1.2 The Project

This regional study should only be used as a guide. Detailed local studies are required to verify hydrogeological conditions at given locations.

The present project is made up of eight parts as follows:

Task 1 - Data Collection and Review
Task 2 - Hydrogeological Maps, Figures, Digital Data Files
Task 3 - Hydrogeological Evaluation and Preparation of Report
Task 4 - Groundwater Information Query Software
Task 5 - Review of Draft Report and GIS Data Files
Task 6 - Report Presentation and Familiarization Session
Task 7 - Provision of Report, Maps, Data Layers and Query
Task 8 - Provision of Compact Disk for Sale to General Public.

This report and the accompanying maps represent Tasks 2 and 3.

1.3 About This Report

This report provides an overview of (a) the groundwater resources of Lakeland County, (b) the processes used for the present project, and (c) the groundwater characteristics in the County.

Additional technical details are available from files on the CD-ROM to be provided with the final version of this report. The files include the geo-referenced electronic groundwater database, maps showing distribution of various hydrogeological parameters, the groundwater query, ArcView files and ArcExplorer files. Likewise, all of the illustrations and maps from the present report, plus additional maps, figures and cross-sections, are available on the CD-ROM. For convenience, poster-size maps and cross-sections have been prepared as a visual summary of the results presented in this report. Copies of these poster-size drawings have been forwarded with this report, and are included as page-size drawings in Appendix D.

Appendix A features page-size copies of the figures within the report plus additional maps and cross-sections. An index of the page-size maps and figures is given at the beginning of Appendix A. A plastic County map outline is provided to overlay the maps, and contains information such as towns, main rivers, etc.

Appendix B provides a complete list of maps and figures included on the CD-ROM.

Appendix C includes the following:

1) a procedure for conducting aquifer tests with water wells[3]
2) a table of contents for the Water (Ministerial) Regulation under the new Water Act
3) a flow chart showing the licensing of a groundwater diversion under the new Water Act
4) interpretation of chemical analysis of drinking water
5) additional information.

The Water (Ministerial) Regulation deals with the wellhead completion requirement (no more water-well pits), the proper procedure for abandoning unused water wells and the correct procedure for installing a pump in a water well. The new Water Act was proclaimed 10 Jan 1999.

Appendix D includes page-size copies of the poster-size figures provided with this report.

Appendix E provides a list of water wells recommended for field verification.

Appendix F includes page-size copies of figures combining Lakeland County and the M.D. of Bonnyville.

[3] See glossary

2. Introduction

2.1 Setting

Lakeland County is situated in east-central Alberta. This area is part of the Alberta High Plains portion of the Interior Plains region (Ozoray, Wallick and Lytviak, 1980). The study area, defined here as 'the County', includes parts of the area bounded by townships 062 to 070, ranges 09 to 17, west of the 4th Meridian. The other County boundaries follow township or section lines. The County occupies part of the Churchill and Athasbasca River Basins.

Regionally, the topographic surface ranges from less than 550 to more than 800 metres above mean sea level (AMSL). The lowest elevations occur along La Biche River (see overlay) and the highest elevations are in the northeastern parts of the County as shown on Figure 1 and Page A-3. The area is well drained by numerous lakes and streams, the main one being Lac la Biche.

