5.3.5 Disturbed Belt Aquifer

The Disturbed Belt Aquifer comprises the permeable parts of the Disturbed Belt, as defined for the present program. The regional groundwater flow direction in the Disturbed Belt Aquifer is toward the Clearwater and North Saskatchewan rivers (see CD-ROM).

5.3.5.1 Depth to Top

The depth to the top of the Disturbed Belt is mainly less than 30 metres and is a reflection of the thickness of the surficial deposits.

5.3.5.2 Apparent Yield

The apparent yields for individual water wells completed through the Disturbed Belt Aquifer are mainly in the range of 10 to 100 m³/day as shown on Figure 20. The available apparent yield data for water wells completed through the Disturbed Belt Aquifer are mainly limited to the eastern half of the Aquifer.

Shown on the adjacent map are the locations of 47 dry water test holes.

There are 93 licensed and/or groundwater users that have water wells completed through the Disturbed Belt Aquifer, for a total groundwater diversion of 3,861 m³/day.

The highest groundwater use is for four licences that allow Husky Oil Operations Ltd. (Husky) to divert up to 1,723 m³/day for gas and petroleum purposes in sections 24 and 34 to 36, township 036, range 10, W5M. The highest authorization is for a Husky water source well in 11-24-036-10 W5M that is licensed to divert 645 m³/day and is completed from 11.5 to 42.6 metres below ground surface in the Disturbed Belt Aquifer.

Of the 93 licences and/or registrations, 48 could be linked to water wells in the AENV groundwater database.

More than 50% of the water wells completed through the Disturbed Belt Aquifer were drilled for oil and gas companies, with the main water well owners at the time of drilling being Northrock Resources Ltd., Amerada Hess Canada Ltd./Amerada Petroleum Corporation, Gulf Canada Resources Ltd., Shell Canada Resources Ltd., Canadian Hunter Exploration Ltd., Poco Petroleum Ltd., and Petro-Canada Oil & Gas Ltd.

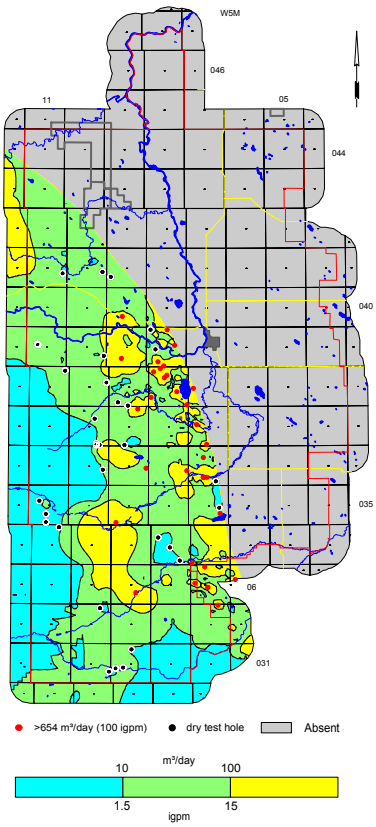

Figure 20. Apparent Yield for Water Wells Completed through Disturbed Belt Aquifer

5.3.5.3 Quality

The groundwaters from the Disturbed Belt Aquifer are mainly a bicarbonate type, with no dominant cation, with 60% of the groundwater samples having TDS concentrations of less than 500 mg/L (page A-36). Eighty percent of the sulfate concentrations in groundwaters from the Disturbed Belt Aquifer are less than 50 mg/L. More than 80% of the chloride concentrations in groundwaters from the Disturbed Belt Aquifer are less than ten mg/L, and 7% of the fluoride concentrations exceed the recommended maximum concentration of 1.5 mg/L.

5.3.6 Dalehurst Aquifer

The Dalehurst Aquifer comprises the permeable parts of the Dalehurst Member, as defined for the present program. The Dalehurst Member subcrops under the surficial deposits in the eastern half of the County. The thickness of the Dalehurst Member varies from less than 150 metres at the eastern edge of the subcrop to more than 450 metres in the western part of the subcrop. The regional groundwater flow direction in the Dalehurst Aquifer is toward the North Saskatchewan River (see CD-ROM).

5.3.6.1 Depth to Top

The depth to the top of the Dalehurst Member ranges from less than ten metres to more than 30 metres in the northern part of the County and is a reflection of the thickness of the surficial deposits (page A-37).

