2.3.3 Casing Diameter and Type

Data for casing diameters are available for 6,431 water wells, with 6,386 (99%) indicated as having a diameter of less than 275 mm and 45 (1%) having a diameter of more than 275 mm. The casing diameters of greater than 275 mm are mainly bored or dug water wells and those with a surface-casing diameter of less than 275 mm are mainly drilled water wells. The groundwater database suggests that the 45 above-mentioned water wells in the County were bored, hand dug, or dug by backhoe. The complete water well database for the County suggests that 126 of the water wells in the County were bored or hand dug.

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. Within the County, casing-diameter information is available for 168 of the 177 water wells completed in the surficial deposits, of which 162 surficial water wells have a casing diameter of less than 275 millimetres and are assumed to be drilled water wells. Within the County, casing-diameter information is available for 5,197 of the 5,257 water wells completed below the top of bedrock, of which 5,183 have a surface casing diameter of less than 275 mm and have been mainly completed with either a perforated liner or as open hole; there are seven bedrock water wells completed with a water well screen.

Where the casing material is known, steel surface casing materials have been used in 95% of the drilled water wells over the last 50 years. For the remaining drilled water wells with known surface casing material, 3% were completed with galvanized steel casing, 2% with plastic casing and 0.2% with wood, concrete or other surface casing materials (used mostly in the 1960s and 1970s). The main years where the type of surface casing was undocumented were between 1955 and 1965. Steel casing was in use in the 1950s and is still used in 95% of the water wells being drilled in the County. Galvanized steel surface casings were mainly used prior to 1955 and from the mid-1960s to the early 1980s, at which time plastic casing started to replace the use of galvanized steel casing.

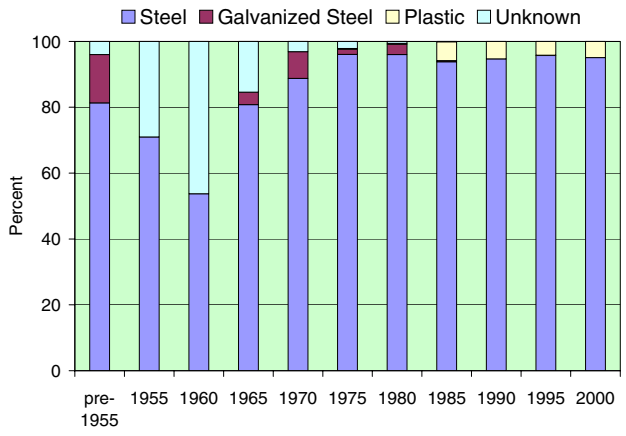

Figure 3. Surface Casing Types Used in Drilled Water Wells

Steel casing has been dominant in the County probably because it has resisted corrosion and also because water well drillers may be reluctant to use plastic (PVC) casing if there have been no documented problems with steel casing in the area.

2.3.4 Dry Water Test Holes

In the County, there are 11,708 records in the groundwater database. Of these 11,708 records, 105 (less than 1%) are indicated as being dry or abandoned with "insufficient water"[7]. Of the 105 "dry" water test holes, 95 are completed in bedrock aquifers; the remaining ten "dry" water test holes are completed in surficial deposits. Only about 11% of all water wells with apparent yield estimates were judged to yield less than 6.5 m³/day (1 igpm).

[7] "dry" can be due to a variety of reasons: skill of driller, type of drilling rig/method used, the geology

2.3.5 Requirements for Licensing

With some exemptions a diversion of groundwater starting after 01 Jan 1999 must have a licence. Exemptions include (1) the diversion for household use of up to 3.4 cubic metres per day (1,250 cubic metres per year [m³/year] or 750 imperial gallons per day[8]), (2) the diversion from groundwaters with total dissolved solids in excess of 4,000 mg/L, (3) the diversion from a manually pumped water well, or (4) a diversion of groundwater which was eligible for registration as "Traditional Agriculture Use" but was not registered can continue to be used for Traditional Agriculture Use but without the protection of the *Water Act*.