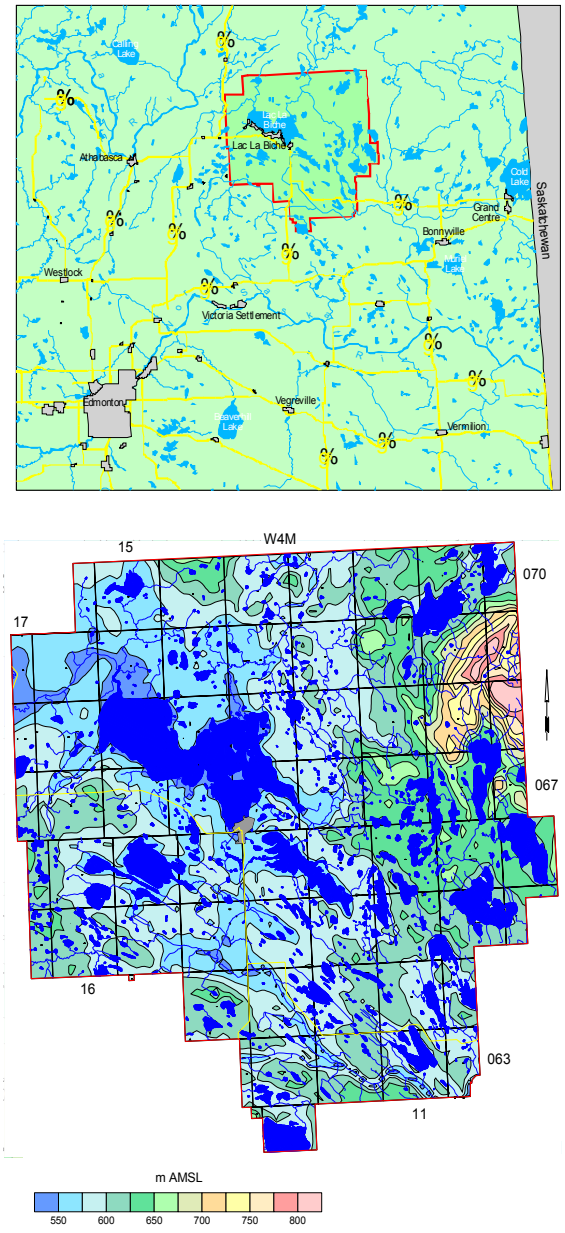

Figure 1. Index Map

2.2 Climate

Lakeland County lies within the Dfb climate boundary. This classification is based on potential evapotranspiration values determined using the Thornthwaite method (Thornthwaite and Mather, 1957), combined with the distribution of natural ecoregions in the area. The ecoregions map (Strong and Leggatt, 1981) shows that the County is located in both the Low Boreal Mixedwood region and the Mid Boreal Mixedwood region. This vegetation change is influenced by increased precipitation and cooler temperatures, resulting in additional moisture availability.

A Dfb climate consists of long, cool summers and severe winters. The mean monthly temperature drops below -3° C in the coolest month, and exceeds 10° C in the warmest month.

The mean annual precipitation averaged from two meteorological stations within the County measured 529 millimetres (mm), based on data from 1947 to 1993. The annual temperature averaged 1.4° C, with the mean monthly temperature reaching a high of 15°C in July, and dropping to a low of -19 °C in January. The calculated annual potential evapotranspiration is 491 millimetres.

2.3 Background Information

2.3.1 Number, Type and Depth of Water Wells

There are currently records for 1,770 water wells in the groundwater database for the County, of which a proposed use is available for 1,600 water wells. Of the 1,600 water wells, 1,510 are for domestic/stock purposes. The remaining 90 water wells were completed for a variety of uses, including industrial, municipal, industrial, observation, investigation and dewatering. Based on a rural population of 4,823 (Phinney, 2002), there are 1.3 domestic/stock water wells per family of four. It is unknown how many of these water wells may still be active (especially in areas where rural pipelines have been constructed in recent years). Of the 1,456 domestic or stock water wells with a completed depth, 1,198 (82%) are completed at depths of less than 50 metres below ground level. Details for lithology[4] are available for 1,033 water wells.

2.3.2 Number of Water Wells in Surficial and Bedrock Aquifers

There are 622 water well records with completion interval and lithologic information, such that the aquifer in which the water wells are completed can be identified. The water wells that were not drilled deep enough to encounter the bedrock plus water wells that have the bottom of their completion interval above the top of the bedrock are water wells completed in surficial aquifers. Of the 622 water wells for which aquifers could be defined, 614 are completed in surficial aquifers, with 65% of these having a completion depth of less than 50 metres below ground level. From Figure 2, it can be seen that most water wells are completed in aquifers in the surficial deposits, which are the dominant aquifer and occur throughout the County. The water wells completed in the lower surficial deposits mainly occur along the linear bedrock lows. The lowest elevation of the linear bedrock low is the thalweg.

