

5.3.10 Muriel Lake Aquifer

The Muriel Lake Aquifer comprises the permeable parts of the Muriel Lake Formation, which underlies the Bonnyville Formation. Structure contours have been prepared for the top of the Muriel Lake Formation. The Muriel Lake Formation has a thickness of mainly less than 30 metres (CD-ROM). The structure contours show the Muriel Lake Formation ranges in elevation from less than 500 metres AMSL near Lac La Biche to more than 560 metres AMSL.

5.3.10.1 Depth to Top

The depth to the top of the Muriel Lake Formation ranges from less than 75 metres below ground level to more than 100 metres at the extreme southeastern part of the County (Page A-42).

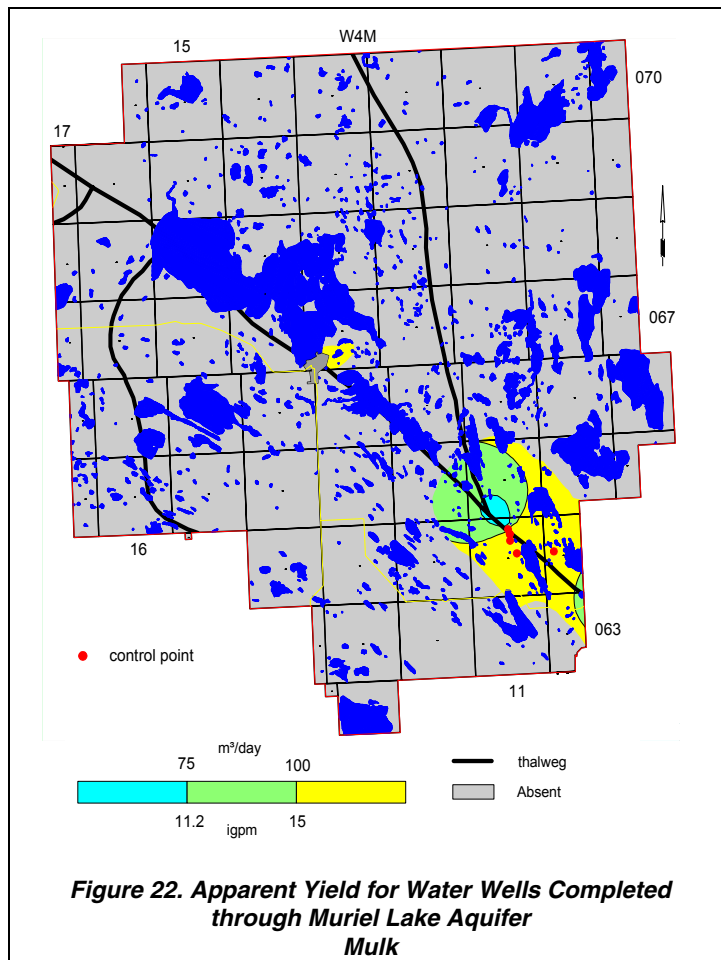
5.3.10.2 Apparent Yield

There are six apparent yields for individual water wells completed through the Muriel Lake Aquifer. All six control points have apparent yields of more than 50 m³/day.

An extended aquifer test conducted with a water source well completed in the Muriel Lake Aquifer in 02-33-062-03 W4M (M. D. of Bonnyville) indicated a total long-term yield of greater than 300 m³/day, based on an effective transmissivity of 130 m²/day (HCL, 1985b).

5.3.10.3 Quality

The groundwaters from the Muriel Lake Aquifer are mainly a bicarbonate type, with calcium-magnesium or sodium as the main cation (see Piper diagram on CD-ROM). The minimum, maximum and median concentrations of TDS, sodium, sulfate, chloride and nitrate + nitrite (as N) in the groundwaters from water wells completed in the Muriel Lake Aquifer in the County have been compared to the SGCDWQ and median concentrations from all surficial deposits in the adjacent table. Of the five constituents that have been compared to the SGCDWQ, the median value of **TDS** exceeds the guidelines.