5.3.6.2 Apparent Yield

The apparent yields for individual water wells completed through the Dalehurst Aquifer are mainly in the range of 10 to 100 m³/day, as shown on Figure 21. The areas showing water wells with yields of greater than 100 m³/day are expected to be throughout the area extent of the Aquifer.

There are 1,114 licensed and/or registered groundwater users that have water wells completed through the Dalehurst Aquifer, for a total authorized groundwater diversion of 11,615 m³/day.

Of the 1,114 licences and/or registrations, 404 could be linked to water wells in the AENV groundwater database.

The highest authorized groundwater use is for 14 licences that allow Petro-Canada Oil & Gas to divert up to 3,201 m³/day for injection purposes, mainly in sections 24 to 26, township 041, range 09, W5M.

Nearly 20% of the water wells completed through the Dalehurst Aquifer were drilled for oil and gas companies, with the main water well owners at the time of drilling being Amerada Hess Canada Ltd./Amerada Petroleum Corporation, Poco Petroleum Ltd., Dome Petroleum Ltd., and Northrock Resources Ltd.

Between 1978 and 2000, extended aquifer tests with water test holes have been conducted by Mow-Tech Ltd. for numerous energy companies throughout the eastern part of Clearwater County. The results of aquifer tests have indicated long-term yields for water wells completed in the Dalehurst Aquifer in or near the Rose Creek area that can vary from less than 30 m³/day in 01-05-047-08 W5M to more than 800 m³/day in 01-17-045-07 W5M.

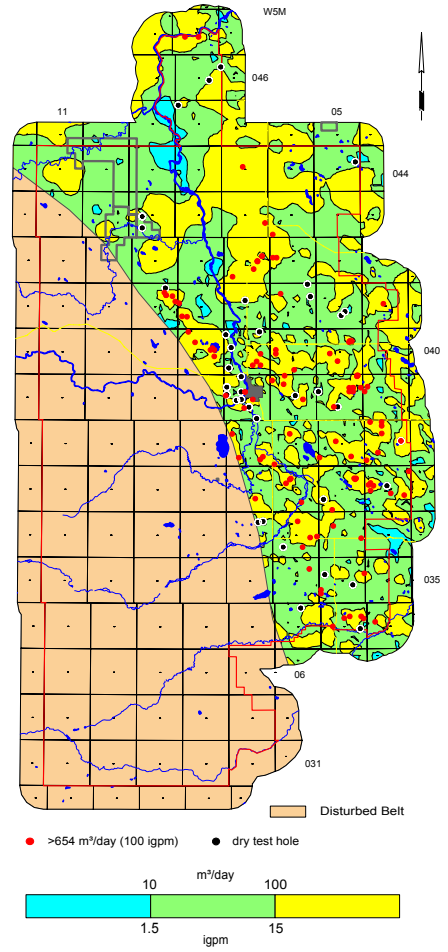

Figure 21. Apparent Yield for Water Wells Completed through Dalehurst Aquifer

5.3.6.3 Quality

The groundwaters from the Dalehurst Aquifer are mainly a bicarbonate type, with no dominant cation, with 75% of the groundwater samples having TDS concentrations of less than 500 mg/L (page A-39). Eighty percent of the sulfate concentrations in groundwaters from the Dalehurst Aquifer are less than 50 mg/L. More than 80% of the chloride concentrations in groundwaters from the Dalehurst Aquifer are less than ten mg/L, and 8% of the fluoride concentrations exceed the recommended maximum concentration of 1.5 mg/L.

6 GROUNDWATER BUDGET

6.1 Hydrographs

In the County, there are two observation water wells that are part of the AENV regional groundwater monitoring network. These are two locations where water levels are being measured and recorded as a function of time: Water Well No. 83-4 in SW 09-036-07 W5M near Ricinus and AENV Obs Water Well No. 95 (Raven Trout Brooding Station) in SW 05-036-05 W5M (see page A-42).

Water Well No. 83-4 was drilled in April 1983 for Alberta Energy & Natural Resources for observation purposes and was monitored by AENV in 1987, from September 1989 to September 1994, and from May 1996 to May 1997. Water Well No. 83-4 was drilled to a total depth of 61.0 metres and completed from 20.1 to 24.7 metres below ground surface in the Disturbed Belt Aquifer.

The adjacent hydrograph shows annual cycles of rise and decline throughout the monitoring period. In an area where there are no expected 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. The rise in water level in late spring/early summer could be associated with recharge when the frost leaves the ground. Overall annual fluctuations in Water Well No. 83-4 mainly range from 0.2 to 0.4 metres. From 1990 to 1997, there was a net decline in the water level of approximately of 0.6 metres.