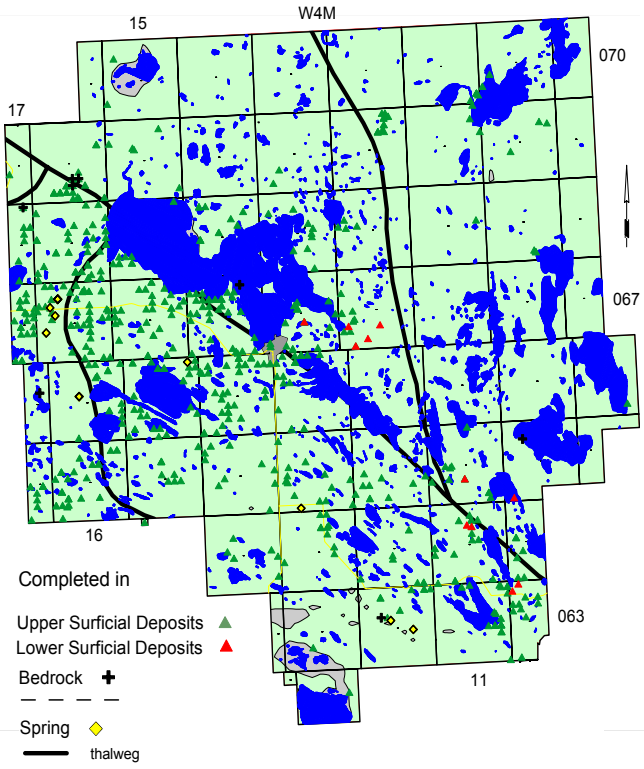

Figure 2. Location of Water Wells and Springs

The data for eight water wells show that the top of the water well completion interval is below the bedrock surface, indicating that the water wells are completed in at least one bedrock aquifer(s).

There are currently records for nine springs in the groundwater database; these springs generally occur in the vicinity of linear bedrock lows and mainly at a surface elevation from 550 to 600 metres AMSL. Of the seven springs having total dissolved solids (TDS) values, four have TDS concentrations of less than 400 milligrams per litre (mg/L) and three have TDS concentrations of more than 750 mg/L. The springs have total hardness values that average 307 mg/L. There is only one available flow rate in the groundwater database for the springs within the County; the flow rate of 4.6 litres per minute (lpm) is for a spring in 12-36-066-15 W4M.

[4] See glossary

2.3.3 Casing Diameter and Type

Data for casing diameters are available for 987 water wells, with 576 (58%) indicated as having a diameter of less than 275 mm and 411 water wells having a surface-casing 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 drilled water wells. In addition to the 987 water wells that have been designated as either bored or drilled water wells based on casing diameter, another 341 water wells have been designated as bored or drilled water wells based on the drilling method only, with no casing size indicated on the water well record. Of the 341 water wells having no casing size, 165 are drilled water wells and 176 are bored water wells. Of the 1,328 drilled and bored water wells, 1,076 have a completion date and a completion depth. From before 1965 to 1969, the water wells completed in the County were mainly drilled water wells. From 1970 to 1984, the water wells completed were mainly bored or hand dug water wells, and from 1985, the completed water wells were mainly drilled water wells.

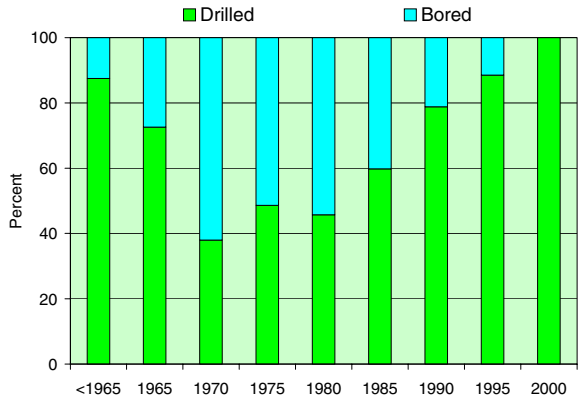

Figure 3. Casing Diameter Used in Water Wells

In the County, steel, galvanized steel and plastic surface casing materials have been used in 97% of the drilled water wells over the last 40 years. Until the mid-1960s, the type of surface casing used in drilled water wells was mainly undocumented. Steel casing was predominantly used in drilled water wells in the 1960s and 1970s but is currently being used in only 3% of the water wells drilled in the County. Galvanized steel surface casing was used in a maximum of 55% of the drilled water wells from the 1970s to the 1990s. Galvanized steel was last used in August 1995. Plastic casing was first used in June 1979, and is currently being used in 97% of the drilled water wells in the County.

