

**Before the Commissioners appointed by
Canterbury Regional Council**

IN THE MATTER OF The Resource
Management Act 1991

AND

IN THE MATTER OF 78 Applications to Take
Water in the Ashburton
River and Valetta
Groundwater Allocation
Zones.

Section 42A Officer's Report

Date of Hearing: 21 July 2008

Report of Marc Ettema

Qualifications and Experience

1. My name is **Marc Ettema** and I have been employed for the last three years by Environment Canterbury as a surface water resource scientist and the seven years before that as a groundwater scientist. For the previous Valetta hearing I worked closely with Grant Davey on the preparation of the groundwater reports. I hold the qualification of a Master of Science degree in geohydrology from the University of Wageningen in the Netherlands. I worked in similar technical fields for the Ministry of Environment and Heritage of Queensland Australia and for the Ministry of Transport in the Netherlands in the surface water division. I have been a member of the New Zealand Hydrological Society since 1988.
2. I acknowledge that I have read the code of conduct for expert witnesses contained in the Environment Court's Practice Note dated 31 March 2005. I have complied with it when preparing my written statement of evidence and I agree to comply with it when I give oral evidence.

Ambit of my evidence

3. Additional to the joint statement with David Painter of agreed facts, I describe here further the surface water hydrology of the Ashburton River and the Valetta Groundwater Allocation Zones and the possible trends in flows and rainfall data.
4. Such evidence is within the ambit of my expertise.

Trends in Rainfall Climate.

5. One of the issues for this hearing is whether the recent observed low groundwater levels can be attributed to a change in the rainfall climate.
6. The Winchmore rainfall station has a useful length of record and is just north of the Ashburton River groundwater zone. It is at a relative central location in regards to the two groundwater zones. Winchmore was set up in the 1950's as an agricultural research station which included a full weather station with lysimeters. Environment Canterbury operates the lysimeters at present.
7. The Winchmore rainfall data was one of the rainfall stations investigated and presented in a report on droughts in Canterbury (Ettema 2006). The result of the standardised precipitation index (SPI) method for Winchmore is shown in figure 1. In a nutshell this graphical method shows deviations from normal rainfall on the horizontal time axis for different time scales of droughts; one month (closest to X-axis) to 2 years (top of graph) with colour coded the deviations from normal. The plots can show for example that a wet period of one or two month can occur in a 2 year overall drought period. For a more detailed description of this method refer to (McKee Doesken and Kleist, 1995).

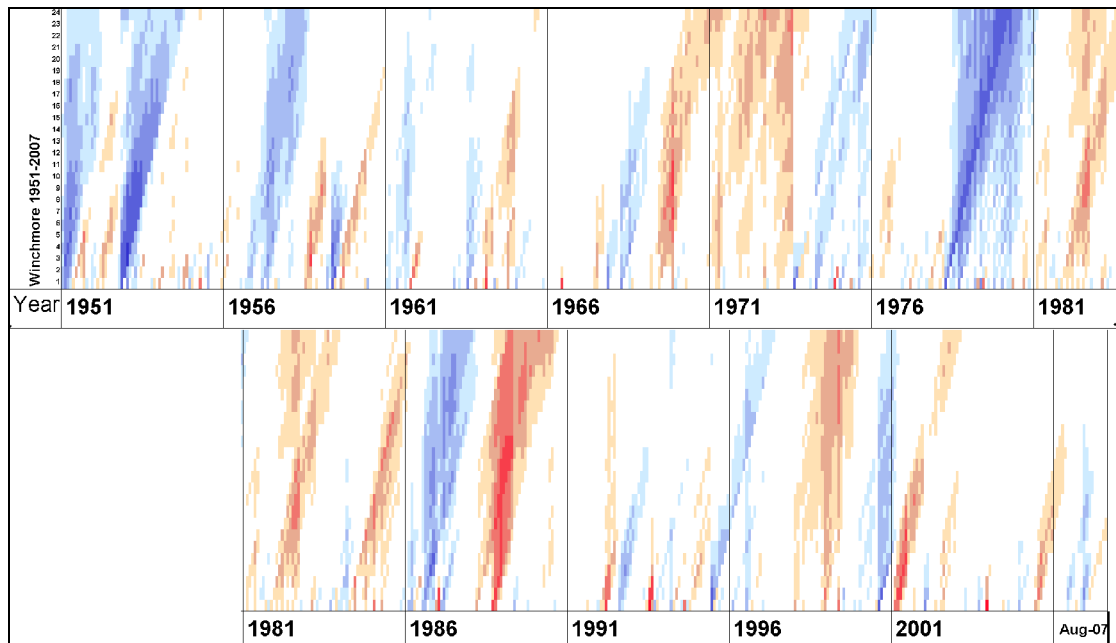


Figure 1 SPI pattern for Winchmore Rainfall data (Ettema 2006, updated)

