
in the matter of: the Resource Management Act 1991

and

in the matter of: applications for resource consent by applicants in
the lower Waitaki River Catchment under the
Waitaki Catchment Water Allocation Regional Plan

Supplementary evidence of **ROBERT JOHN POTTS**

Dated: 18 September 2008

SUPPLEMENTARY EVIDENCE OF ROBERT JOHN POTTS

Concept for condition during restriction periods

- 1 My full name is **Robert John Potts**.
- 2 I have put into writing the concept that I put forward at the end of evidence presentation on a practical method of imposing irrigation restrictions at the time of low flows in the lower Waitaki River.
- 3 As stated at the hearing, this is a matter that I considered overnight prior to presenting my main evidence and it was given on the basis of assisting the Commissioners. It does not necessarily have the endorsement of Meridian Energy Limited.
- 4 I have since further refined the concept and I have also inquired whether Dr David Painter would run a six-hour rolling average through the Tideda model that he presented in his primary and supplementary evidence. I would like to make it clear that Dr Painter has provided this information to allow me to assist you and in doing so does not necessarily indicate endorsement or approval of the concept. Dr Painter has therefore provided the information in Table 1 but unfortunately his client declined him from providing the graphical information. This has been carried out by one of Meridian's analysts.
- 5 The concept suggested is based on two rolling averages: A 24-hour rolling average to provide trends and to put abstractors on notice that restrictions are possible; and a 6-hour rolling average that triggers the level of restriction. This would operate independently from any input from Meridian but is intended to give downstream abstractors some forewarning that restrictions may be imposed – a matter which may be desirable to such abstractors.
- 6 The 24-hour rolling average presented by David Stewart and Dr Painter appears to give a reasonable trend of receding river flows without too much noise and seems to have some acceptance by the irrigators. The figure from Dr Painter's supplementary evidence is shown below (Figure 1), with the red line being the 24-hour rolling average. This shows dropping flows from 08 – 11 January 2004, again on 16 and 17 and again on 18 and 19 January 2004. Using the 24-hour rolling average for compliance would have resulted in restrictions on 10 – 12 January but not in the latter period when the river dropped below 190 cumecs on three occasions for durations of up to approximately 12 hours. However, the 24-hour rolling average could have been useful in putting abstractors on alert that restrictions were possible. This could be set up as a trigger on the rolling 24 hour average, say at 200 or 210

cumecs via an ECAN system to provide text communication to cell phones or through a phone tree.

- 7 For the example shown, abstractors would have been put on warning on 09 January that restrictions were possible on following days. This would have occurred again on 17 January and possibly again on 19 January depending on where the trigger was set. The warning may not always work, as could have been possible on 18 January had the warning not been provided on 17 January. However, the 24-hour rolling average is just a tool to give warning of a likely restriction in order that abstractors can gear up for some disruption.

Figure 1: Various Rolling Averages (from Dr Painter Supplementary Evidence)



Illustrating Tables 2, 3 in the evidence of David Stewart. The 190 line is 100 minimum flow + 90 allocation. 2 days + of restriction 9-12 January with hourly or daily sequential average data. Significant restriction 17-19 January with hourly sequential, but not with daily sequential or 24-hour moving mean.

- 8 Actual restrictions would be based on the 6-hour rolling average. This is shown in Figure 2 below. The reasons for adopting the 6-hour figure are:
- 8.1 This is roughly the time taken for water to flow from Waitaki Dam to Black Point. A shorter time step may not result in better protection of the river with fluctuating flows;

- 8.2 This time step more closely mimics river flows than the 24-hour time step and thus does not result in long periods when the river would be below 100 cumecs without restrictions (see Figure 2);
- 8.3 The frequency of occurrence (equates to disruption to abstractors), is the same as the 24-hour rolling average for 100 cumecs minimum flow (see Table 1 below); and
- 8.4 It gives a reasonable period of time for abstractors to undertake flow sharing via Water User Groups or switching off some irrigation machinery.

