Tonkin & Taylor

Memo

To:	Bruce Geden	**T&T Ref**:	28063.503
From:	David Leong	**Date:**	15 April 2014
cc:	Dewi Knappstein; Sally Marx; David Bouma		
Subject:	WWUP – Potential Use of Tauweru and Huangarua Rivers for Conveyance Comments on Potential Time Lags and Flow Ramping Losses		

1 Introduction and context

This memo fulfils part of the requirements of Task 1B of the Preliminary Feasibility Phase of the Wairarapa Water Use Project (WWUP) – refer to T&T Offer of Service dated February 2014, T&T Ref. 28063.103/v01.

Task 1B concerns the potential use of natural river channels for conveying scheme water, and comprises an assessment of the use of the Tauweru and Huangarua Rivers for conveyance with respect to potential for losses to groundwater, time delays in delivery, and magnitude of flow ramping losses. (Note that 'Taueru' and 'Tauweru' have been used interchangeably in this memo.)

Our earlier memo dated 31 March 2014 provided an analysis of the concurrent steam flow gaugings in the Huangarua and Tauweru Rivers with the aim of identifying any potential major flow losses (or gains) from the river bed that could affect the viability of particular flow delivery options. This brief memo provides the balance of the assessment under Task 1B. It comprises a high level assessment of the potential time delay in water arriving at the distribution intake from the time it is released at the dam, and comment on the consequences and implications for supply-demand scheduling.

2 Challenges from using a river for conveyance

There will be particular operational challenges in using the river for conveyance depending on the distance along the watercourse from the dam to the intake point. For a lengthy conveyance, apart from the potential water loss to the channel bed (which we expect to be minor as explained in our earlier memo dated 31 March 2014), there may be a considerable time lag in water arriving at the intake from the dam, as well as environmental effects from changes to the natural river flow regime during the irrigation season. Associated with the delivery time lag is the potential water wastage on initiation and especially at the cessation of the flow release from storage. These flow ramping losses (on start-up and shut-down) are related to the "inertia" of the river system, which is associated with the distance and speed of travel.

Over an irrigation season the accumulated losses from flow ramping will depend on the temporal pattern of water demand at the intake point. A constant and steady supply pattern (e.g. sustained for a period of weeks) will clearly incur a smaller volume of ramping flow loss compared with a frequently changing pattern of release from storage, especially if the supply swings are large (e.g. zero supply to maximum supply).

In relation to a river conveyance system, several points are noteworthy:

- Compared with a reticulated system fully comprising of man-made canals and/or pipes, a delivery system incorporating a long river conveyance will be considerably less responsive and have lower efficiency overall because there will be a volume of water that is surplus to abstraction requirements following the cessation of flow release from storage

- For a system with a long river conveyance, the operating regime (including water ordering/supply protocols with water users) for scheduling supply will require specific adaptation and optimisation to reduce surplus water volumes from flow ramping, e.g. through suppressing rapid and large flow changes, and incentivising users against such changes
- In a design drought, typically characterised by prolonged low flow conditions, supply from storage is likely to be sustained at elevated levels for long periods, which means that the flow ramping loss, as a percentage of the volume of the water delivered, is likely to be relatively low. In contrast the water demand pattern in a "normal" or "wet" year is expected to be more variable, giving rise to considerably greater ramping losses. However, the increased losses in such years are not anticipated to be critical to the overall supply security/reliability of the system (i.e. the supply-demand balance is critically stressed only in dry years).

3 Tauweru River

Site 10 Tividale is proposed to be located on the upper Tauweru River just below the confluence with the Mangapurupuru Stream. The proposed distribution intake is located upstream of the Te Whiti Bridge on the lower Tauweru River, i.e. some 69 km downstream of the storage dam (distance measured following the watercourse). Figure 1 plots the available concurrent gauging results for the Tauweru River against distance from the dam site (negative values indicate locations upstream of the storage site).