8. From the plot we see that the known drought periods stand out in red (early 1970, 1982-1983, 1989, 1998 and 2001). After the 2001 the drought the index appears neutral on a time scale larger than one year but has a few dry/wet sequences up to 6 months time scale. The 2004/05 year was drier than normal for about a year. There is no major drought occurring at the moment. On the other hand it hasn't been extremely wet since 2000, but that in itself is not that unusual either (comparable to 1957 -1967 and 1991-1996)
9. Analysis on 60 year the monthly rainfall data does not show a trend over time.
10. Conclusion is that there is no obvious long term trend in rainfall and no major drought has occurred since 2001 and that 2004/2005 was a dry year.
11. Davey (2004) relates the low groundwater levels in the Valetta area of 2003-2005 to:
 - drier winters, low winter recharge
 - wetter summers keeping the surface irrigation demand lower causing less recharge under borderdyke area's
 - changes to old borderdyke systems to spray irrigation and laser levelled borderdyking causing less groundwater recharge

Surface water trends

Inflows

12. Only two surface water sites are available for long term trend analysis in the Ashburton Groundwater Allocation Zone; North Ashburton at the Old Weir and the South Ashburton at Mount Somers station. The location of the sites coincides with the top end of the Ashburton Groundwater Allocation Zone and there are no significant abstractions upstream. Over the last four years (2001-

2006) the flows at the two sites into the groundwater zone have been around normal which matches the rainfall situation. The 2000-01 drought showed strongest in the North Branch with a one in 43 year 7-day mean annual low flow (7DMALF) measured, while the South Branch, with slightly more alpine headwaters, experienced a one in 7 year 7DMALF (Ettema 2006). There is no apparent change in the inflow over time and the variation in inflows is correlated with the rainfall patterns over the same time. Gabites (2006) used regression to calculate mean flows of some tributaries at the top end of the groundwater zones and these are shown in Table 1

No	Flow Site	Mean Flow m ³ /s
68806	South Ashburton at Mount Somers	11.098
68810	North Ashburton at Old Weir	8.406
68819	Taylors Stream at SH72	2.394
68818	Bowyers Stream at Stavely	0.564
68826	Pudding Hill Stream at Gorge	1.648
68817	Woolshed Creak at Mt Somers	0.398
1638	Hinds River North Br at Quantocks	0.235
169111	Hinds River South Br below ADC take	0.071
	Total	24.814

Table 1 Mean in flows into Valetta and Ashburton River groundwater zone. (Gabites 2006)

13. Comparing the total surface water inflows with the total Rangitata Diversion Race take (27m³/s) which is distributed in the wider Ashburton area, it is obvious that the effects of the Rangitata Diversion Race on the hydrology and geohydrology must be significant.

Outflows

Ashburton

14. Trends in the outflow of the two groundwater allocation zones are harder to determine. The natural mean flow at State Highway 1 Bridge is about 29.11m³/s (Horrell 2004) while the actual measured flow over the available record (June-1996 – June 2007) was 18.2m³/s. Surface water abstractions are the main obvious cause, but directly and indirectly hydraulically connected groundwater takes will lower this flow as well. The flows in the Wakanui Creek (just north of coastal Ashburton River) have totally declined especially in summers and subsequent to changes to the drainage system in 1983 (Bubb 2003).

Valetta

15. The Coastal streams between the Ashburton and the Hinds Rivers discharged about 2m³/s in 2001 but the data for these streams is very limited. ECan installed a recorder on the Parakanoi Drain on the 22nd of Jan 2004. Before that this drain was the only spot gauged monthly in 2001 for the stream health project together with a dozen other sites in the area. The Parakanoi almost

went dry in the summer of 2004 but was dry for more than four months between 15-Dec-05 and 20-Apr-06 (Appendix 1). There are no earlier records of this drain going dry except for some anecdotal evidence.

