BEFORE THE INDEPENDENT COMMISSIONERS

UNDER	the Resource Management Act 1991
AND	
IN THE MATTER	of the proposed Canterbury Land and Water Regional Plan

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STATEMENT OF EVIDENCE OF RODERICK HENDERSON ON BEHALF OF NGĀ RŪNANGA OF CANTERBURY, TE RŪNANGA O NGĀI TAHU AND NGĀI TAHU PROPERTY LIMITED

4 February 2013

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1. INTRODUCTION

1.1 My name is Roderick Donald Henderson.

1.2 I am currently employed by the National Institute of Water and Atmospheric Research Ltd (NIWA) as a hydrological scientist.

Qualifications and Experience

1.3 I have been a practising hydrologist since commencing employment with the Ministry of Works and Development Hydrology Centre in 1979, with particular interest in engineering hydrology, hydrological extremes, and the hydrology of New Zealand's hydropower systems. From 2007 to 2010 I was the Programme Co-ordinator for the Public Good Science Funded National Database: Water Resources and Climate Programme. Since 2009 I have been the Group Manager of the Applied Hydrology Group at NIWA Christchurch.

1.4 I hold a Bachelor's degree in Civil Engineering and a Master's degree in Resource Management, both from the University of Canterbury. I am a member of the New Zealand Hydrological Society (since 1979), the New Zealand Freshwater Sciences Society (since 1980), the International Association of Hydrological Sciences (since 1999), and the Meteorological Society of New Zealand (since 2003).

1.5 I am co-author of a publication on decadal climate influences on New Zealand hydrological extremes[1] and also co-author of a publication on mapping the mean flow hydrology of New Zealand[2]. I am the author or co-author of numerous reports on the hydrological characteristics and simulation of natural hydrology of New Zealand's power schemes, including; the Coleridge power scheme, the Tongariro Power

[1] McKerchar, A.I. and Henderson, R.D. 2003. “Shifts in flood and low-flow regimes in New Zealand due to interdecadal climate variations”. Hydrological Sciences Journal, August 2003. 48(4): 637-654

[2] Woods, R.A.; Hendrikx, J.; Henderson, R.D.; Tait, A.B. (2006). Mean Flow Hydrology of New Zealand Rivers. Journal of Hydrology (NZ) 45(2): 95-110

Development, the Manapouri power scheme and the Waitaki River power scheme.

1.6 I am co-author of reports on the Water Physical Stock Accounts of New Zealand for Statistics New Zealand, and a number of contract reports on water resource issues.

1.7 I have been involved in the following relevant investigations and studies:

a. Analysis of lake levels on Lake Coleridge as part of the re-consenting process[3]

b. Presentations to the Waitaki Allocation Board hearings regarding Waitaki River simulation modelling

c. Presentation to the Environment Court hearing on the North Bank Tunnel Concept

d. Presentation to the Environment Court hearing on the Hunter Downs Irrigation application

e. Presentation to the Environment Court hearing on Environment Waikato's Variation 6

f. Presentation to the recent Environment Canterbury hearing on proposed amendments to the National Water Conservation (Rakaia River) Order

g. Mapping 7-day mean annual low flow for the Pareora, Otaio and Waihao Rivers

h. Modelling inflows and groundwater leakage along the Ashburton River

1.8 I am familiar with the Code of Conduct for Expert Witnesses in the Environment Court Practice Note and I agree to comply with the Code. This evidence is within my area of expertise except where I state that I am relying on information provided by another party. I have not

[3] Henderson, R.D. and Clement, J.A. 1995. Analysis of lake level fluctuations on Lake Coleridge. NIWA consultancy report ELE903 for Lake Coleridge Working Party. 23p.

knowingly omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of Evidence

1.9 I have been asked by Te Rūnanga o Ngāi Tahu to prepare evidence in relation to the inter-connectedness of surface water and groundwater resources and the effects on river flow of these connections.

1.10 In preparing this evidence I have reviewed:

a. The evidence of Maurice Duncan;

b. Chapters of “Freshwaters of New Zealand” and “Groundwaters of New Zealand” by Maurice Duncan and Paul White; and

c. The New Zealand River Environment Classification User Guide.[4]

Summary of Findings

1.11 Canterbury rivers exhibit a wide range of characters, as represented by the top two levels of classification in the REC (Climate and Source-of-Flow). This range needs to be taken into account when considering the division of the region into management zones.

1.12 Spring-fed rivers are the result of groundwater emerging above the surface. This forms the dominant part of their hydrology. Thus they are directly affected by groundwater extraction that lowers water levels.

1.13 Alpine (Glacial), Mountain and Hill-fed rivers also have groundwater contributions to their flow and surface water-groundwater interactions. The baseflow in these rivers is derived from groundwater.

1.14 Groundwater recharge comes not only from rain but also from rivers. Some of this is flow below the stream bed that re-emerges later, and some contributes to deeper groundwater stores and flows.