Constituent	No. of Analyses	Range for County in mg/L			All Surficial Median	Recommended Maximum Concentration GCDWQ
		Minimum	Maximum	Median		
Total Dissolved Solids	4	1164	1518	1231	1220	500
Sodium	5	142	167	164	230	200
Sulfate	4	406	653	418	235	500
Chloride	4	12	21	15	40	250
Nitrate + Nitrite (as N)	4	0	0	0.0	0.0	10

Concentration in milligrams per litre unless otherwise stated
 Note: indicated concentrations are for Aesthetic Objectives except for Nitrate + Nitrite (as N), which is for Maximum Acceptable Concentration (MAC)
 SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality
 Federal-Provincial Subcommittee on Drinking Water, March 2001

Table 10. Concentrations of Constituents in Groundwaters from Muriel Lake Aquifer

The median concentrations of TDS and sulfate from water wells completed in the Muriel Lake Aquifer are greater than the median concentrations from water wells completed in all surficial deposits.

5.3.11 Bronson Lake Aquifer

The Bronson Lake Aquifer comprises the permeable parts of the Bronson Lake Formation, which underlies the Muriel Lake Formation. The Bronson Lake Formation has a thickness of mainly less than 15 metres (see CD-ROM). Structure contours have been prepared for the top of the Bronson Lake Formation. The structure contours show the Bronson Lake Formation ranges in elevation from less than 460 to more than 560 metres AMSL.

5.3.11.1 Depth to Top

The depth to the top of the Bronson Lake Formation ranges from less than 75 metres below ground level to more than 100 metres at the Formation edges (page A-45).

5.3.11.2 Apparent Yield

In the County, there is only one control point for apparent yields for individual water wells completed through the Bronson Lake Aquifer. The higher yields shown on the adjacent figure are the reflection of gridding a control point outside the County.

In the County, there are no licensed water wells completed in the Bronson Lake Aquifer.

5.3.11.3 Quality

In Lakeland County, there are no chemistry data for water wells completed through the Bronson Lake Aquifer.

In the M.D. of Bonnyville, there are twenty water wells with sufficient data to determine the groundwater type. The groundwaters from the Bronson Lake Aquifer in the M.D. are mainly a bicarbonate type, with calcium-magnesium or sodium as the main cation.