16. The flow at this site shows a correlation of R^2 of 0.87 with the groundwater level in well K38/0093. This well (water level data since 1977) had its lowest ever readings in the same period that the drain went dry in 2005. The trend from the plot is $0.000028\text{m}^3/\text{s}/\text{day}$ which is equal to about a 300 l/s decline over the last 30 years or roughly a halving of the flow. Most of the decline seems to be in the last 4 years. The trend should be used with caution because the climate in the late seventies was slightly wetter than normal creating potentially an artificially higher trend. The R^2 of the regression with time is only 0.17 but that will be caused by seasonal fluctuations.
17. We can assume that the trends in nearby streams are very similar to what we see in the Parakanoi Drain based on their proximity and groundwater being the source of the water. A limited number of simultaneous gaugings have been conducted on these drains and the preliminary results show a good correlation between them. A detailed report on the flows in these drains is scheduled for 2008/2009.

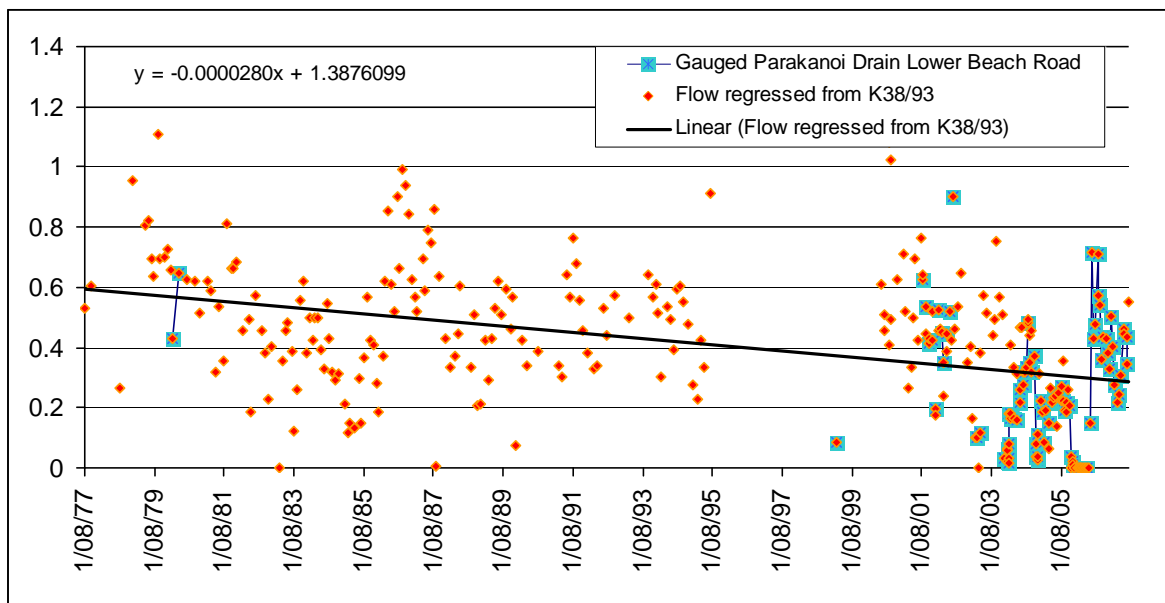


Figure 2 Trend in Parakanoi flow from regression with well K38/0093

18. Another method of analysing a trend in surface water flows is the number of days that rivers went on restriction. Unfortunately this source of data is not perfect for trend analysis. Over the years there have been:
 - changes in minimum flow;
 - changes in location of minimum flow sites;
 - increased abstractions;
 - increasingly complicated consents conditions;
 - variable staff resources and priorities;
 - the method of record keeping changed in November 2004.

