Review of "Water allocation project - Upper Manawatu catchment; Water resource assessment – Allocation limits and minimum flows; Technical report to support policy development", by Jon Roygard, Jeff Watson and Maree Clark (Horizons Regional Council), version 5 November 2005

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Executive Summary

This report reviews a major Horizons Regional Council report on water allocation and minimum flows of the Upper Manawatu River catchment. The report was technically correct from a hydrological perspective. A number of minor comments were made, and these can be easily addressed.

Introduction

The report under review focused on water allocation of the Upper Manawatu River catchment (1260 km^2), upstream of the confluence of the Manuwatu and Tiraumea rivers. The review, requested by Lindsay Fung (Team Leader Research, Horizons Regional Council) and funded through Envirolink, focused on the hydrological aspects of the report, with Cawthron Institute reviewing the instream flow incremental methodology studies, the water allocation methodologies and the report as a whole.

Review comments are presented below in the section order that they appear in the report.

Overall, the report was technically correct from a hydrological perspective. An annotated version of the report was provided to Horizons to help identify minor errors.

Section 1 – Planning context

This section provides a useful introduction to the purpose and scope of the report, and the context of water allocation of the upper Manawatu as a component of Horizons' regional "One Plan" concept.

Section 2 – The upper Manawatu catchment

This section provides an excellent overview of the physical features and hydrological knowledge of the catchment (1260 km^2). The rainfall gradient from the wet Ruahines in the north-west of the catchment through to the relatively drier areas in the centre and east of the catchment is well presented in Map 6. Sections 2.6-2.11 provide excellent coverage of water quality and the instream environment.

Comments and suggestions are listed below:

- Table 4 gives a list of the catchment's flow recording sites (14 sites). It is suggested that the catchment areas to each recording site in the table are rounded to the nearest square kilometer.

- Map 8 shows the location of the flow recording sites. It is notable that the Manawatu at Weber Rd site, which drains more than half (711 km^2) of the upper Manawatu (1260 km^2) is the only long-term monitoring site for the eastern half of the catchment, except for the new Mangatoro at Mangahei Rd site. This may be expected since most of the catchment rainfall, water use and allocation requirements are in the west of the upper Manawatu. The lower density of monitoring of the south-east of the upper Manawatu is also highlighted by the lower density or non-existence of low flow gauging locations in this area (shown in Map 7). It is recommended that mention is made of the spatial variability of flow monitoring density in the report, and that both Weber Rd and Mangahei Rd must be retained as long-term sites since they cover a large area (over half) of the upper Manawatu catchment.

- On Map 8, it would be worthwhile highlighting the four existing long-term sites (e.g., by using a different colour for each site's text box), and the four new long-term sites.

- Maps 9 to 35 provide a very useful summary of low flow gaugings carried out in the catchment, and its sub-catchments. On each map, the legend needs to be larger to be more easily read.

- Section 2.4.5 provides excellent information on flow statistics, such as flow duration curves and mean annual low flows (MALF) for the four main flow data sites. The few gaps in the data records were handled appropriately in the estimation of the flow statistics. Some text comparing the MALF estimates with the flow duration low flows could be useful. For example, the MALF estimates (1- and 7-day durations) occur between the 90 and 100 percentiles on the flow duration curves. (A suggested wording is made to address this, as part of the next comment.)

- The second paragraph in the MALF sub-section (pages 67 and 68) is unclear and misleading. It is recommended that this paragraph is either deleted or replaced by:

"The MALF provides an estimate of the annual minimum low flow that can be expected to occur each year. Summer flows often recede lower than the MALF. Comparison of Tables 5 and 6 shows that the MALF estimates for the four upper Manawatu sites lie in the 90 to 100 percentile range of the flow duration curve."

- Section 2.5.3 on consented water introduces the important concept (for later in the report) of <u>zones</u>. Key allocation zones and sub-zones are defined later in the report. It is suggested for clarity that either the zones and sub-zones are defined in this section, or at least are consistent with the zones and sub-zones used later in the report. The zones need to be labelled correctly and consistently in Maps 37-46 and Table 11 (to be consistent with Table A in the Executive Summary). This comment also applies for Table 13.

Section 3 – Values in the upper Manawatu catchment

This section provides an excellent survey of water users needs and values, and an important basis for the water allocation methodology. There were no hydrological review comments on this section.

Section 4 – Water allocation methodology

The methodology is based upon definition of a "core allocation" flow for a catchment defined by the difference between a defined "management flow" of known frequency of occurrence, less a defined "minimum flow" required for instream environment purposes. When the core allocation is fully allocated and used, the frequency of the minimum flow becomes that of the management flow.

Section 4.9 presents estimation of flow percentiles and MALF at key river zones.

