

18 June 2009

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MEMORANDUM

FROM : DAVID SCOTT

TO : ANNA VELTMAN
CC

SUBJECT : WAIMAKARIRI RIVER ALLOCATION OPTIONS - IMPLICATIONS FOR
GROUNDWATER RECHARGE

This is in response to your request for comment on the implications for groundwater recharge of alternative allocation options for the Waimakariri River. I have considered estimates of mean daily flow for the period Jan-1967 to Feb-2007 for the following scenarios:

Scenario	Description
66401	Waimak OHB – natural
1116640	Waimak OHB - A only
2866401	Waimak OHB - gap 30, B = 20 - all year
2966401	Waimak OHB - gap 30, B = 40 - all year
3366401	Waimak OHB - 1:1 sharing, B = 20
3466401	Waimak OHB - 1:1 sharing, B = 40

and have drawn the following conclusions regarding potential impacts on recharge to groundwater:

- for the gap and sharing options there is little to distinguish between the alternative B block sizes,
- the gap options would have less potential effect than the sharing options but all options are likely to have only minor effects,
- any of the four options would be preferable to the current status (an unconstrained B block with no gap).

The basis for my opinion is as follows:

- 1) Simultaneous flow gaugings of the Waimakariri River suggest that the seepage loss from the river is sustained at low flows appearing to be around 7.5 m³/s albeit with a significant measurement uncertainty. This contradicts the common presumption that seepage loss is likely to be some proportion of the river flow. In his evidence to CPW on behalf of CCC Peter Callander acknowledged the relatively steady loss and suggested that the extensive permeable gravels in the bed of a large braided river may buffer the effects of varying river flow. This argument has some merit and observations in the bed of the Rakaia River (Scott and Thorpe, 1986) demonstrated the capacity for significant flow within the gravels of the river bed.
- 2) A complementary perspective is provided by considering how the combined discharge capacity of a river/aquifer system is exercised at different river flows. I have performed some simple MODFLOW simulations of a river/aquifer system which show that seepage losses stabilise once river flow rises above a threshold value.

This theoretical analysis suggests that groundwater gradients adjacent to a river would be relatively independent of river flow. Examination of groundwater levels in the monitoring array at Crossbank for the period August 1999 to March 2009 shows that groundwater gradients have been remarkably steady (mean ~ 0.0023 , standard deviation = 5% of mean, i.e. 67% of the time the gradient is within 5% of the mean) and with little influence from changes in river low.

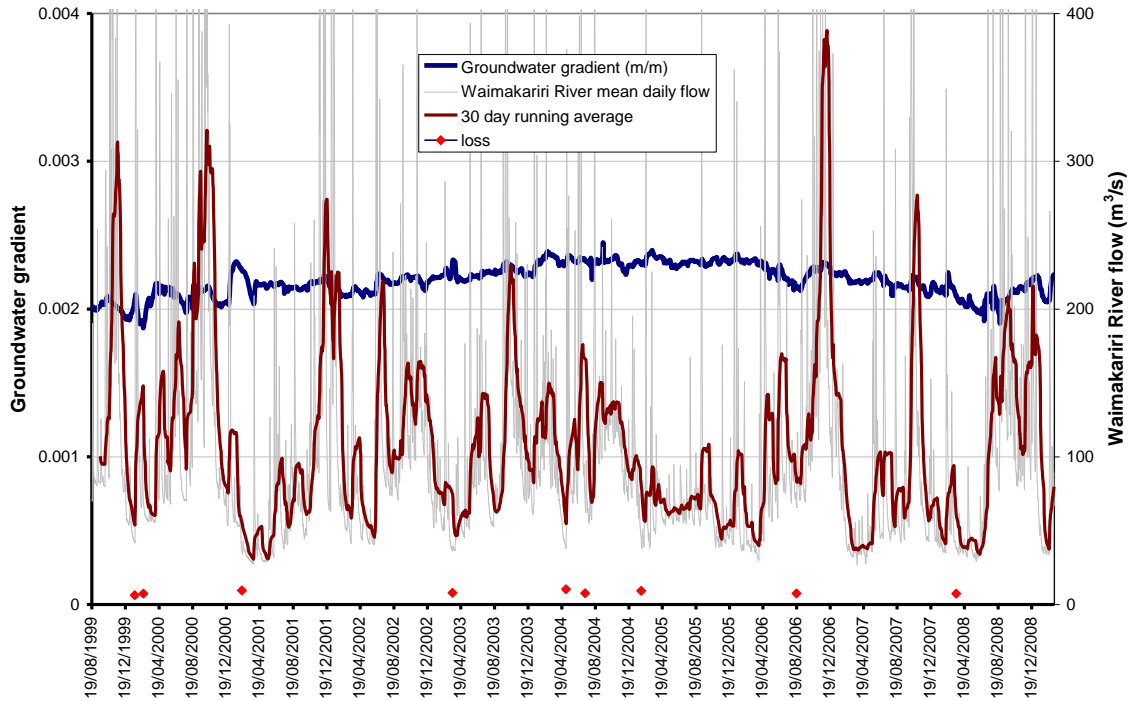


Figure 1: Groundwater gradient at Crossbank, Waimakariri River flow at Old Highway Bridge and flow loss gaugings for the period August 1999 to December 2008.

