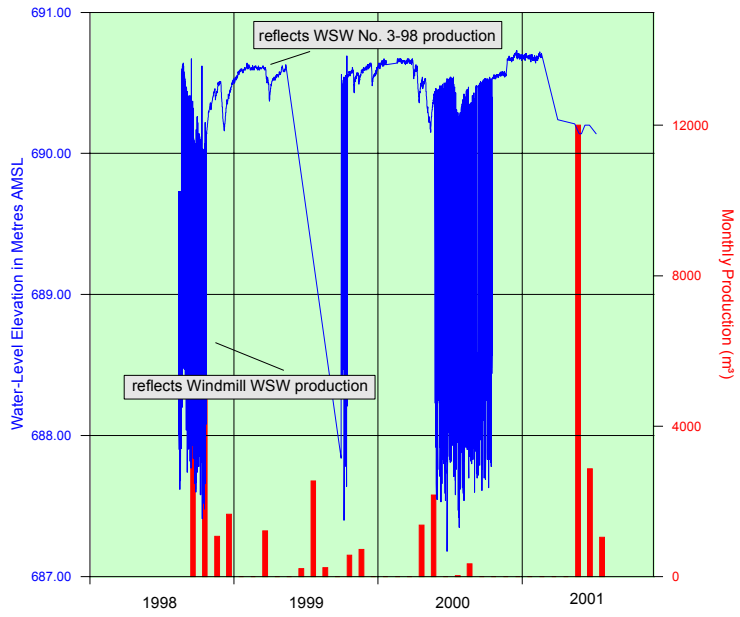

Figure 31. PFRA Windmill WSW Water Levels vs WSW No. 3-98 Groundwater Production

Alberta Energy Company Ltd. operates a water source well (WSW No. 3-98) in 04-04-016-06 W4M, approximately 25 kilometres northwest of Medicine Hat. This water source well is authorized to divert 200 m³/day. The PFRA Windmill Water Supply Well in NW 04-016-06 W4M is used as an observation water well by AECL. Both water wells are completed in the Lower Sand and Gravel Aquifer. The Windmill WSW is licensed to divert 6.7 m³/day. The water-level fluctuations in the Windmill WSW are mainly a result of production from the Windmill WSW, as opposed to the groundwater diversion from WSW No. 3-98, as shown on Figure 31.

Hydrographs for the nine AENV Obs WWs and the PFRA Windmill WSW cited in the above text are in Appendix A and on the CD-ROM.

6.2 Estimated Water Use from Unlicensed Groundwater Users

An estimate of the quantity of groundwater removed from each geologic unit in Cypress County must include both the licensed diversions and the unlicensed use. As stated previously on page 7 of this report, the daily water requirement for livestock for the County based on the 1996 census is estimated to be 13,767 cubic metres. Of the 13,767 m³/day required for livestock, 6,071 m³/day has been licensed by Alberta Environment, which includes both surface water 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 7,696 m³/day of water required for livestock watering is obtained from unlicensed groundwater use. In the groundwater database for the County, there are records for 2,695 water wells that are used for domestic/stock purposes. These 2,695 water wells include both licensed and unlicensed water wells. Of the 2,695 water wells, 500 water wells are used for stock, 766 are used for domestic/stock purposes, and 1,429 are for domestic purposes only.

There are 1,266 water wells that are used for stock or domestic/stock purposes. There are 36 licensed groundwater users for agricultural (stock) purposes, giving 1,230 unlicensed stock water wells. (Please refer to Table 2 on page 7 for the breakdown by aquifer of the 36 licensed stock groundwater users). By dividing the number of unlicensed stock and domestic/stock water wells (1,230) into the quantity of groundwater required for stock purposes that is not licensed (7,696 m³/day), the average unlicensed water well diverts 6.3 m³/day. Because of the limitations of the data, no attempt has been made to compensate for dugouts, springs or inactive water wells, and the average stock use is considered to be 6.3 m³/day per stock water well.

Groundwater for household use does not require licensing. Under the Water Act, a residence is protected for up to 3.4 m³/day. However, the standard groundwater use for household purposes is 1.1 m³/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	1.1 m³/day
Stock	6.3 m³/day
Domestic/stock	7.4 m³/day

Based on using all available domestic, domestic/stock, and stock water wells and corresponding calculations, the following table was prepared. The table shows a breakdown of the 2,695 unlicensed and licensed 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 the table below indicate that most of the 9,830 m³/day, estimated to be diverted from unlicensed domestic, stock, or domestic/stock water wells, is from the Upper and Lower Sand and Gravel aquifers, and from the Oldman Aquifer.

	Unlicensed and Licensed Groundwater Diversions							*Licensed Groundwater Diversions*	*Unlicensed Groundwater Diversions*
Aquifer Designation	Number of Domestic	Daily Use (1.1 m³/day)	Number of Stock	Daily Use (6.3 m³/day)	Number of Domestic and Stock	Daily Use (7.4 m³/day)	Totals m³/day	Totals (m³/day)	Totals m³/day
Upper Sand/Gravel	457	503	202	1,264	283	2,082	3,849	17	3,832
Lower Sand/Gravel	446	491	110	688	212	1,560	2,739	200	2,539
Bedrock	28	31	11	69	3	22	122	0	122
Paskapoo	3	3	0	0	0	0	3	0	3
Scollard	5	6	0	0	0	0	6	0	6
Horseshoe Canyon	8	9	0	0	1	7	16	0	16
Bearpaw	109	120	35	219	71	522	861	0	861
Oldman	168	185	91	63	142	1,045	1,293	68	1,225
Foremost	119	131	35	219	38	280	629	20	609
Lea Park	1	1	1	6	1	7	15	0	15
Milk River	2	2	6	38	0	0	40	81	0
Unknown	83	91	9	56	15	110	258	180	78
Totals	1,429	1,572	500	2,622	766	5,636	9,830	566	9,264

Table 6. Unlicensed and Licensed Groundwater Diversions