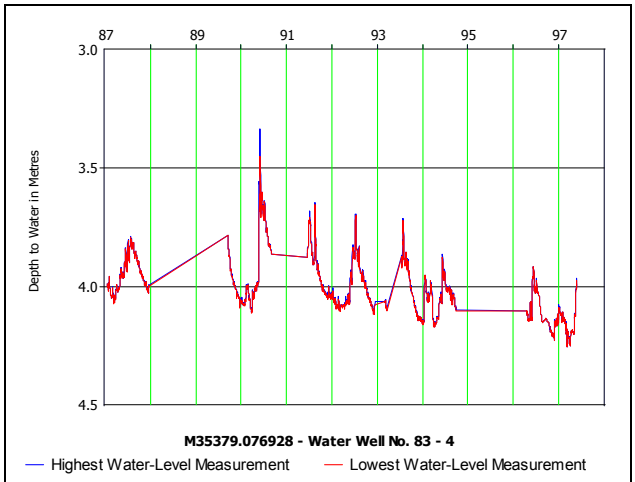

Figure 22. Hydrograph – Water Well No. 83-4

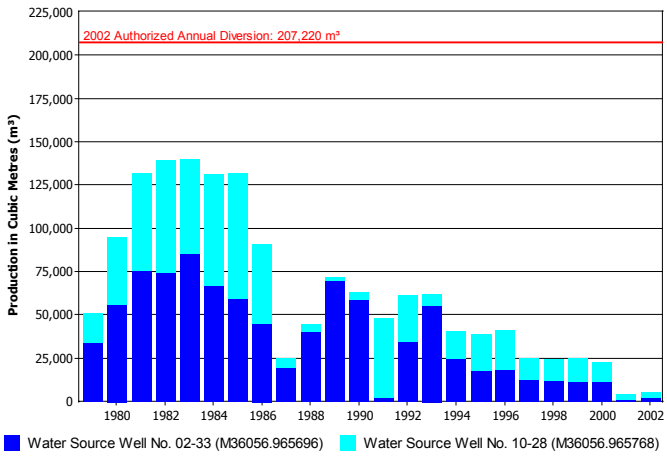

Figure 23. Annual Production from WSW Nos. 02-33 and 10-28

Enerplus Resources Corporation (Enerplus), formerly Suncor Inc., maintains two water source wells and five observation water wells for its Medicine River Unit No. 3 enhanced-oil-recovery project in the eastern part of Clearwater County. Enerplus is authorized to divert 207,220 m³/year from Water Source Well (WSW) Nos. 02-33 and 10-28, which are completed in the Dalehurst Aquifer. Mow-Tech Ltd.[21] has been monitoring the water levels in the two water source wells and five observation water wells since 1978.

Enerplus has diverted from WSW No. 02-33 and WSW No. 10-28 as much as 139,650 m³/year in 1983 (67% of the authorized amount) to as little as 3,855 m³/year in 2001 (2% of the authorized amount).

Observation WW No. 02-28 is one of the five observation water wells that is monitored as part of the Enerplus groundwater monitoring program. Observation WW No. 02-28 in 02-28-038-04 W5M is completed open hole from 7.3 to 18.3 metres below ground surface in the Dalehurst Aquifer and is 800 metres south of WSW No. 10-28 and 1,630 metres south of WSW No. 02-33.

[21] Mow-Tech Ltd. 1-800-GEO-WELL

A mathematical model aquifer [22] was used to calculate water levels in Obs WW No. 02-28 based on the Enerplus weekly groundwater production from 1979 to the end of 2002, with an aquifer transmissivity of 90 m²/day and a corresponding storativity of 0.00001. 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.