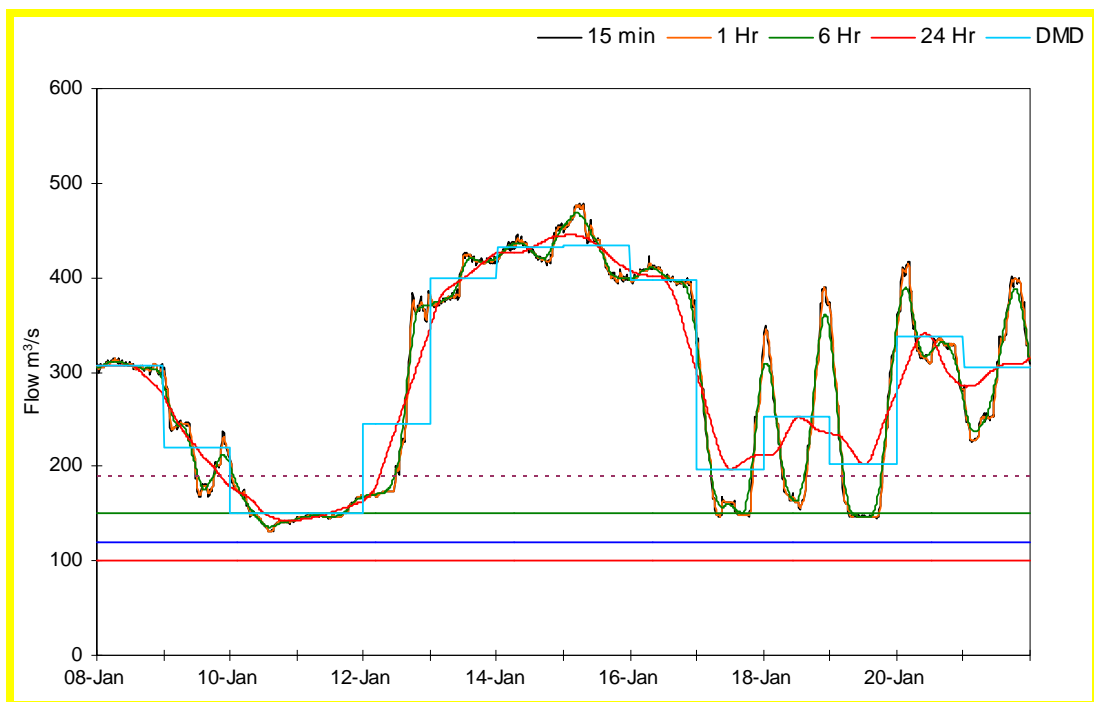


Figure 2: Rolling Averages January 2004

- 9 Figure 2 shows that using the 6-hour rolling average, abstractors would be restricted to some extent on 10, 11 and 12th January following a warning via the 24-hour rolling average on the 9th January. They would be restricted again on 17th but without warning, again on 18th for a short period and again on the 19th.
- 10 A 6-hour time scale for abstractors will create some difficulty for them in dealing with the restriction due to the timescale requiring more frequent assessment. Although I agree with the abstractors' consultants that a 24-hour time step would be desirable in managing their schemes and individual irrigation systems, from Dr Painters modelling and the low frequency of occurrence of restrictions being imposed via the 6-hour time step, I do not consider be sufficiently significant to be unbearable.

- 11 Table 1 below shows that for the 28.5 years of record modelled by Dr Painter, that the number of occurrences of restrictions based on a 100 cumec minimum flow is 1 (although multiple occurrences close together are counted as one, i.e. in Figure 1 above the occurrence would be counted as 1).

