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Ref :

MEMORANDUM

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TO : ANNA VELTMAN
cc Tim Davie, John Glennie, Don Vattala, Suzanne Gabites, Luisa Magalhaes, Adrian Meredith

SUBJECT : FLOW RELATIONSHIP BETWEEN THE WAIMAKARIRI AT OTARAMA AND THE WAIMAKARIRI AT OLD HIGHWAY BRIDGE.

Background

The current plan review of the Waimakariri River regional plan provides an opportunity to reconsider the location of the minimum flow site currently at Old Highway Bridge (OHB). There appears to be a considerable amount of support to move the minimum flow site to Otarama, as the river exits the upper gorge, as communicated throughout the Central Plains Water hearing. This short technical memo. discusses the technical issues regarding the relocation of the minimum flow site.

Aim

To discuss the options for establishing a minimum flow site at Otarama on the Waimakariri River to:

1. Improve the management of consent conditions from above the current takes
2. Implement a workable management regime to allow critical fresh flows to pass down the river.
3. Avoid the effects of tidal influences at OHB

1. Improve the management of consent conditions from above the current takes

The existing consent conditions, such as the minimum flow and partial restrictions, refer to unmodified flows estimated at OHB. Therefore, the recorded flow has to be naturalised by estimating the amount of water which has been taken by out of stream users. This process requires all the takes to be estimated, where they are not measured and available on telemetry. Therefore the naturalisation of flows is currently not practicable as the out of stream takes are either not measured, measured but not on telemetry or measured on telemetry but not available in real time.

There are three ways to overcome these practical difficulties:

- move the minimum flow site to above the takes
- change OHB to a residual flow site and establish a new residual flow.
- measure all the takes and have the data available in real time and naturalise the flow

The moving of the minimum flow site from OHB to Otarama, which is above the takes, has the benefit that no real time naturalisation is required as well as reducing the risk of not meeting the OHB minimum flow condition for out of stream takes. However, establishing an equivalent minimum flow at Otarama which equates to the 41m³/s unmodified minimum flow at OHB is not without uncertainty. This is due to a number of factors: the flows in and out of the river between Otarama and OHB are not constant and will vary even for the same flow recorded at Otarama, some of the out of stream takes between Otarama and OHB are not measured and the number of concurrent gaugings at OHB and Otarama are currently limited and include uncertainty and errors.

This is illustrated by discussing the available concurrent gauging data between Otarama and OHB and the relationships which can be derived.

Available Data

As of June 2009 there have been 25 gaugings at the Otarama site over the last 38 years, two in 1971 and the other 23 in the last two and a half years. Sixteen of these were gauged concurrently with the OHB site. The range of flows that have been gauged at Otarama is between 31m³/s and 220m³/s. Four of the recent OHB gaugings have been adjusted based on the time of travel delay between the gauging sites. In these cases the gauging value at OHB is considered to be earlier than when the associated flow would have travelled through the system, so a flow value from the recorded stage has been used. The OHB gaugings have been naturalised, this was done using a spreadsheet created by Richard de Joux that was used for the Central Plains Water hearing evidence. This uses a series of assumptions for water use based on a demand model and also available actual water use supplied by Waimakariri Irrigation Ltd. On four of the gauging runs all of the major takes have been measured and the gaugings have been naturalised by adding back these takes.

Results

The relationship between the flows for the two sites can be seen in figures 1 and 2. The least squares linear regression from the data gives a flow of 41.9m³/s at Otarama when the naturalised flow at OHB is at 41 m³/s. Using this relationship it is assumed that for 50% of the time that when the flow at Otarama is 41.9 m³/s that the naturalised flow at OHB is above 41m³/s and for the other 50% the flows will be below 41 m³/s. Uncertainty (error) bars of 8% have been added to the data points to display the standard gauging error and a new relationship has been calculated. As this work is principally looking at the minimum flow relationship the sample has been split to flows below 80m³/s, approximately the lower quartile flow, giving 12 concurrent gaugings below this value. This relationship therefore takes a precautionary approach to looking at the associated flows between OHB and Otarama. This new relationship gives a value of 51.9m³/s cumecs at Otarama when the naturalised flow at OHB is at 41m³/s.