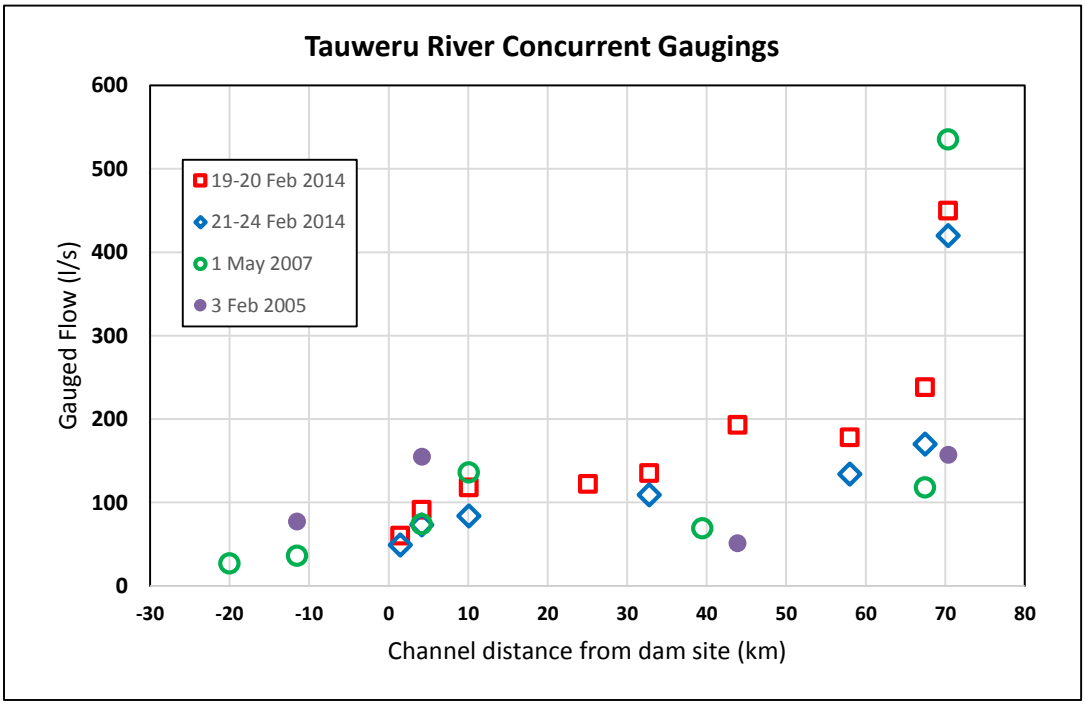

Figure 1 Concurrent gaugings on the Tauweru River – channel distances are approximate

In the February 2014 low flow gaugings by GWRC (refer to T&T memo dated 31 March 2014), the average flow velocity from current meter gaugings of the mainstem was about 0.12 m/s. At this velocity, which is typical of low flow conditions in the river (flows of between 0.05 and 0.25 m^3/s were recorded upstream of the Kourarau Stream confluence), it would take almost a week to traverse the 69 km distance between the dam site and the intake site. At higher flows the water velocity increases significantly. The typical range of controlled flow releases from a Tividale storage varies according to the scheme configuration. For example, for the single storage scheme (live storage of 26 million m^3) the maximum release is about 5 m^3/s, with a typical range during the height of the irrigation season of between 2 and 4 m^3/s, while for the multi-storage scheme (live storage at Tividale of about 44 million m^3), the typical flow release range during the irrigation season is between about 3 and 7 m^3/s.

A cursory review of the historical flow gauging data for the Te Whiti Rd Bridge (site no 150666) and Te Weraiti (site no 29231) sites indicates that the flow velocity corresponding with the typical range of releases during the irrigation season is likely to be some 2 to 4 times the velocity under low flow conditions, i.e. around 0.25 to 0.5 m/s. Therefore, a travel time from the storage to the intake of around 1.5 to 3 days is expected.

From our experience and modelling studies for other river conveyance projects, we anticipate that the actual lag times will vary depending on the base flow in the river at the time and on the magnitude of the release flow. A specific hydraulic modelling study (together with field measurements to calibrate the hydraulic model) will be required to fully understand the responsiveness of the river system to flow changes at the storage site, and to confirm the conveyance lag times. Such a study should be completed during the feasibility study phase.

In practical terms, some of the released water cannot be utilised because of the considerable time lag, and nature of the ramp-up and ramp-down phases when releases start and stop respectively. Achieving timely water delivery will depend on the ability to accurately and reliably predict the water demand and flow recessions in the river system. Even then, there will be occasions when the released water from storage would no longer be required for abstraction (retained by the river) following unforecasted rainfall in the service areas.