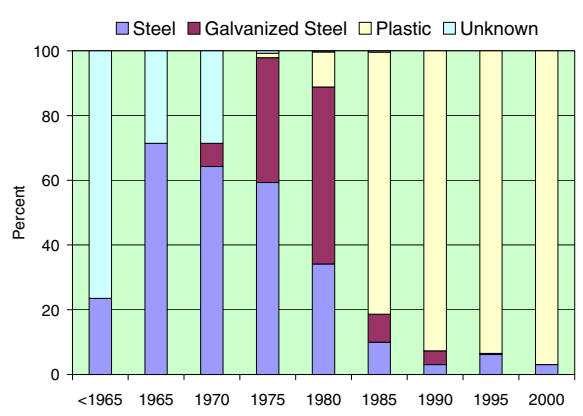

Figure 4. Surface Casing Types Used in Drilled Water Wells

2.3.4 Dry Water Test Holes

In the County, there are 2,254 records in the groundwater database. Of these 2,254 records, 147 are indicated as being dry or abandoned with "insufficient water".

2.3.5 Requirements for Licensing

Water wells used for household needs in excess of 1,250 cubic metres per year (748 imperial gallons per day[5]) and all other groundwater use must be licensed. The only groundwater uses that do not need licensing are (1) household use of up to 1,250 m³/year and (2) groundwater with total dissolved solids in excess of 4,000 mg/L. In the last update from the Alberta Environment (AENV) groundwater database in September 2001, eleven groundwater allocations were shown to be within the County. All of the 11 licensed groundwater users could be linked to the AENV groundwater database. Of the 11 licensed groundwater users, eight are for agricultural purposes, two are for municipal, and the remaining one is for recreation purposes. The total maximum authorized diversion from the water wells associated with these licences is 151 cubic metres per day (m³/day), although actual use could be less. Of the 151 m³/day, 76 m³/day (51%) is authorized for agricultural purposes, 64 m³/day

[5] see conversion table on page 56

(42%) is for municipal purposes and 10 m³/day (7%) is for recreational purposes, as shown below in Table 1. A figure showing the locations of the licensed users is in Appendix A (Page A-7) and on the CD-ROM. Table 1 also shows a breakdown of the eleven licensed groundwater allocations by the aquifer in which the water well is completed. The largest total licensed allocations are in the Empress Aquifer – Unit 3. Of the 151 m³/day licensed groundwater use in the Empress Aquifer – Unit 3, 42% of the groundwater allocation is from a water supply well in 10-36-066-15 W4M.

Aquifer **	No. of Diversions	Licensed Groundwater Users* (m³/day) Agricultural	Municipal	Recreation	Total	Percentage
Grand Centre	3	25.7	0.0	0.0	25.7	17.1
Marie Creek	1	6.8	0.0	0.0	6.8	4.5
Empress - Unit 3	5	20.3	64.0	10.1	94.4	62.7
Unknown	2	23.6	0.0	0.0	23.6	15.7
Total	11	76.4	64.0	10.1	151	100
Percentage		50.8	42.5	7	100	

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

Table 1. Licensed Groundwater Diversions

Based on the 2001 Agriculture Census, the calculated water requirement for 65,730 livestock for the County is in the order of 3,727 m³/day. This value does not include domestic animals, but does include intensive livestock use. Of the 3,727 m³/day average calculated livestock use, AENV has licensed a groundwater diversion of 76 m³/day (2%) and licensed a surface-water diversion of 156 m³/day (4%). The remaining 94% of the calculated livestock use would have to be from unlicensed sources.

2.3.6 Base of Groundwater Protection

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[6] 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 Base of Groundwater Protection ranges from less than 50 metres to more than 250 metres below ground level in the southern part of the County, as shown on Figure 5 and on the cross-sections presented in Appendix A and on the CD-ROM. The main area where the depth to Base of Groundwater Protection is less than 50 metres is in the extreme northeastern part of the County.

[6] See glossary

Of the 1,694 water wells with completed depth data, 52 water wells are completed below the Base of Groundwater Protection. In the County, the Base of Groundwater Protection is mainly below the Milk River Formation (see Pages A-12 to A-15). In the northeastern part of the County, the Base of Groundwater Protection is at the base of the Bonnyville Formation. These 52 water wells have been posted on the adjacent figure and show that they are mainly located where the depth to Base of Groundwater Protection is more than 50 metres. Chemistry data are available for 39 of these 52 water wells; TDS concentrations are greater than 4,000 mg/L for 35 of the 39 water wells.