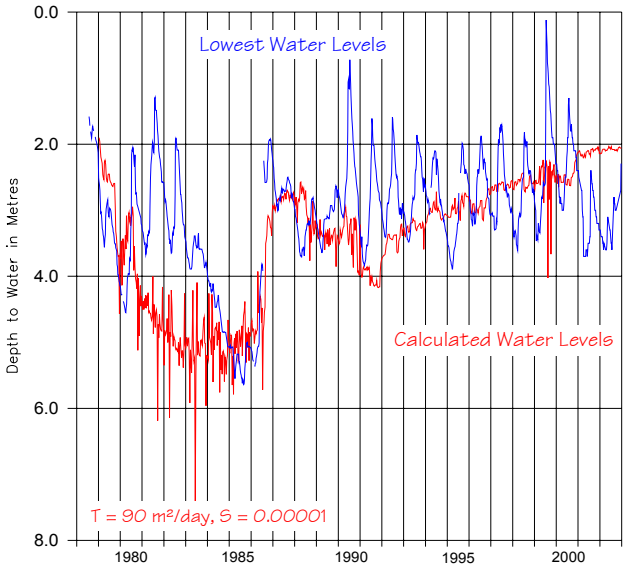

Figure 24. Water-Level Comparison - Obs WW No. 02-28

A comparison of the measured and calculated water levels shows a reasonable match when compared to the general patterns of the lowest weekly water-level fluctuation in Obs WW No. 02-28. The main exception to this is from mid-1980 to the latter part of 1984, when the average calculated water levels are in the order of 0.5 to 1.5 metres lower than the measured water levels. This discrepancy is considered due to the higher than average spring and summer aquifer recharge events in 1980, 1981 and 1982, as indicated by the rise in the measured water levels in Obs WW No. 02-28 shown below in Figure 25.

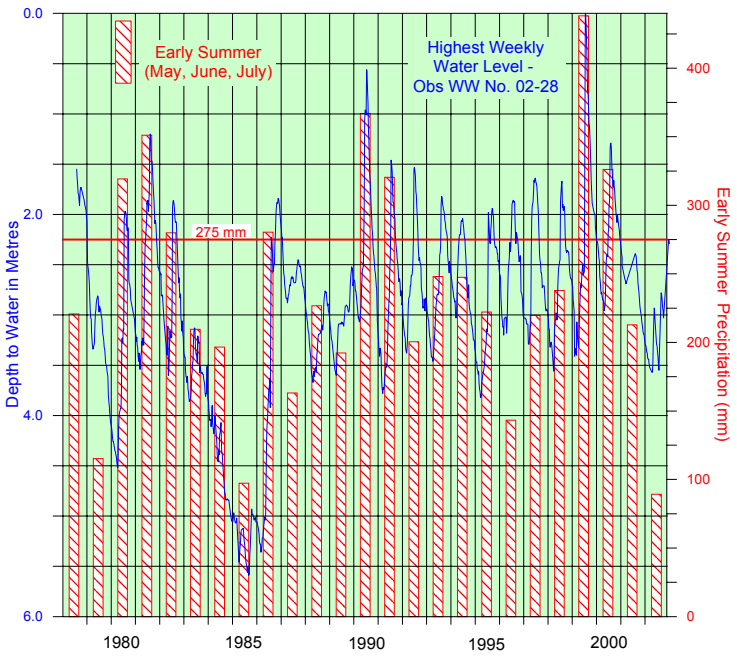

Figure 25. Obs WW No. 02-28 Measured Water Level and Early-Summer Precipitation

The water level in Obs WW No. 02-28 for the majority of years shows a similar fluctuation. There is a rise in water level during the first half of the year followed by a general water-level decline until the first half of the following year. This type of pattern is best illustrated in the years 1980, 1981 and 1982. From 1978 to 2002, the water levels in Obs WW No. 02-28 have ranged mainly between close to 1.5 metres and close to 3.5 metres below the reference point.

The adjacent graph indicates that when the early-summer precipitation exceeds 275 millimetres, measured at the Red Deer meteorological station, the water level in Obs WW No. 02-28 can be expected to reach a high of 2.0 metres below the reference point, regardless of whether the groundwater diversion is 139,600 m³/year (1982) or 22,370 m³/year (2000).

Since monitoring began in 1978, the general pattern of the water levels measured in the water source wells and the five observation water wells is a reflection of groundwater production combined with spring and summer recharge to the sandstone and shale aquifer within the Dalehurst Member in which the water source wells are completed.

[22] IAAM (see glossary)

Magin Energy Inc. (Magin) diverts groundwater from a water source well in 14-36-039-05 W5M for its enhanced-oil-recovery project in the eastern part of Clearwater County. Mow-Tech Ltd. has been monitoring the water levels in the water source well and three observation water wells since October 1998. One of the water wells monitored by Mow-Tech Ltd. is the DeMonnin Domestic (Dom) Obs WW in SE 02-040-05 W5M. The DeMonnin Dom Obs WW is completed at a depth of 24.4 metres below ground surface in the Dalehurst Aquifer.