Table 1: Number of Flow Restriction Occurrences based on rolling Averages (01 July 1979 – 31 December 2007) (from Dr Painter)

River Flows below* (m³/s)	150	120	100
Instantaneous	40	7	5
1-hour moving mean	35	5	4
6-hour moving mean	27	3	1
24-hour moving mean	14	1	1
48-hour moving mean	6	0	0
72-hour moving mean	6	0	0
7-day moving mean	2	0	0

* Numbers of occurrences are minima; multiple occurrences close together counted as one

- 12 From my HDI evidence where I used the full 73 year record and using a 100 cumec minimum flow the frequency of restriction increases due to the longer hydrology record but remains low at about 5% of the time, with 71 days of some partial restriction occurring in the worst season, i.e. the frequency of occurrence is not likely to be high but the effect in dry inflow years will result in extended periods of restriction or water sharing.
- 13 From the evidence of Mr Jowett, the likely frequency of occurrence of long duration restrictions is in the order of > 1 in 15 years.
- 14 As commented in the paragraphs above, the implementation of restrictions will not be frequent, thus when they do occur, there may be abstractors who have never had to deal with restrictions in the past. However, restrictions are a part of life for other run-of-river abstractors in Canterbury and now also for some groundwater abstractors.
- 15 There are a number of methods that can be used, such as:

- 15.1 Water User Groups (WUG). Smaller individual abstractors take their full amount but on a rostered basis to meet the level of restriction, i.e. for 25% restriction, 3 of 4 abstractors would take their water and one would be switched off. The time on and off would be worked out within the WUG;
- 15.2 Larger Individual Takes. These have the ability to manage their own system by turning off some of their equipment, such as one centre pivot or one Rotorainer or some K-lines. A large Rotorainer operates at around 50 L/s as does a 100 ha pivot, so a Large Individual Abstractor could be considered to be taking >100L/s;
- 15.3 Schemes. The schemes that are part of these applications are both likely to be set up to be on-demand spray irrigation schemes. A scheme will therefore be set up as one large WUG, with rostered supply. The schemes could be set up on telemetry with automatic gate adjustment. This may sound onerous but occurs in schemes all around the world and other schemes in NZ are investigating full automation to make their water go further and to allow operation of on-demand systems. Automation will eventually be the norm.
- 16 The level of restrictions will be updated every 6 hours. As commented on at the hearing, I consider that restrictions could be put into 10 cumec bands, as outlined in Table 2 below which will mean that the river needs to change by a moderate amount before alterations need to be made to the irrigation equipment. This is based on the formula in the addendum to my evidence, with AC (All Consents) set to 90 cumecs and EC (Existing Consents) set to 51.89 cumecs.

$$\text{New Take}_{\text{Restricted}} = \frac{[\text{Flow}_{\text{KR}} - \{100 + (\text{EC} * \text{F})\}] * (\text{New Take}_{\text{max}})}{\{\text{AC} - (\text{EC} * \text{F})\}}$$

- 17 To date, the Plexos model using status quo inflows and managing the flows to meet Meridian's 120 cumec minimum plus a buffer, shows that the dam discharge never goes below 150 cumecs. More recent evidence presented by Meridian shows that with technology upgrades the discharge may reduce to closer to 120 cumecs more often – although flows below 150 cumecs would still be a relatively rare event.
- 18 Table 2 shows that during the infrequent occurrence that restrictions may be imposed, giving the existing irrigators 100% priority causes greater restrictions on the new takes, particularly when the river flows get below 170 cumecs. If the minimum flow is set at 150 cumecs (as it

might be for one month under the proposed MRNAG flow regime), then obviously restrictions would need to come on at higher flows.