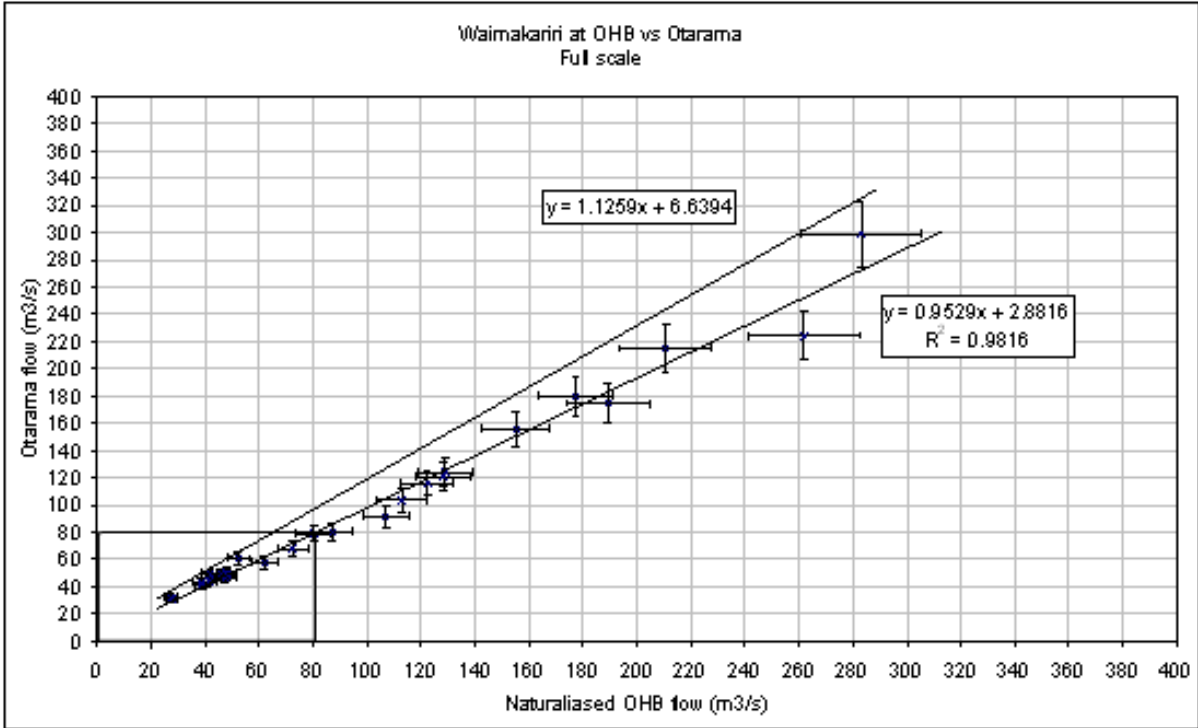


Figure 1. Relationship between Waimakariri at OHB and Otarama full scale

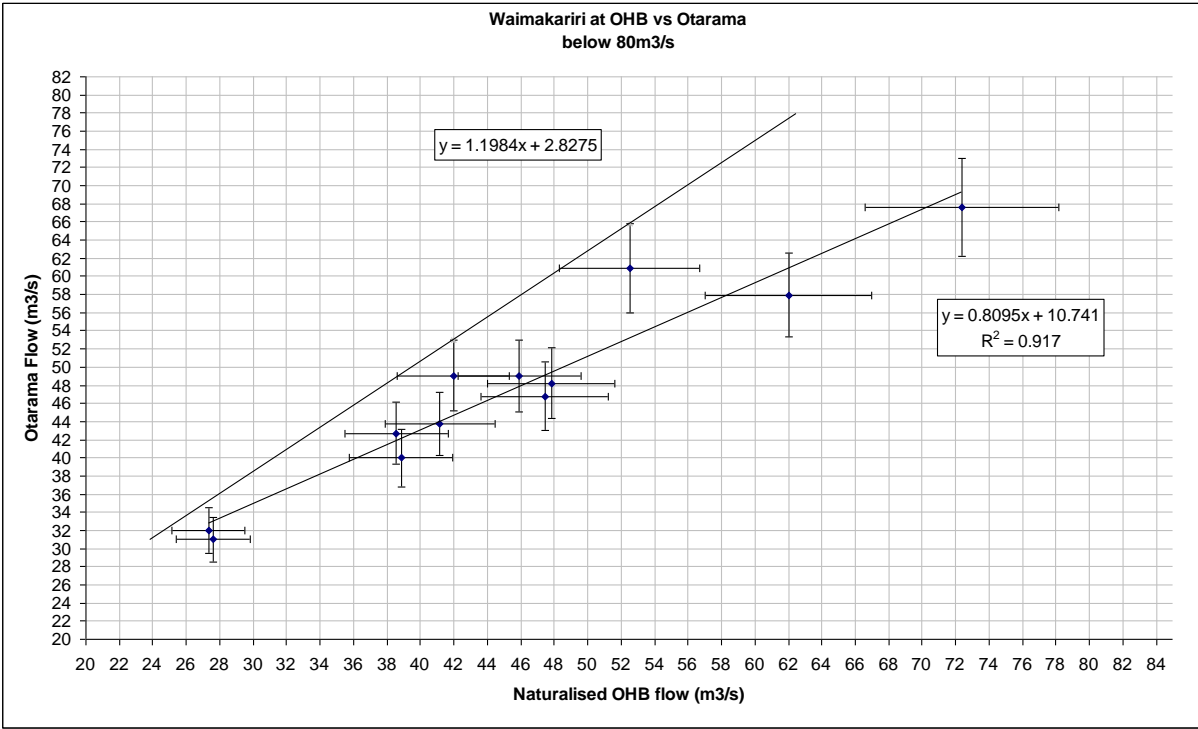


Figure 2. Relationship between Waimakariri at OHB and Otarama looking at OHB flows below 80m³/s

To therefore establish Otarama as the minimum flow site would result in some doubt whether the existing modified minimum flow of 41m³/s was being met at OHB. To reduce this risk a higher minimum flow should be chosen, such as 52m³/s at Otarama but this would have consequences for the reliability of supply for out of stream users.

The second option is to make OHB a residual flow site and Otarama a early warning trigger site. The residual flow could be set at $41\text{m}^3/\text{s}$ recorded at OHB, which is the current modified minimum flow. The problem with the recorded flow being below the takes is that the user has to anticipate the impact they are having on the flow which is quite difficult especially when the take is not measured. To reduce this risk the Otarama flow could be used as an early warning to indicate that a flow threshold at OHB is likely to be breached. The flow at Otarama could be made available to the users so that they have time to make a proportionate response. This will not remove the risk completely due to the uncertainty of the relationship and will depend on how precautionary the users wish to be.

The third option is to measure the takes with telemetry communication and naturalise the flow at OHB in "real time". This would allow the current consent conditions to be monitored directly without estimation, the only error being the measurement error and time of travel issues. It would still rely on the irrigators making a judgement about their impact on the flow at OHB but with the actual takes measured this risk should be reduced considerably. A water user group would be advantageous in deciding who should reduce/cease to meet the minimum flow. It would still be useful to have the early warning from Otarama so that any reductions can be agreed between the users.

2. Implement a workable management regime to allow critical fresh flows to pass down the river.

The ecological analysis undertaken for the plan revision has highlighted the need to protect critical freshes of $130\text{m}^3/\text{s}$ after 21 days of lower flow. In practice this means allowing these fresh flows to pass down the river without abstraction by out of stream takes. To achieve this would require an upstream early warning which would then be communicated to all consent holders so that they could cease abstraction for an agreed period. The average travel time for freshes between Otarama and OHB is 24 hours, however, triggering this condition for a flow of $130\text{m}^3/\text{s}$ at Otarama may still only give approximately between 2-4 hours warning. This is because the trigger condition would apply to all flood flows and not just smaller freshes. It is debatable if this is long enough to give out of stream users chance to switch off their takes. If a longer lead in time is required then the trigger level could be set lower and/or initially triggered from the water level recorder site at Esk. These refinements will have to be resolved once the principle of fresh protection has been agreed.