In the August 2003 update from the Alberta Environment (AENV) groundwater database, 1,461 groundwater licences and registrations were shown to be within the County, with the most recent groundwater user being registered in April 2003. Of the 1,461 licensed and registered groundwater users, 1,270 (87%) are registrations of Traditional Agriculture Use under the *Water Act*. These 1,270 registered users will continue to divert groundwater for stock watering and/or crop spraying. Typically, the groundwater diversion for crop spraying averages less than one m³/day so most registered groundwater diversion is for stock watering. Of the 1,270 registrations, only 372 (29%) could be linked to the AENV groundwater database. Of the remaining 191 from the 1,461 groundwater users, 88 are for agricultural purposes (mainly stock watering), 60 are for industrial purposes (mainly enhanced recovery or injection), 26 are for commercial purposes (mainly oil/gas companies), eight are for municipal purposes (mainly urban), six are recreation purposes, and the remaining three are for fishery purposes. Of these 191 licensed groundwater diversion in the County, 124 (65%) could be linked to the AENV groundwater database. The maximum amount of groundwater that can be diverted each year from the water wells associated with these licences and registrations is 16,235 m³/day, although actual use could be less. Of the 16,235 m³/day, 2,978 m³/day (18.3%) is registered for Traditional Agriculture Use, 811 m³/day (5%) is licensed for agricultural purposes, 11,804 m³/day (72.7%) is licensed for industrial purposes, 275 m³/day (1.7%) is licensed for commercial purposes, 301 m³/day (1.9%) is licensed for municipal purposes, 54 m³/day (0.3%) is licensed for recreation purposes, and the remaining 12 m³/day is licensed for fishery purposes (0.1%), as shown below in Table 1. A figure showing the locations of the groundwater users with a licence and/or registration is in Appendix A (page A-7) and on the CD-ROM. Table 1 also shows a breakdown of the 1,461 groundwater licenses and/or registrations by the aquifer in which the water well is completed. Approximately 70% of the total quantity of licensed and registered groundwater use is in the Dalehurst Aquifer. The water wells associated with the 112 licensed and registered use where a specific aquifer cannot be determined is because insufficient completion information is available.

Aquifer **	No. of Licences and Registrations	Registrations (m³/day)	Licensed Groundwater Users* (m³/day)						Total Quantity of Licensed and Registered Groundwater Diversion (m³/day)	Percentage
			Agricultural	Industrial	Commercial	Municipal	Recreation	Fishery		
Multiple Surficial Completions	68	150	21	0	18	0	10	0	199	1.2
Upper Sand and Gravel	39	49	76	3	1	0	7	0	136	0.8
Lower Sand and Gravel	34	78	64	0	10	0	7	0	159	1.0
Disturbed Belt	93	115	10	3,496	145	95	0	0	3,861	23.8
Dalehurst	1,114	2,361	637	8,268	101	206	30	12	11,615	71.5
Upper Lacombe	1	0	0	37	0	0	0	0	37	0.2
Unknown	112	225	3	0	0	0	0	0	228	1.4
Total	1,461	2,978	811	11,804	275	301	54	12	16,235	100
Percentage		18.3	5.0	72.7	1.7	1.9	0.3	0.1	100	

* - data from AENV ** - Aquifer identified by HCL

Table 1. Licences and Registrations of Groundwater by Aquifer

[8] see conversion table on page 60

Based on the 2001 Agriculture Census (Statistics Canada), the calculated water requirement for 350,611 livestock for the County is in the order of 12,137 m³/day. This value includes intensive livestock use but not domestic animals and is based on an estimate of water use per livestock type. Of the 12,137 m³/day average calculated livestock use, AENV has authorized a groundwater diversion of 3,788 m³/day (agricultural and registration) (32%) and licensed a surface-water diversion based on a consumptive use of 115 m³/day (<1%); the remaining 67% of the calculated livestock use would have to be mainly from unlicensed sources.

2.3.6 Groundwater Chemistry and Base of Groundwater Protection

Groundwaters from an aquifer in the surficial deposits can be expected to be chemically hard, having a total 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. There were two groundwater samples that had Nitrate + Nitrite (as N) concentrations that were greater than the Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ) for the surficial aquifers and twelve groundwater samples that had Nitrate + Nitrite (as N) concentrations that were greater than the SGCDWQ for the upper bedrock aquifer(s); a plot of Nitrate + Nitrite (as N) in surficial aquifers is on the accompanying CD-ROM. The TDS concentrations in the groundwaters from the upper bedrock in the County range from less than 500 to more than 1,000 mg/L (page A-32). Groundwaters from the bedrock aquifers frequently are chemically soft, with generally low concentrations of dissolved iron. The chemically soft groundwater is high in concentrations of sodium. Eight percent of the chemical analyses for upper bedrock water wells indicate a fluoride concentration above 1.5 mg/L, with most of the exceedances occurring in the eastern-central part of the County (page A-33).

