7 RECOMMENDATIONS

The present study has been based on information available from the groundwater database. The database has three problems:

1) the quality of the data;
2) the coordinate system used for the horizontal control; and
3) the distribution of the data.

The quality of the data in the groundwater database is affected by two factors: a) the technical training of the persons collecting the data, and b) the quality control of the data. The possible options to upgrade the database include the creation of a "super" database, which includes only verified data. The first step would be to field-verify the 27 existing water wells listed in Appendix E. These water well records indicate that a complete water well drilling report is available along with at least a partial chemical analysis. The level of verification would have to include identifying the water well in the field, obtaining meaningful horizontal coordinates for the water well and the verification of certain parameters such as water level and completed depth. An attempt to update the quality of the entire database is not recommended.

The results of the present study indicate that the only readily identifiable aquifers in the surficial deposits are the sand and gravel deposits associated with the linear bedrock low present in the western part of the County. The present analysis has shown that the groundwater flow in the Upper Horseshoe Canyon Aquifer may not be sufficient to sustain the authorized diversion by AEP. However, because this analysis is based on a regional study, the results should be considered no more than an indication and further work should be completed to quantify the flow through the aquifers.

In the bedrock there are indications that a useable aquifer may be present in parts of the Oldman Aquifer. The top of the Oldman Aquifer varies between 250 and 550 metres below ground level. This Aquifer would represent the maximum depth that can be considered for the development of groundwater supplies for traditional purposes. Because of the depth of the Aquifer, it would not normally be developed because of the cost and the risk of not encountering a suitable groundwater supply. Therefore, a test-drilling program could be considered to evaluate the Oldman Aquifer in areas where only limited groundwater supplies are available from shallower aquifers. One such area could be in the southwestern part of the County where less than 10 m^3/day of groundwater is available from the Middle Horseshoe Canyon Aquifer. The purpose of the program would be to determine the parameters of the Oldman Aquifer and the chemical quality of the groundwater from the Oldman Aquifer to assist local residents in determining if an attempt should be made to develop a groundwater supply from the Oldman Aquifer.

One of the main shortages of data for the determination of a groundwater budget is water levels as a function of time. There are no observation-water-well-data sources in the County from which to obtain water levels for the groundwater budget. One method to obtain additional water-level data is to solicit the assistance of the water well owners who are stakeholders in the groundwater resource. In the M.D. of Rocky View, for example, water well owners are being provided with a tax credit if they accurately measure the water level in their water well once per week for a year. A pilot project indicated that approximately five years of records are required to obtain a reasonable data set. The cost of a five-year project involving 50 water wells would be less than the cost of one drilling program that may provide two or three observation water wells.

In general, for the next level of study, the database needs updating. It requires more information from existing water wells, and additional information from new ones.

Before an attempt is made to upgrade the level of interpretation provided in this report and the accompanying maps and groundwater query, it is recommended that all water wells for which water well drilling reports are available be subjected to the following actions:

1. The horizontal location of the water well should be determined within 10 metres. The coordinates must be in 10TM NAD 27 or some other system that will allow conversion to 10TM NAD 27 coordinates.
2. A four-hour aquifer test (two hours of pumping and two hours of recovery) should be performed with the water well to obtain a realistic estimate for the transmissivity of the aquifer in which the water well is completed.
3. Water samples should be collected for chemical analysis after 5 and 115 minutes of pumping, and analyzed for major and minor ions.

In addition to the data collection associated with the existing water wells, all available geophysical logs should be interpreted to establish a more accurate spatial definition of individual aquifers.

There is also a need to provide the water well drillers with feedback on the reports they are submitting to the regulatory agencies. The feedback is necessary to allow for a greater degree of uniformity in the reporting process. This is particularly true when trying to identify the bedrock surface. The water well drilling reports should be submitted to the AEP Resource Data Division in an electronic form. The money presently being spent by AEP and Prairie Farm Rehabilitation Administration (PFRA) to transpose the paper form to the electronic form should be used to allow for a technical review of the data and follow-up discussions with the drillers.