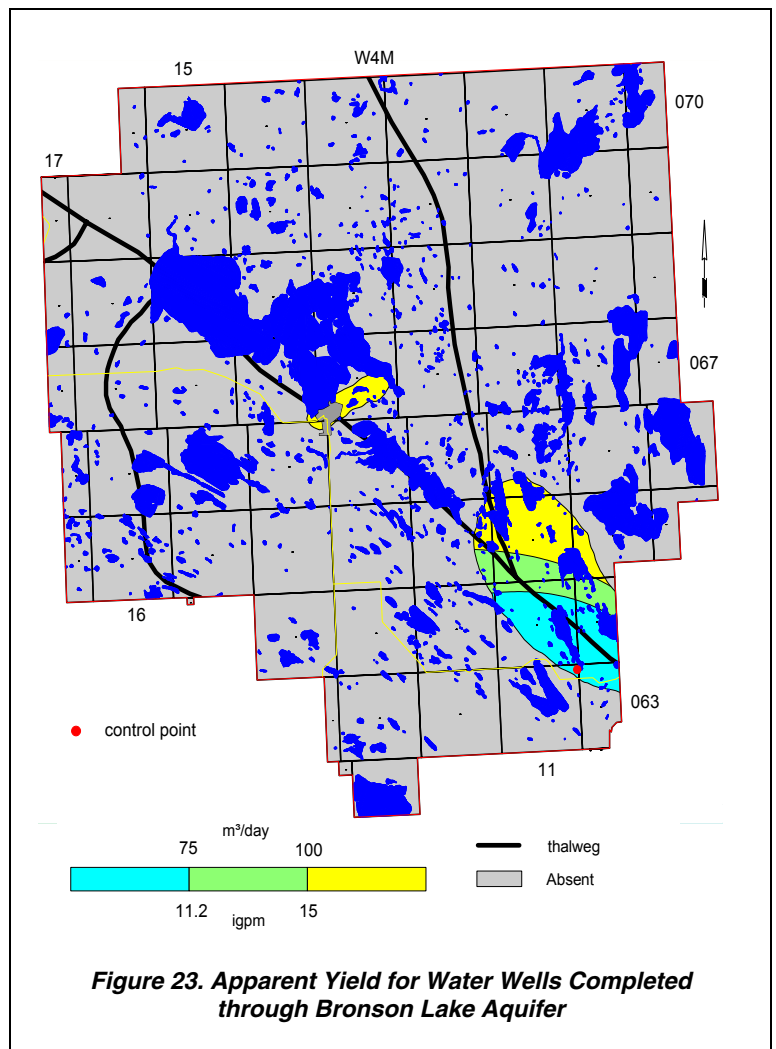


Figure 23. Apparent Yield for Water Wells Completed through Bronson Lake Aquifer

5.3.12 Empress Aquifer – Unit 3

The Empress Aquifer – Unit 3 comprises the permeable parts of the Empress Formation – Unit 3. Structure contours have been prepared for the top of the Empress Formation – Unit 3. The Empress Formation – Unit 3 has a thickness of mainly less than 50 metres (see CD-ROM). The structure contours show the Empress Formation – Unit 3 ranges in elevation from less than 500 to more than 560 metres AMSL.

5.3.12.1 Depth to Top

The depth to the top of Unit 3 ranges from less than 50 metres below ground level to more than 100 metres in parts of the north-central, northwestern and southeastern areas of the County (Page A-47).

5.3.12.2 Apparent Yield

The apparent yields for individual water wells completed through the Empress Aquifer – Unit 3 are mainly greater than 100 m³/day, with 19% of the values being less than 50 m³/day, 25% between 50 and 150 m³/day, and 56% of the values being more than 150 m³/day. Shown on the adjacent map are the locations of two dry test holes: one in SW 09-066-14 W4M and one in SE 09-069-16 W4M.

In the County, there are five licensed water wells that are completed in the Empress Aquifer - Unit 3, for a total authorized diversion of 94 m³/day. The highest allocation of 64 m³/day is for a water supply well in 10-36-066-15 W4M used for municipal purposes. All five licensed water wells could be linked to a water well in the AENV groundwater database.

An extended aquifer test conducted with a water supply well completed in the Empress Aquifer – Unit 3 at the Lac La Biche Airport in section 02, township 067, range 14, W4M indicated a total long-term yield of 230 m³/day, based on an effective transmissivity of 76 m²/day (HCL, December 1976c).

In 1973, Alberta Environment supervised the drilling and completion of five water supply wells for the community of Imperial Mills in sections 26 and 27, township 069, range 12, W4M. The completed depths of these water supply wells ranged from 40 to 49 metres below ground surface in the Empress Aquifer – Unit 3. The water wells were developed with air and apparent yields were estimated to range from 200 to 330 m³/day (Kerr, April 1978c).