19. The Ashburton Hinds Drains seem to be on restriction more than in previous years (Ettema 2006 Appendix 5), despite climatic conditions being about average over that period. In 2005/2006 the Parakanoi Drain was on full restriction for 163 days and on partial restriction for 25 days (Ettema 2006 Appendix 6).
20. The Eiffelton Irrigation Scheme noted that the natural flow in these drains has ceased on several occasions in the past few years and that the scheme was pumping more groundwater water to maintain the (minimum) flows in 2005/06 (Letter from Eiffelton Irrigation Scheme to ECan). This confirms the findings from figure 3. The low flow sites for the scheme are on Windemere, Deals and Home Paddock Drains with one site shifted to Poplar Rd on the request of the Scheme. The (major) drains in the area have only been witnessed as dry in the drought of the early seventies. (Pers. comm. Ian McKenzie). The electricity cost for the scheme to pump in a dry year can be double the amount of a normal year. In the 2005/2006 year the pumping costs were estimated to be \$65 per hectare or around \$162,500 for the total scheme while in a wetter year they normally are around \$25-\$30/ha.
21. The downward trend in surface water outflows in the Hinds-Ashburton streams are closely related to the trend in groundwater levels.
22. The effects of the trends are more apparent when climatic conditions are drier than normal.
23. Increasing groundwater abstractions will further decline groundwater levels and with it the flows in the Valetta streams.
24. It is likely that further increases in borderdyke irrigation efficiency will reduce general groundwater levels in the area and with it the outflows of the spring fed streams.

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Appendix 1. Manual Gaugings on the Parakanoi Drain.

Date	m ³ /s				
1-Aug-67	0.197	30-Jan-04	0.078	21-Oct-05	0.208
26-Jan-68	0.163	2-Feb-04	0.18	10-Nov-05	0.039
17-May-68	0.394	9-Feb-04	0.165	25-Nov-05	0.02
29-Nov-68	0.226	19-Feb-04	0.178	2-Dec-05	0.012
19-Sep-69	0.317	24-Mar-04	0.165	15-Dec-05	0
12-Feb-71	0.039	21-Apr-04	0.16	17-Jan-06	0
12-Nov-71	0.118	18-May-04	0.215	26-Jan-06	0
9-Mar-72	0.065	2-Jun-04	0.262	31-Jan-06	0
30-Aug-72	0.323	22-Jun-04	0.276	20-Feb-06	0
10-Jun-74	0.72	1-Jul-04	0.317	17-Mar-06	0
10-Aug-78	1.04*	13-Jul-04	0.316	20-Apr-06	0
26-Oct-79	0.817	28-Jul-04	0.334	24-May-06	0.146
7-Feb-80	0.431	12-Aug-04	0.484	20-Jun-06	0.714
16-Apr-80	0.646	27-Aug-04	0.348	11-Jul-06	0.43
22-Feb-99	0.087	13-Sep-04	0.317	26-Jul-06	0.478
13-Aug-01	0.627	18-Oct-04	0.371	18-Aug-06	0.713
11-Sep-01	0.537	4-Nov-04	0.082	28-Aug-06	0.573
9-Oct-01	0.412	9-Nov-04	0.035	7-Sep-06	0.543
12-Nov-01	0.426	18-Nov-04	0.024	29-Sep-06	0.36
17-Dec-01	0.198	22-Nov-04	0.112	12-Oct-06	0.436
22-Jan-02	0.526	30-Nov-04	0.039	8-Nov-06	0.429
19-Feb-02	0.45	22-Dec-04	0.222	24-Nov-06	0.383
12-Mar-02	0.351	17-Jan-05	0.186	14-Dec-06	0.327
16-Apr-02	0.448	8-Feb-05	0.083	5-Jan-07	0.503
14-May-02	0.521	24-Mar-05	0.15	22-Jan-07	0.403
25-Jun-02	0.903*	27-Apr-05	0.216	8-Feb-07	0.274
7-Mar-03	0.101	11-May-05	0.232	8-Mar-07	0.216
27-Mar-03	0.115	3-Jun-05	0.238	27-Mar-07	0.246
17-Dec-03	0.033	30-Jun-05	0.247	10-Apr-07	0.308
5-Jan-04	0.021	26-Jul-05	0.223	14-May-07	0.46
12-Jan-04	0.066	10-Aug-05	0.271	16-May-07	0.444
21-Jan-04	0.033	19-Aug-05	0.223	13-Jun-07	0.433
29-Jan-04	0.016	1-Sep-05	0.19		
		28-Sep-05	0.217		