Constituent	No. of Analyses	Range for County in mg/L Minimum	Maximum	Median	Recommended Maximum Concentration SGCDWQ
Total Dissolved Solids	1,485	202	4,129	440	500
Sodium	1,090	0	1,035	82	200
Sulfate	1,188	0	1,308	18	500
Chloride	1,286	0	355	2	250
Fluoride	1,117	0	8.11	0.2	1.5

Concentration in milligrams per litre unless otherwise stated
Note: indicated concentrations are for Aesthetic Objectives except for Fluoride, which is for Maximum Acceptable Concentration (MAC)

SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality
Federal-Provincial-Territorial Committee on Drinking Water, April 2002

Table 2. Concentrations of Constituents in Groundwaters from Upper Bedrock Aquifer(s)

The minimum, maximum and median[9] concentrations of TDS, sodium, sulfate, chloride and fluoride in the groundwaters from water wells completed in the upper bedrock in the County have been compared to the SGCDWQ in Table 2. Of the five constituents compared to the SGCDWQ, none of the median concentrations exceed the guidelines.

[9] see glossary

In general, Alberta Environment defines the Base of Groundwater Protection as the elevation below which the groundwater will have more than 4,000 mg/L of total dissolved solids. By using the ground elevation, formation elevations, and Alberta Energy and Utilities Board (EUB) information indicating the formations containing the deepest useable water for agricultural needs, a value for the depth to the Base of Groundwater Protection can be determined. These values are gridded using the Kriging[10] method to prepare a depth to the Base of Groundwater Protection surface. This depth, for the most part, would be the maximum drilling depth for a water well for agricultural purposes or for a potable water supply. If a water well has total dissolved solids exceeding 4,000 mg/L, the groundwater use does not require licensing by AENV. In the County, the depth to the Base of Groundwater Protection ranges from less than 400 metres in the northern and eastern parts of the County to more than 2,300 metres in the southwestern parts of the County, as shown on Figure 4, on some cross-sections presented in Appendix A, and on the CD-ROM.

There are 7,700 water wells with completed depth data, of which two are completed below the Base of Groundwater Protection. Both water wells completed below the Base of Groundwater Protection are/were used for industrial purposes. Chemistry data are not available for the two water wells. There is a water well that was drilled for domestic purposes in NW 33-039-05 W5M with a TDS concentration of 4,129 mg/L. The completion depth of the water well is above the Base of Groundwater Protection.

Proper management of the groundwater resource requires water-level data. These data are often collected from observation water wells. At the present time, there are two AENV-operated observation water wells within the County (see page A-42 for observation water well locations). Additional data can be obtained from 38 water source wells and observation water wells of the licensed groundwater diversions. In the past, the data for authorized diversions have been difficult to obtain from AENV, in part because of the failure of the applicant to provide the data.

Even with the available sources of data, the number of water-level data points relative to the size of the County is too few to provide a reliable groundwater budget (see section 6.0 of this report). The most cost-efficient method to collect additional groundwater monitoring data would be to have the water well owners measuring the water level in their own water well on a regular basis, as has been the case in the Wildrose Country Ground Water Monitoring Association and Flagstaff County.

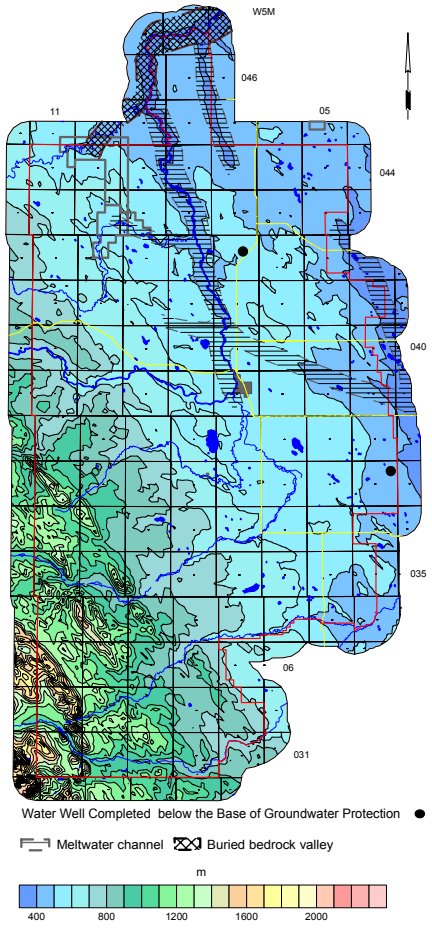

Figure 4. Depth to Base of Groundwater Protection (after EUB, 1995)