The weekly measured water levels in Obs WW No. 02-28 were compared to the daily measured water levels in the DeMonnin Dom Obs WW from June to August, 1999. On July 7, 1999, 40 mm of rain was recorded at the Red Deer meteorological station. In response, the water level in Obs WW No. 02-28 rose to the surface and was flowing during the July 9 and July 16 weekly water-level monitoring. A similar water-level fluctuation was also noted at the DeMonnin Dom Obs WW as shown on the adjacent figure; the DeMonnin Dom Obs WW is approximately 14 kilometres north of the Enerplus observation water well.

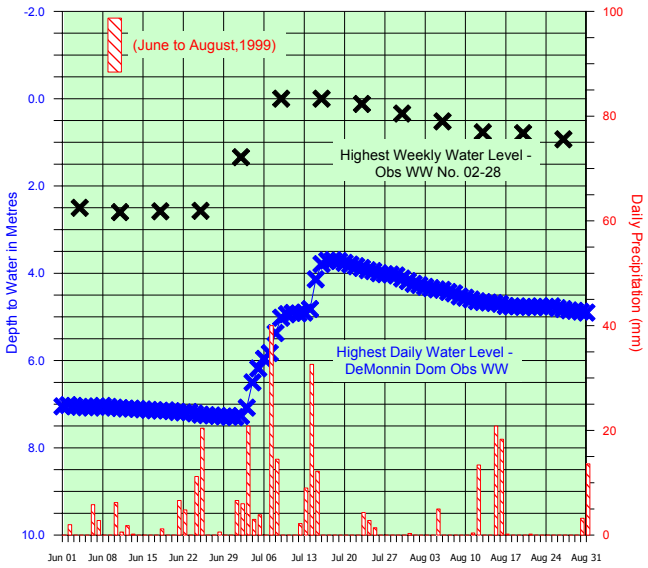

Figure 26. Obs WWs Water Levels and June to August, 1999 Precipitation

AENV Obs WW No. 95 (Raven Trout Brooding Station) in SW 05-036-05 W5M was drilled in May 1981 and completed open hole from 35.7 to 36.6 metres below ground surface in the Dalehurst Aquifer.

Because a water-level measurement reference was not provided by Alberta Environment for AENV Obs WW No. 95, changes in water levels were referenced to the non-pumping water level of 21.1 metres measured on May 27, 1981. The hydrograph for AENV Obs WW No. 95 shows annual cycles of rise and decline throughout the monitoring period (see page A-42).

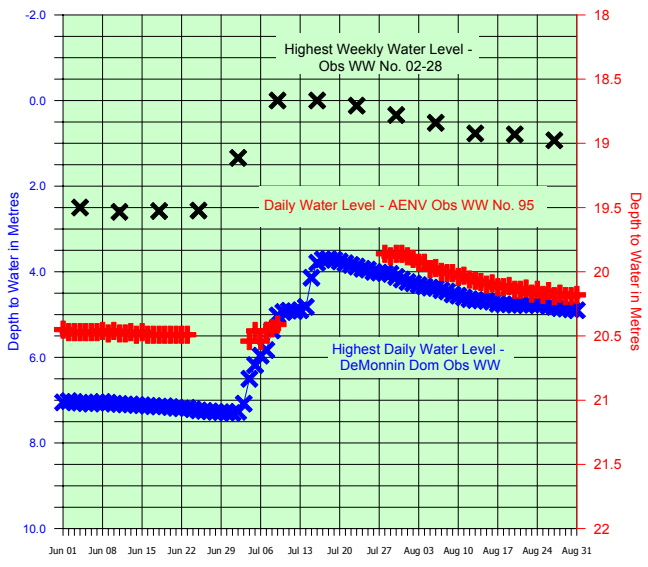

Figure 27. Water-Level Comparions – AENV Obs WW No. 95, Obs WW No. 02-28 and DeMonnin Obs WW - 1999

AENV Obs WW No. 95 is located 28 kilometres southwest of the Enerplus Obs WW No. 02-28. The daily measured water-level fluctuations in AENV Obs WW No. 95 were compared to the daily measured water levels in the DeMonnin Dom Obs WW and the weekly measured water levels in Obs WW No. 02-28 from June to August, 1999. Although water-level data are not available from June 10 to June 27, 1999 in AENV Obs WW No. 95, the water-level rise beginning on July 7 and the following water-level decline parallel the water-level trends in Obs WW No. 02-28 and the DeMonnin Dom WW.