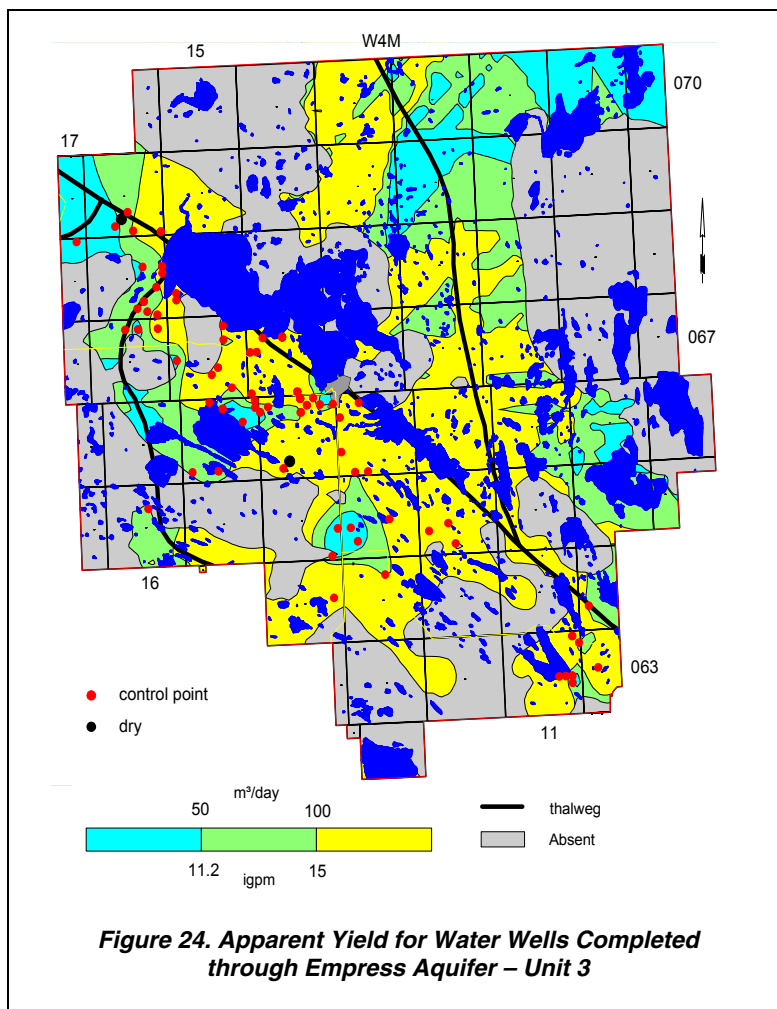


Figure 24. Apparent Yield for Water Wells Completed through Empress Aquifer – Unit 3

5.3.12.3 Quality

The groundwaters from the Empress Aquifer – Unit 3 are mainly a bicarbonate type, with calcium-magnesium or sodium as the main cation (see Piper diagram on CD-ROM). The minimum, maximum and median concentrations of TDS, sodium, sulfate, chloride and nitrate + nitrite (as N) in the groundwaters from water wells completed in the Empress Aquifer – Unit 3 in the County have been compared to the SGCDWQ and median concentrations from all surficial deposits in the adjacent table. Of the five constituents that have been compared to the SGCDWQ, the median values of **TDS** and **sodium** exceed the guidelines.

Constituent	No. of Analyses	Range for County in mg/L			All Surficial Median	Recommended Maximum Concentration GCDWQ
		Minimum	Maximum	Median		
Total Dissolved Solids	51	310	2974	1349	1220	500
Sodium	44	11	788	379	230	200
Sulfate	51	0	833	181	235	500
Chloride	51	4	1280	148	40	250
Nitrate + Nitrite (as N)	46	0	9	0.0	0.0	10

Concentration in milligrams per litre unless otherwise stated
 Note: indicated concentrations are for Aesthetic Objectives except for Nitrate + Nitrite (as N), which is for Maximum Acceptable Concentration (MAC)
 SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality
 Federal-Provincial Subcommittee on Drinking Water, March 2001

Table 11. Concentrations of Constituents in Groundwaters from Empress Aquifer – Unit 3

The median values of TDS, sodium and chloride from water wells completed in the Empress Aquifer – Unit 3 are greater than the median concentrations from water wells completed in all surficial deposits.

A groundwater sample from the water supply well at the Lac La Biche Airport in section 02, township 067, range 14, W4M has a TDS concentration of 1,100 mg/L, a sodium concentration of 385 mg/L, a sulfate concentration of 1 mg/L, a chloride concentration of 310 mg/L, and a nitrate + nitrite (as N) of less than 1 mg/L (HCL, 1976c).

A groundwater sample from the Imperial Mills water supply well (25-04) in NW 26-069-12 W4M has a TDS concentration of 448 mg/L, a sodium concentration of 100 mg/L, a sulfate concentration of 14 mg/L, a chloride concentration of 20 mg/L, and a nitrate + nitrite (as N) of less than 0.1 mg/L (Kerr, April 1978c).

5.3.13 Lower Sand and Gravel Aquifer (Empress – Unit 1)

The Empress Aquifer – Unit 1 is a saturated sand and gravel deposit that occurs at or near the base of the surficial deposits in the deeper parts of the linear bedrock lows. The thickness of the Empress Formation – Unit 1 is mainly greater than ten metres but less than 15 metres (see CD-ROM). Structure contours have been prepared for the top of the Empress Formation – Unit 1. The structure contours show the Empress Formation – Unit 1 ranges in elevation from less than 480 to more than 520 metres AMSL.

5.3.13.1 Depth to Top

The depth to the top of the Empress Formation – Unit 1 is mainly between 100 and 150 metres below ground level in the County (Page A-50).

5.3.13.2 Apparent Yield

In the County, there are six control points for apparent yields for individual water wells completed through the Empress Aquifer – Unit 1.

The apparent yields for individual water wells completed through the Empress Aquifer – Unit 1 are mainly greater than 50 m³/day.