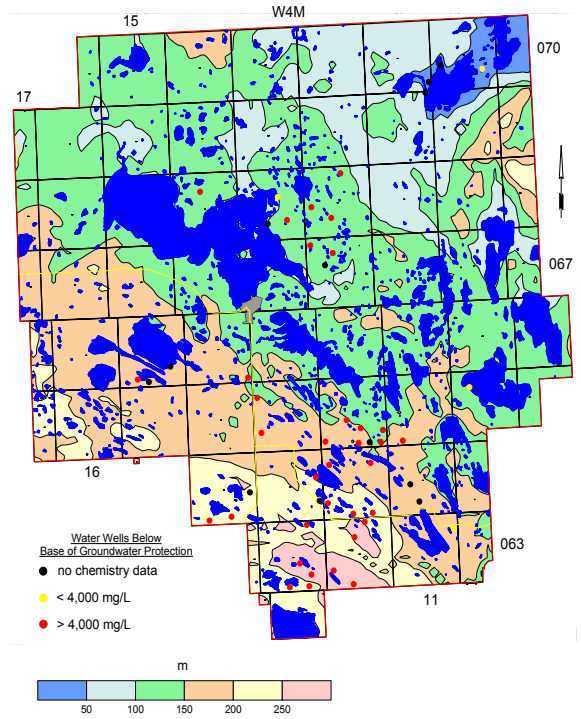

Figure 5. Depth to Base of Groundwater Protection (after EUB, 1995)

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. Additional data can be obtained from some of the licensed groundwater diversions. In the past, the data for licensed diversions have been difficult to obtain from AENV, in part because of the failure of the licensee 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 (see section 7.0 of this report).

3. Terms

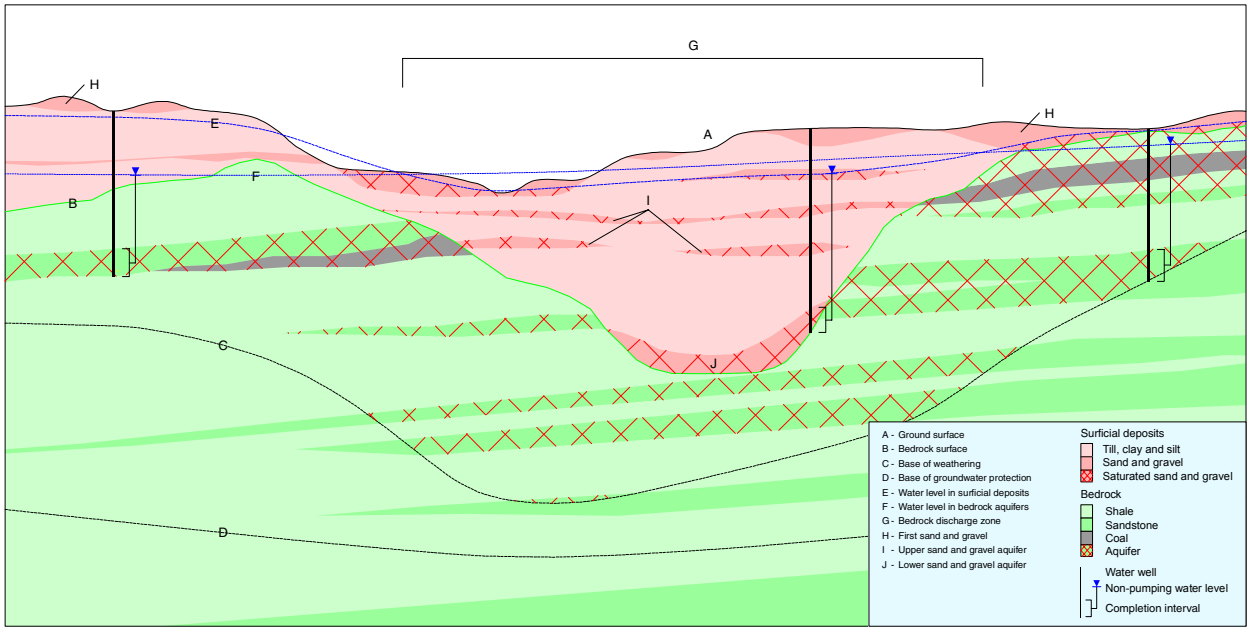

Figure 6. Generalized Cross-Section (for terminology only)