4 Huangarua River

Site 135 White Rock Road is proposed to be located on the Makara River near Birch Hill just downstream of the confluence with the Mangapari Stream. The distribution intake would likely be located on the Huangarua River upstream of Hikawera Bridge (Hinakura Road) in order to avoid extensive pumping to deliver scheme water to service areas, i.e. sited approximately 11 km downstream of the storage dam (distance measured following the watercourse). Figure 2 plots the available concurrent gauging results for the Makara/Huangarua River against distance from the dam site.

In the March 2014 gauging (refer to T&T memo dated 31 March 2014), the average flow velocity in the Huangarua River from current meter gaugings varied from location to location and averaged around 0.22 m/s. At this velocity, which is typical of moderate to low flow conditions in the river (a flow of 0.8 to 1 m^3/s was recorded in the Huangarua River), it would take about 14 hours to traverse the 11 km distance between the dam site and the intake site. The water velocity will be higher under the increased flows resulting from storage releases. During the irrigation season controlled flow releases from a White Rock Rd storage is expected to typically range between about 2.5 and 4.5 m^3/s. Assuming an average flow velocity of 0.4 m/s under such conditions, the travel time from the storage to the intake would be of the order of 6 to 8 hours.

This time lag is considerably shorter than for Tividale on the Tauweru River, and therefore the attendant issues from using the Huangarua River for conveyance is expected to be much more manageable as a result. Potential ramping flow losses to the river will also be considerably less.

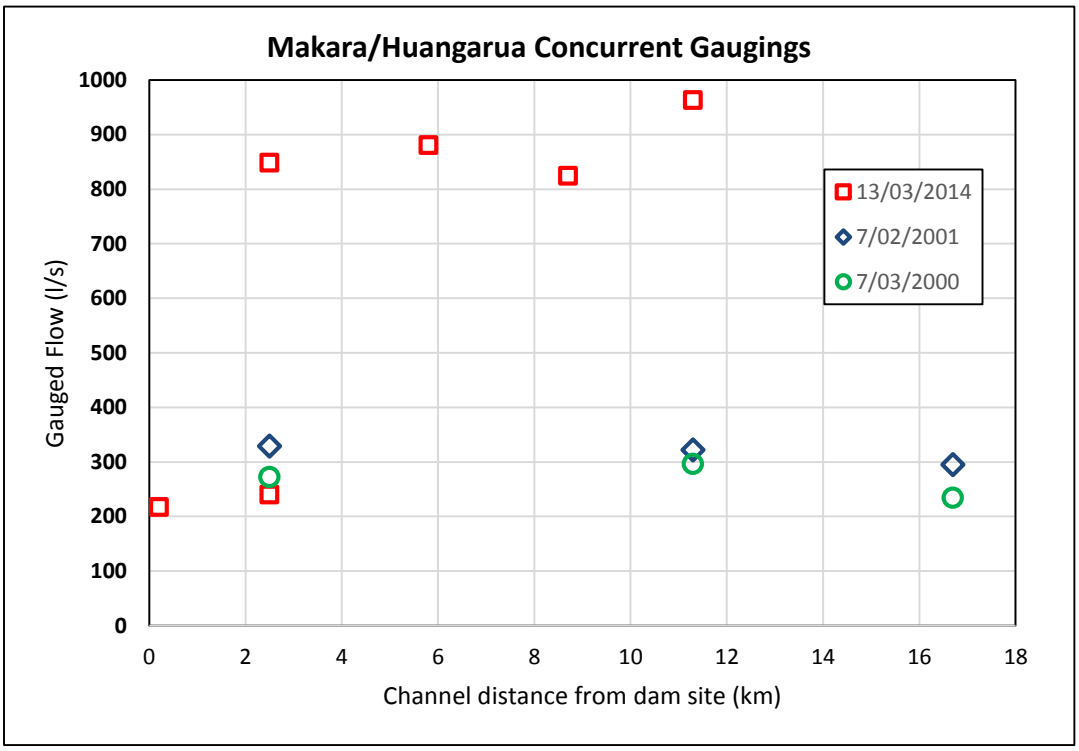

Figure 2 *Concurrent gaugings on the Makara/Huangarua Rivers – channel distances are approximate*

15 April 2014
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