In the County, there are no licensed water wells completed in the Empress Aquifer – Unit 1.

5.3.13.3 Quality

The groundwaters from the Empress Aquifer - Unit 1 are primarily a sodium-bicarbonate type (see Piper diagram on CD-ROM). The minimum, maximum and median concentrations of TDS, sodium, sulfate, chloride and nitrate + nitrite (as N) in the groundwaters from water wells completed in the Empress Aquifer – Unit 1 in the County have been compared to the SGCDWQ and median concentrations from all surficial deposits below in Table 12. Of the five constituents that have been compared to the SGCDWQ, the median values of **TDS** and **sodium** exceed the guidelines.

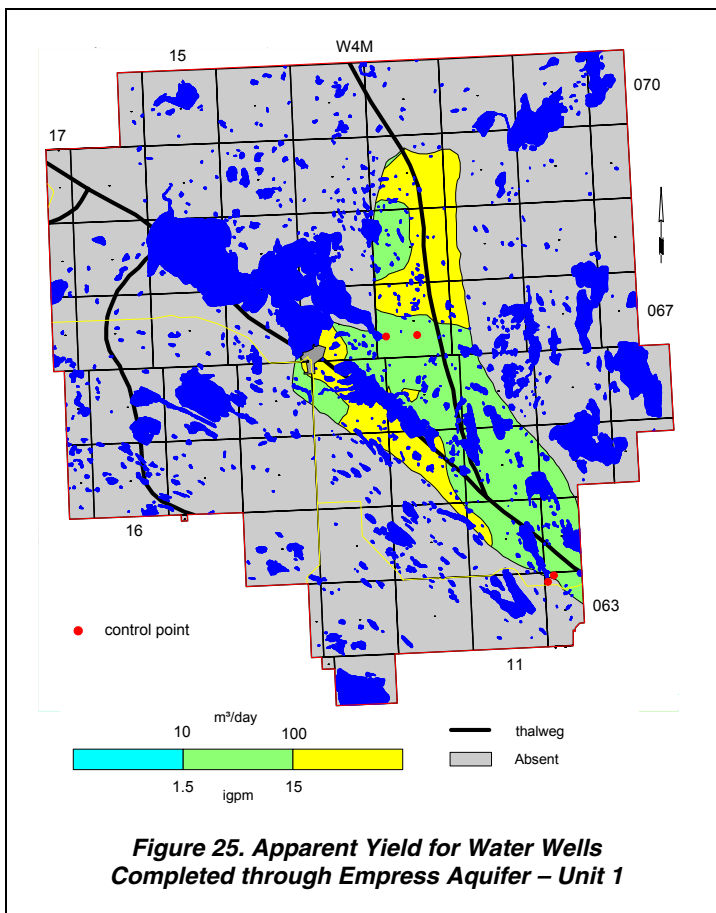


Figure 25. Apparent Yield for Water Wells Completed through Empress Aquifer – Unit 1

Constituent	No. of Analyses	Range for M.D. in mg/L			All Surficial Median	Recommended Maximum Concentration GCDWQ
		Minimum	Maximum	Median		
Total Dissolved Solids	5	1054	2202	1295	1220	500
Sodium	5	134	740	377	230	200
Sulfate	5	100	344.38	323	235	500
Chloride	5	17	909	103	40	250
Nitrate + Nitrite (as N)	5	0	0	0.0	0.0	10

Concentration in milligrams per litre unless otherwise stated
 Note: indicated concentrations are for Aesthetic Objectives except for Nitrate + Nitrite (as N), which is for Maximum Acceptable Concentration (MAC)
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 Federal-Provincial Subcommittee on Drinking Water, March 2001

Table 12. Concentrations of Constituents in Groundwaters from Empress Aquifer – Unit 1

The median concentrations of TDS, sodium, sulfate and chloride from water wells completed in the Empress Aquifer – Unit 1 exceed the median concentrations from water wells completed in all surficial deposits.