3. Avoid the effects of tidal influences at OHB

The river is tidal at the OHB and this affects the flow approximately every 12 hours. The moving of the minimum flow site to Otarama, which is above any tidal influence, would remove the need to analytically amend the flow. Compared to the current practice this would be advantageous to out of stream users.

Another option is to develop an automated process to take out the effects of the tide. Such a process has been used before and could be reinstated with additional refinement, such as using the flows at Otarama to determine if the flow peak is a tidal peak or a river hydrograph.

Conclusions

The technical memo has discussed the reasons for and advantages and disadvantages of relocating the minimum flow site from Old Highway Bridge to Otarama.

There are two main reasons why moving the minimum flow site from OHB to Otarama would appear advantageous: It is above the takes and above the tidal influences. Therefore no naturalisation needs to be done and consent conditions can be monitored and triggered

easily. It also improves the water management for out of stream users as they would no longer need to predict the effects of their takes on downstream flows at OHB.

Therefore, technical analysis is required to transfer the $41\text{m}^3/\text{s}$ unmodified flow at OHB to an equivalent flow at Otarama. To do this a number of concurrent gaugings have been undertaken at Otarama and OHB. The gaugings show that there is a possible range of flows that will give $41\text{m}^3/\text{s}$ at OHB. This is because of variability in the hydrological response, uncertainty in the abstractions by the unmeasured takes and errors in the gaugings and recorded flow. From the very small sample (12 number) of concurrent low flow gaugings a minimum flow of $52\text{m}^3/\text{s}$ would have to be set at Otarama so that $41\text{m}^3/\text{s}$ would most probably occur at OHB. This conservative estimate would have an impact on the reliability of supply for out of stream users which may not be acceptable.

An alternative option is to retain OHB as a residual flow site with a residual recorded flow of $41\text{m}^3/\text{s}$ with Otarama flow recorder providing an early warning communicated to all out of stream users. This option would be improved if all the takes were telemetered so that real time decisions could be made by the out of stream users. For example if a early warning was disseminated for a falling flow of $52\text{m}^3/\text{s}$ at Otarama and the out of stream takes were $5\text{m}^3/\text{s}$ and OHB was $42\text{m}^3/\text{s}$, then a reduction of $1\text{-}2\text{m}^3/\text{s}$ could be coordinated between the out of stream users in the A Block.

This option does not deal with the effect of the tidal influences at OHB and therefore a automated process would need to be developed to remove the effects. This is technically feasible, although not as robust as moving to a site above the tidal effects.

The other policy change in the revised plan will be to protect fresh flows of $130\text{m}^3/\text{s}$ after a low flow period of 21 days. This will require upstream early warnings triggered from Otarama maybe in combination with the water level recorder at the Esk. The precise details of this management regime will need to be developed and discussed with the out of stream users to ensure that it is practical and workable.

Recommendations

Establish a fresh protection and minimum flow site for the Waimakariri River at Otarama. The minimum flow is recommended to be set at $52\text{m}^3/\text{s}$ and OHB should be retained to check the residual recorded flow is above $41\text{m}^3/\text{s}$. Any other trigger levels can be added to the $52\text{m}^3/\text{s}$. eg Top of A Block will be $52\text{m}^3/\text{s}$ plus $22\text{m}^3/\text{s} = 74\text{m}^3/\text{s}$. It is recommended that the flows and relationship between Otarama and OHB are reviewed no longer than 5 years time.

This option will require further investment in the recorder site(s) so that the site(s) can be polled more frequently and trigger flows communicated to out of stream users. It is recommended that ECan technical staff identify the costs and practicalities of delivering these improvements.

If the impact on out of stream reliability is too great then an alternative option is to keep OHB as a residual flow site, requiring $41\text{m}^3/\text{s}$ recorded to be retained in the river. Otarama would then become an early warning trigger site as well as the fresh protection site.

Throughout the notification period these recommendations need to be discussed with those most affected, which will be the out of stream users.