[10] See glossary

3 TERMS

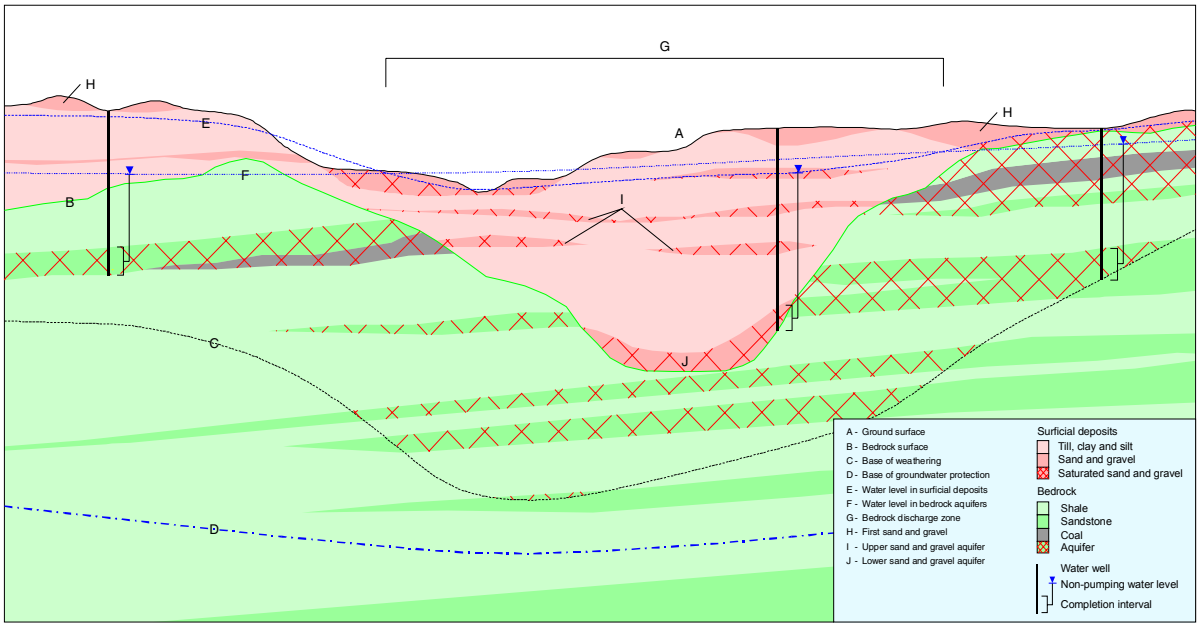

Figure 5. Generalized Cross-Section (for terminology only)

(for larger version, see page A-9)

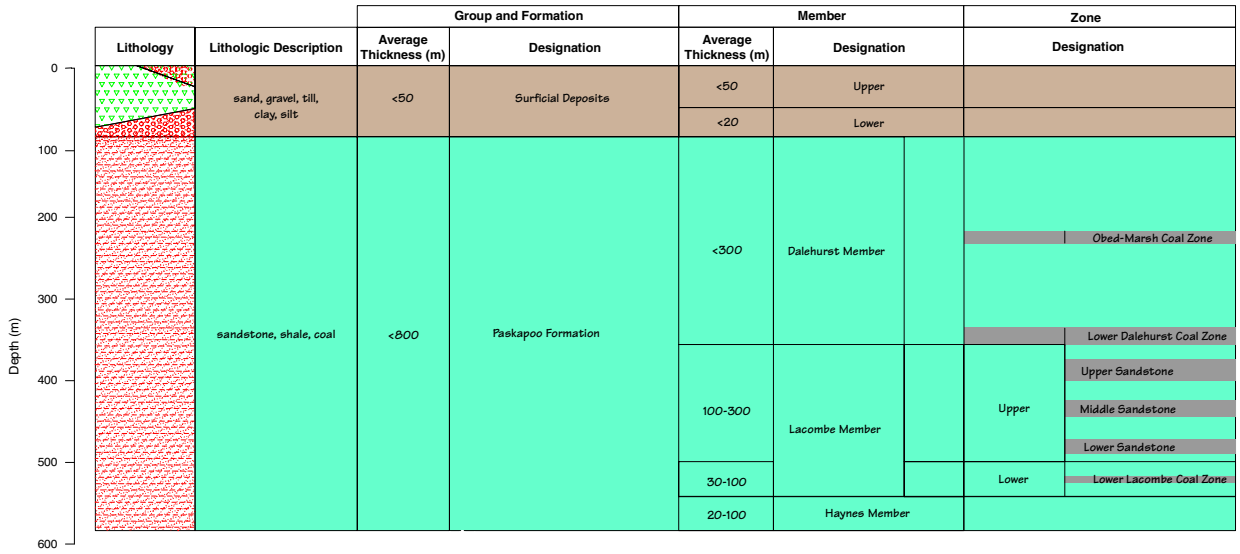

Figure 6. Geologic Column

(for larger version, see page A-10)