5.4 Bedrock

5.4.1 Geological Characteristics

In the County, the uppermost bedrock is the Lea Park Formation, consisting mainly of dark grey shales of marine origin. At locations where deep bedrock valleys occur, the Lea Park Formation has been eroded, exposing the Milk River Formation and the *undivided* Colorado Group (Pages A-12 to A-17). The Milk River Formation and Colorado Group are a marine shale of upper Cretaceous Age; the base of the marine shales is at an elevation of approximately 300 metres AMSL. Neither the Lea Park Formation, the Milk River Formation or the *undivided* Colorado Group contains any aquifers that would be suitable for the development of groundwater supplies, since they are considered essentially impermeable.

There will be no direct review of the Lea Park Formation, the Milk River Formation or the *undivided* Colorado Group in the text of this report; the only maps associated with the Lea Park Formation and the *undivided* Colorado Group to be included on the CD-ROM will be structure-contour maps.

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 where water levels are being measured and recorded with time. These observation water wells are completed in surficial deposits near linear bedrock lows (Page A-54). The two AENV Obs WWs have been monitored since 1985.

Alberta Environment Obs WW No. 190 in SW 27-064-11 W4M is completed from 78.6 to 84.7 metres below ground surface in the Muriel Lake Aquifer. AENV Obs WW No. 191 in SW 27-064-11 W4M is completed from 104.5 to 114.3 metres below ground surface in the Empress Aquifer – Unit 1. These observation water wells are located southeast of the junction of the Buried Helena and Imperial Mills valleys near Rich Lake and are primarily used to monitor the water level in the Buried Helena Valley.

The AENV Obs WW Nos. 190 and 191 hydrographs show annual cycles of recharge in late spring/early summer and a decline throughout the remainder of the year. Overall annual fluctuations in AENV Obs No. 190 range from approximately 0.05 to more than 0.1 metres (Page A-54), and in AENV Obs WW No. 191 range from approximately 0.01 to 0.2 metres, as shown above in Figure 26. From 1985 to 1995, there has been a net decline in the water level of in the order of 0.5 metres in both observation water wells. From 1995 to 1998, there has been a slight rise in the water levels of 0.1 metres in AENV Obs WW No. 190, as shown on Figure 27. There was a break in the monitoring record in AENV Obs WW No. 191 from mid-1996 to 1999. From 1999 to the end of the available monitoring data in 2000, there was a decline in the water level of 0.05 metres.

In order to determine if the fluctuations were responding to precipitation, the two AENV Obs WWs were compared to the precipitation data measured at the Venice weather station located southwest of Lac La Biche. The Venice weather station has the most complete data set per year in the County.

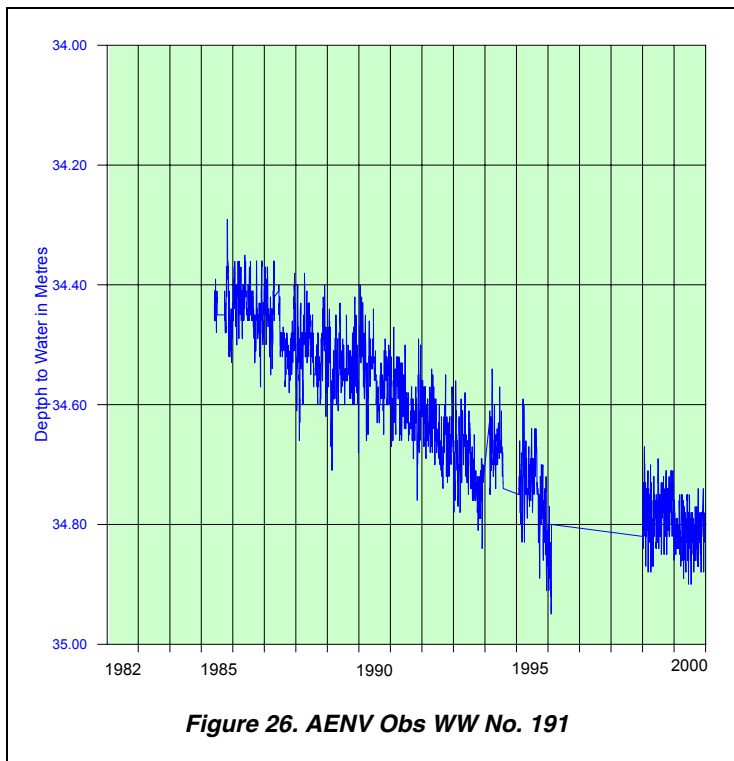


Figure 26. AENV Obs WW No. 191