An effort should be made to form a partnership with the petroleum industry. The industry spends millions of dollars each year collecting information relative to water wells. Proper coordination of this effort could provide significantly better information from which future regional interpretations could be made. This could be accomplished by the County taking an active role in the activities associated with the construction of lease sites for the drilling of hydrocarbon wells and conducting of seismic programs.

Groundwater is a renewable resource and it must be managed.

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9 GLOSSARY

Aquifer	a formation, group of formations, or part of a formation that contains saturated permeable rocks capable of transmitting groundwater to water wells or springs in economical quantities.
Aquitard	a confining bed that retards but does not prevent the flow of water to or from an adjacent aquifer.
Available Drawdown	in a confined aquifer, the distance between the non-pumping water level and the top of the aquifer.
	in an unconfined aquifer (water table aquifer), two thirds of the saturated thickness of the aquifer.
Deltaic	a depositional environment in standing water near the mouth of a river.
Facies	the aspect or character of the sediment within beds of one and the same age (Pettijohn, 1957).
Fluvial	produced by the action of a stream or river.
Friable	poorly cemented.
Hydraulic Conductivity	the rate of flow of water through a unit cross-section under a unit hydraulic gradient; units are length/time.
Kriging	a geo-statistical method for gridding irregularly-spaced data.
Lacustrine	fine-grained sedimentary deposits associated with a lake environment and not including shore-line deposits.
Piper tri-linear diagram	a method that permits the major cation and anion compositions of single or multiple samples to be represented on a single graph. This presentation allows groupings or trends in the data to be identified.
Shoreface	the narrow zone seaward from the low-tide shoreline, permanently covered by water, over which beach sand and gravels actively oscillate with changing wave conditions.
Surficial Deposits	includes all sediments above the bedrock.
Till	a sediment deposited directly by a glacier that is unsorted and consisting of any grain size ranging from clay to boulders.
Transgression	the speading of sea over land areas.

Transmissivity — the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient: a measure of the ease with which groundwater can move through the aquifer.

Apparent Transmissivity: the value determined from a summary of aquifer test data, usually involving only two water-level readings.

Effective Transmissivity: the value determined from late pumping and/or late recovery water-level data from an aquifer test.

Aquifer Transmissivity: the value determined by multiplying the hydraulic conductivity of an aquifer by the thickness of the aquifer.

Yield — a regional analysis term referring to the rate a properly completed water well could be pumped, if fully penetrating the aquifer.

Apparent Yield: based mainly on apparent transmissivity.

Long-Term Yield: based on effective transmissivity.

STARLAND COUNTY

Appendix B

MAPS AND FIGURES ON CD-ROM

CD-ROM

A) Database
B) ArcView Files
C) Query
D) Maps and Figures

1) General

Index Map
Surface Casing Types used in Drilled Water Wells
Location of Water Wells
Depth of Existing Water Wells
Depth to Base of Groundwater Protection
Bedrock Topography
Bedrock Geology
Cross-Section A - A'
Cross-Section B - B'
Geologic Column
Generalized Cross-Section (for terminology only)
Risk of Groundwater Contamination
Relative Permeability
Type of Fluid Encountered in the Oldman Aquifer

2) Surficial Aquifers

a) Surficial Deposits

Thickness of Surficial Deposits
Non-Pumping Water-Level Surface in Surficial Deposits
Total Dissolved Solids in Groundwater from Surficial Deposits
Sulfate in Groundwater from Surficial Deposits
Chloride in Groundwater from Surficial Deposits
Fluoride in Groundwater from Surficial Deposits
Total Hardness of Groundwater from Surficial Deposits
Piper Diagram - Surficial Deposits
Amount of Sand and Gravel in Surficial Deposits
Thickness of Sand and Gravel Aquifer(s)
Water Wells Completed in Surficial Deposits
Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)