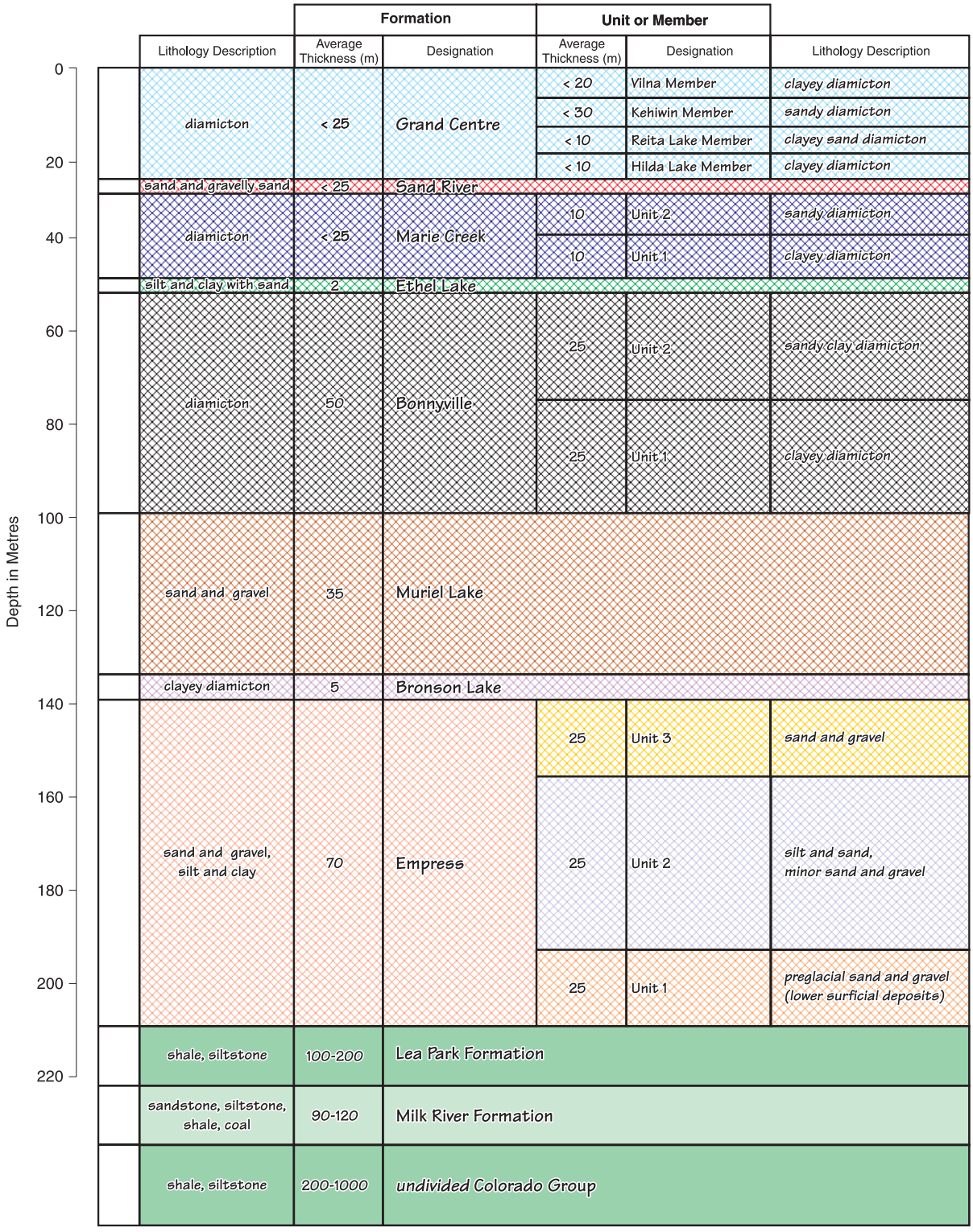

Figure 7. Geologic Column
(modified after Andriashek and Fenton, 1989)