- 3) Finally, even if some direct dependence on river flow is assumed, there is little to distinguish between the alternative allocation regimes. I have illustrated this by comparing the estimated recharge for the hypothetical (and conservative) case where seepage loss is assumed to be a constant 10% of the river flow. This comparison is illustrated in Figure 2 and shows that:
- the 10%-ile flow loss is essentially the same for all options (including the A block option alone) reflecting the fact that the B block options apply at flow levels above the 10%-ile flow,
 - at median flows there is little to distinguish between the alternative B block sizes,
 - the flow sharing options have the potential to have a larger effect at median flows than the gap options. NB: Because of the conservative nature of the assumption regarding the relationship between recharge and river flow the difference between the gap and flow sharing options is likely to be exaggerated.

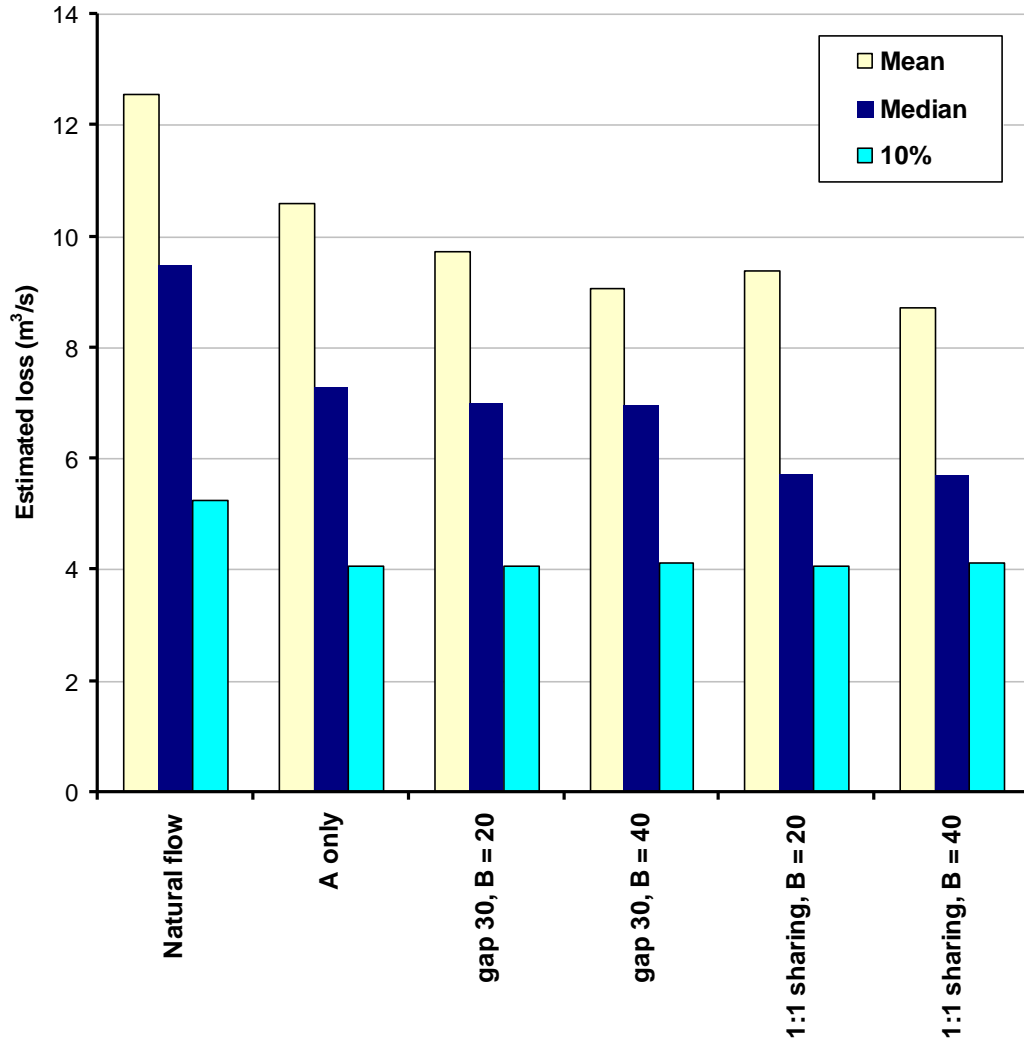


Figure 2: Estimated flow loss for hypothetical (and conservative) assumption that recharge is a constant 10% of the flow at Old Highway Bridge. NB: Flow loss estimates should be regarded as speculative.

Note: It is generally understood that a large proportion of the Waimakariri River loss flows to the south of the river. Nevertheless, it is reasonable to expect that the above conclusions apply to losses on either side of the river.

References

Scott, D.M. and H.R. Thorpe (1986). Groundwater Resources Between the Rakaia and Ashburton Rivers. Hydrology Centre Publication No. 6. Ministry of Works and Development, Christchurch. 105pp.