River Flow [Band for Posing Restrictions]	River Minimum Flow	Percentage of Demand that can be Taken	Percentage of Demand that can be Taken
m ³ /s	m ³ /s	Existing Take 100% Priority (F = 1)	All Share on Equal Priority (F = 0)
190 [≥ 190]	100	100	100
185 [180 – 190]		87	94
175 [170 – 180]		61	83
165 [160 – 170]		34	72
155 [150 – 160]		8	61
240 [≥ 240]	150	100	100
235 [230 – 240]		87	94
225 [220 – 230]		61	83
215 [210 – 220]		34	72
205 [200 – 210]		8	61
195 [190 - 200]		0	44
185 [180 – 190]		0	39
175 [170 – 180]		0	28
165 [160 – 170]		0	17
155 [150 – 160]		0	6

Table 2: Percent of Demand that can be taken within each Flow Band

Reporting of Rolling Averages

- 19 For clarification, the two figures above show the rolling average reported at a mid point of that time step. This shows a better fit and is less confusing than the more traditional way of presenting rolling means with the rolling mean plotted at the end of the time period. Figure 3 shows the more traditional reporting method, i.e. a 6-hour rolling mean uses 24 individual 15 minute time steps and the mean is updated at the completion of 6 hours and plotted at that time position.
- 20 Both methods are correct. The method used by Dr Painter will give better results for using the 24-hour rolling average for trends as it brings the reporting back closer to real time.

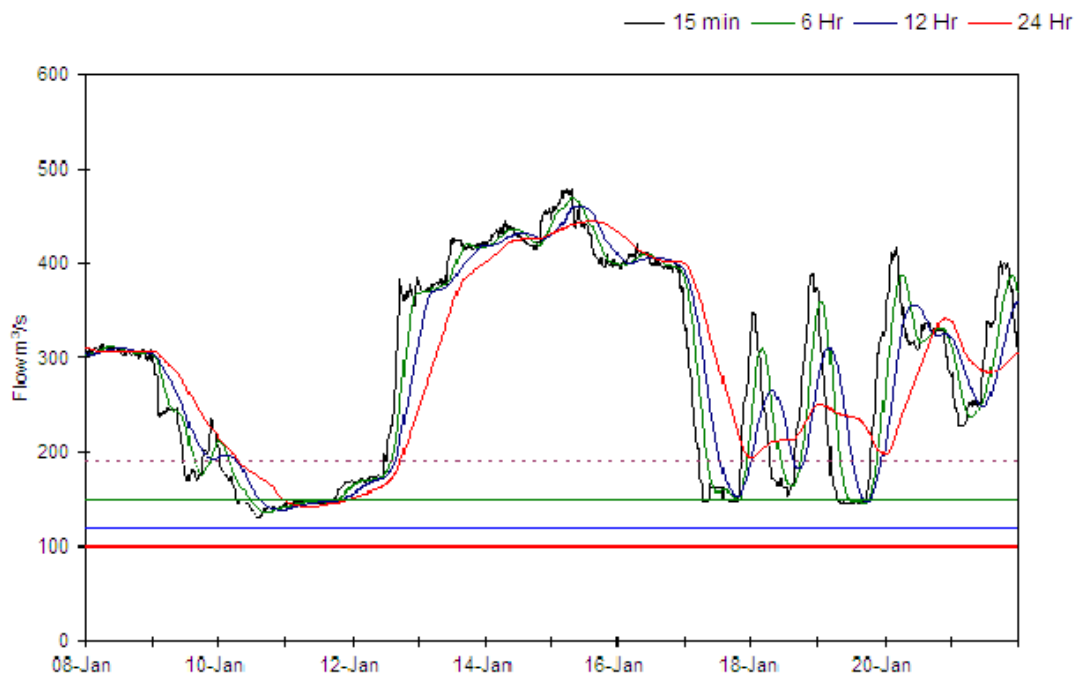


Figure 3: Rolling Averages End Point Reporting

Conclusions

- 21 The use of a 24-hour rolling average for showing trends and to provide some forewarning to abstractors appears practical.
- 22 Use of a 6-hour rolling average appears to be a reasonable compromise between practicability of switching irrigation equipment on and off and providing low flow protection to the river.
- 23 It is apparent from modelling that the frequency of restriction occurrence would not be great.

Dated: 18 September 2008

Robert John Potts