Overall, the report applies the allocation methodology and flow estimation methods correctly (from a hydrological perspective) to the upper Manawatu catchment.

Particular comments and suggestions are made below:

- In Section 4.4.1, in the sub-section on flow frequency analysis (page 220), a number of concepts need to be better clarified and explained. Concerning low flow frequency statistics, it is not correct to state that basing "water allocation options on these statistics would introduce uncertainty". They may provide "confusion", it is agreed, but no more uncertainty than would be the case with using flow duration curve statistics that are also uncertain. It is suggested that the last two paragraphs on page 220 are replaced by:

     "The return period of a low flow event indicates the average number of years that may be expected between annual minimum flow events. More correctly, a low flow return period is the reciprocal of the probability of its

occurrence in any one year. For example, the one-in-five year return period low flow is defined as having a one in five chance of occurring in any one year.

Estimates of low flow return periods change given the length of a flow record, and when one or more extreme low flows occur in the record. A drought in the record can change the estimate of a return period of a low flow. Return period low flows are therefore "uncertain", like any other statistics estimated from data (including the percentiles for flows estimated from flow duration curves, next section).

Return periods are statistical descriptors of low flows. Similarly, low flow percentiles from flow duration analysis of the full flow record, are statistical descriptors of low flows. The difference between the two descriptors is that one is based on the annual minimum flows (flow frequency) and the other is based on the whole record. Both descriptors involve uncertainty, and both are equally valid. For clarity and to avoid confusion by using the term "return period", flow frequency descriptors are not used in this report, and MALF is the only low flow used that is derived from annual minimum flow data."

- The sub-section entitled "Modelling management flows" (page 227) of Section 4.4.1, requires some changes in the text to make it more understandable and technically correct. The problem lies with the terms "modelling" and "modelled" used on this page, as it is not clear whether any modelling of the data has taken place. The method used to examine the effects of use of different flow percentiles as the management flow seems to be an analysis of the existing data records, rather than use of any models. If this is the case, then the sub-section would be better called "Analysis of management flows", and the word "modelling" should be replaced by "analysis", and "modelled" replaced by "examined".

- A technical point about this page, and the ensuing Tables 30-33, is that the new information presented is the range of number of days of restriction per year (under a flow percentile management flow). The average number of days of restriction per year, if this section is based on an analysis of the historical data records, is known from the definition of the percentile flow. For example, using Q_{90}, it is known by the definition of Q_{90} that there will be 18 days of restrictions on average per year, for half years November-April.

- On page 231, the meaning of the last two sentences of sub-section "Current resource consent applications" is unclear. The first sentence of the two makes little sense, and the second sentence needs more information to present a clear summary of the sub-section.

- Section 4.8 "Defining management zones". It would be very useful to tabulate the catchment areas associated with each of the defined river management zones and

sub-zones, excluding the contributing areas of any zones upstream. A map of the defined river zones and sub-zones is also required, with the contributing catchment areas shaded. The river zones and sub-zones (and their catchment areas), could be highlighted in colour to more easily identify them. Note, in the text, the definitions of sub-zones 5B (Kumeti) and 5C (Oruakeretaki) are incorrectly labelled and need correcting (page 244).

- In Section 4.9 regression analyses were used for flow estimation, and presented with scatter plots and associated r^2 fit statistics. The "standard error of estimate" is also useful, and it is recommended that this is provided for each regression estimate. Reference should be made to the Henderson et al. (2003) work on low flow regressions.

Section 5 – Water allocation options for the upper Manawatu catchment

Eight options for upper Manawatu management flows (flow percentiles: Q_{90}, Q_{91}, …, Q_{97}) were analysed and a clear rationale was presented for the selection of Q_{92}. Based on this selection, the allocations for each of the defined zones were extensively defined, and well summarised in Table 60. No major comments were required for this section.

Section 6 – Knowledge gaps and future directions

Most of the gaps identified in the report are listed in this section, with follow-up work programmes listed in order to bridge the gaps.

From a hydrological perspective, the first gap listed on low flow data could be expanded upon to cover the spatial variability of monitoring in the upper Manawatu catchment. It may be worthwhile in future to carry out more low flow gauging runs in the eastern half of the catchment, to better capture the low flow character of these rivers and streams, compared with the better monitored western half of the catchment.

Another area that may be worth touching on in the report, and may be required in future work, is ground water allocation and its effect on surface water resources. Some ground water takes were shown on maps in the report.

Reference

Henderson, R.D.; Ibbitt, R.P.; McKerchar, A.I. 2003. Reliability of linear regression for estimation of mean annual low flow: a Monte Carlo approach. Journal of Hydrology (NZ) 42 (1): 75-95.