b) First Sand and Gravel

Thickness of First Sand and Gravel
First Sand and Gravel - Saturation

3) Bedrock Aquifers

a) General

Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)
Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)
Sulfate in Groundwater from Upper Bedrock Aquifer(s)
Chloride in Groundwater from Upper Bedrock Aquifer(s)
Fluoride in Groundwater from Upper Bedrock Aquifer(s)
Total Hardness of Groundwater from Upper Bedrock Aquifer(s)
Piper Diagram - Bedrock Aquifers
Recharge/Discharge Areas between Surficial Deposits and Upper Bedrock Aquifer(s)
Non-Pumping Water-Level Surface in Upper Bedrock Aquifer(s)

b) Scollard Aquifer

Depth to Top of Scollard Formation
Structure-Contour Map - Top of Scollard Formation
Non-Pumping Water-Level Surface - Scollard Aquifer
Apparent Yield for Water Wells Completed through Scollard Aquifer
Total Dissolved Solids in Groundwater from Scollard Aquifer
Sulfate in Groundwater from Scollard Aquifer
Chloride in Groundwater from Scollard Aquifer
Piper Diagram - Scollard Aquifer
Recharge/Discharge Areas between Surficial Deposits and Scollard Aquifer

c) Upper Horseshoe Canyon Aquifer

Depth to Top of Upper Horseshoe Canyon Formation
Structure-Contour Map - Top of Upper Horseshoe Canyon Formation
Non-Pumping Water-Level Surface - Upper Horseshoe Canyon Aquifer
Apparent Yield for Water Wells Completed through Upper Horseshoe Canyon Aquifer
Total Dissolved Solids in Groundwater from Upper Horseshoe Canyon Aquifer
Sulfate in Groundwater from Upper Horseshoe Canyon Aquifer
Chloride in Groundwater from Upper Horseshoe Canyon Aquifer
Piper Diagram - Upper Horseshoe Canyon Aquifer
Recharge/Discharge Areas between Surficial Deposits and Upper Horseshoe Canyon Aquifer

d) Middle Horseshoe Canyon Aquifer

Depth to Top of Middle Horseshoe Canyon Formation
Structure-Contour Map - Top of Middle Horseshoe Canyon Formation
Non-Pumping Water-Level Surface - Middle Horseshoe Canyon Aquifer
Apparent Yield for Water Wells Completed through Middle Horseshoe Canyon Aquifer
Total Dissolved Solids in Groundwater from Middle Horseshoe Canyon Aquifer
Sulfate in Groundwater from Middle Horseshoe Canyon Aquifer
Chloride in Groundwater from Middle Horseshoe Canyon Aquifer
Piper Diagram - Middle Horseshoe Canyon Aquifer
Recharge/Discharge Areas between Surficial Deposits and Middle Horseshoe Canyon Aquifer

e) Lower Horseshoe Canyon Aquifer

Depth to Top of Lower Horseshoe Canyon Formation
Structure-Contour Map - Lower Horseshoe Canyon Formation
Non-Pumping Water-Level Surface - Lower Horseshoe Canyon Aquifer
Apparent Yield for Water Wells Completed through Lower Horseshoe Canyon Aquifer
Total Dissolved Solids in Groundwater from Lower Horseshoe Canyon Aquifer
Sulfate in Groundwater from Lower Horseshoe Canyon Aquifer
Chloride in Groundwater from Lower Horseshoe Canyon Aquifer
Piper Diagram - Lower Horseshoe Canyon Aquifer
Recharge/Discharge Areas between Surficial Deposits and Lower Horseshoe Canyon Aquifer

f) Bearpaw Aquitard

Depth to Top of Bearpaw Aquitard
Structure-Contour Map - Top of Bearpaw Aquitard

g) Oldman Aquifer

Depth to Top of Oldman Aquifer
Structure-Contour Map - Top of Oldman Aquifer
Type of Fluid Encountered in Oldman Aquifer

STARLAND COUNTY
Appendix C

GENERAL WATER WELL INFORMATION