* not included in the regression with K38/0093, possibly higher flow because of rainfall in previous week

Appendix 2. (from Ettema 2006) Rivers on restriction

Year	Restriction	Ashburton Hinds drains* (Days)
1997/98	Total	0
	Partial (H)	
1998/99	Total	55
	Partial	
1999/00	Total	46
	Partial	
2000/01	Total	57
	Partial	
2001/02	Total	111
	Partial	
2002/03	Total	36
	Partial	
2003/04	Total	148
	Partial	
2004/05	Total	270
	Partial	124
2005/06	Total	N/A (I)
	Partial	N/A

(H) The increased restrictions reflect an increase in monitoring by an increase in staff numbers and possibly an increase in complaints and an increase in consents.

(I) Parakanoi Drain 2005/06

Total 163
Partly 25.

(*a number of sites were included in the 'Ashburton Hinds Drains', per Nov 2004 sites are recorded individually):

Appendix 3. Flow gaugings North Ashburton River at Digbys Bridge.

Date	Time	CardIndex	Stage(m)	Flow (m³/s)	VObs'	Agency	Comments
14-May-61		C13762		119.426			NB: SLOPE-AREA GAUGING
31-Aug-70		C13777		198.100			
15-Feb-71		C13763		0.041			
11-Jan-72		C13764		0.441			
20-Feb-73		C13765		0.067			
17-May-73		C13766		1.939			
31-May-73		C13767		0.273			
12-Jul-73		C13768		2.340			
12-Dec-73		C13769		0.925			
4-Apr-74		C13770		1.893			
18-Jul-74		C13771		5.060			
9-Dec-74		C13772		3.765			
4-Nov-77		C13773		6.714			
20-Feb-78		C13826		0.431			
18-Dec-78		C14370		22.812			
3-Jun-81		C13774		33.247			
17-Feb-82		C13775		0.000			NB: NO FLOW.
18-Nov-85		C13776		5.177			
2-Mar-95	2360			0.000			
3-Mar-95		C13099		0.000			RIVER DRY.
1-Apr-95		C13113		0.000			RIVER DRY.
1-Apr-95	1100			0.000			
20-Jan-99	1340	T990034		0.000			
29-Jan-99	1200	S990049		0.000			
5-Feb-99	1200	S990056		0.000			
11-Feb-99	1400	S990070		0.000			
25-Feb-99	1200	S990106		0.000			
9-Mar-99	1525	S990133		0.000			
23-Mar-99	1330	T990197		0.000			
26-Mar-99	1450	R990194		0.899			
23-Jun-99	1137	S17464		2.044			
25-Jun-99	1130	S17477		1.352			
30-Jun-99	1125	S17487		0.178			
21-Dec-99	1050	R990566		1.331			
14-Jun-05	1130	T2005429		0.000	Dry	ECan	Dry, No Flow DRY

North Ashburton River at Shearers Road gridref: K36:005-130

Date	Time	CardIndex	Stage(m)	Flow (m³/s)	VObs'	Agency	Comments
4-Feb-98	1200	S980114		0.000			Dry
26-Feb-98	1102	S16069		0.000			DRY - VISUAL INSPECTION
5-Mar-98	1200	S16056		0.000			DRY - VISUAL INSPECTION
26-Mar-98	1220	S16102		0.000			DRY - VISUAL INSPECTION
7-Apr-98	1152	S16212		1.283			
29-Apr-98	1329	S16200		1.072			
24-Jun-98	1142	R16475		1.007			
5-Oct-98	1310	S16591		2.240			
20-Jan-99	900	S16897		0.000			Dry
29-Jan-99	1015	S16945		0.000			Dry
5-Feb-99	1200	S16970		0.000			Dry
11-Feb-99	1245	S16974		0.000			Dry
25-Feb-99	1010	S17049		0.000			Dry
9-Mar-99	1020	S17102		0.000			Dry
23-Mar-99	1055	S17161		0.000			Dry
26-Mar-99	1120	S17173		3.447			
21-Dec-99	1610	S17928		2.814			
29-Feb-00	950	S18065		0.383			
27-Jun-01	1330	S19602		0.000			Dry
14-Jun-05	1020	T2005425		0.332		ECan	

Appendix 4. Some Correlations between Hinds Drains flows.