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[4] Snelder, T., B. Biggs, et al. (2010). "New Zealand River Environment Classification User Guide." From http://www.mfe.govt.nz/environmental-reporting/about/tools-guidelines /classifications/freshwater/rec-user-guide-2010.pdf

2. RIVER TYPES

2.1 The flow characteristics of rivers are highly dependent on the climate of the catchment and the source of flow. These two parameters are the top-level descriptors used in the River Environment Classification (REC) developed by NIWA for MfE. Climate is divided by temperature (Cool and Warm) and rainfall (Dry, Wet and extremely Wet) into six classes. Source of flow is divided into categories based on: elevation as follows: Glacial Mountain, Mountain, Hill, Low-elevation; lakes based on the proportion of lake influenced catchment; and three manually assigned categories (spring, wetland and regulated).

2.2 An example of the differences to be seen as a result of these various forcing factors is shown in Figure 1, taken from Biggs et al., 2005[5]. The vertical axis in each case shows the flow divided by the median flow (Q50). All four rivers are in the Canterbury region.

2.3 The Spring-fed river is far less variable than the other two, mostly varying gradually around the median flow. This is because the flow is mostly provided from the intersection of the slowly varying groundwater levels with the channel of the river. A Spring-fed example from a non-urban setting on the Canterbury plains would display fewer freshes as most rainfall soaks through the soil before entering the deeper groundwater layers.

2.4 The Hill-fed river has the highest variability, because the low flows are relatively drier than for the mountain river and the floods are larger relative to the generally smaller median flow.

2.5 A Glacial Mountain river (distinguished by the presence of fine glacial sediment) would behave in a hydrologically similar manner to the mountain river, but there would be less flow in winter when the headwaters are frozen, and slightly more sustained flows in summer as the seasonal snow and some ice melts.

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[5] Biggs, B. J. F., V. I. Nikora, et al. (2005). "Linking scales of flow variability to lotic ecosystem structure and function." River Research and Applications 21: 283-298.

2.6 The classification of any river may change as one moves up or down the river, depending on the classification and relative importance of tributaries encountered.

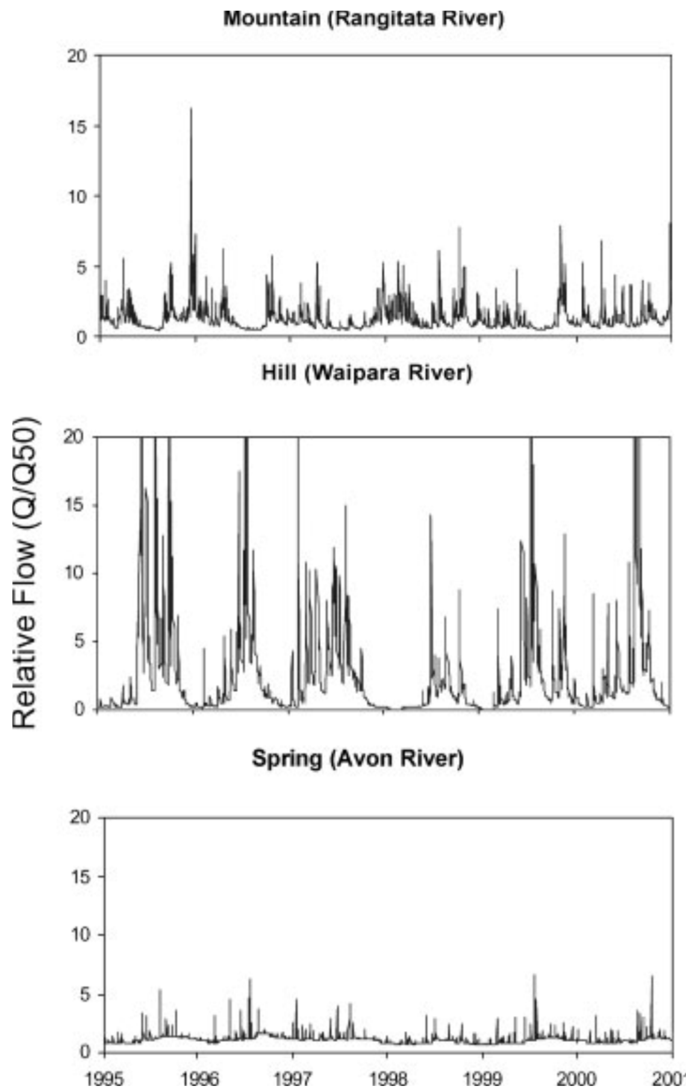

Figure 1. Example hydrographs from mountain *[sic]*, hill, and spring source-of-flow rivers. All rivers are in the Canterbury region, South Island of New Zealand. Note that while there are frequent flow perturbations in the spring-fed Avon River, these are of a relatively low magnitude compared with freshes and floods in the other two rivers and are partly the result of urban runoff from paved surfaces in the Avon catchment.

2.7 According to the REC classification, of the large Canterbury rivers, only two remain as Glacial Mountain at the coast. These are the Rangitata and Rakaia. The Waitaki is classified as lake affected to the coast and this explains some of the differences between it and the other alpine rivers. The Waimakariri is classified as Cool Wet Mountain to the coast, and both the Hurunui and Waiau are classified as Cool Wet Hill at the coast, because of the large areas of their catchments that are at lower elevation.

2.8 The smaller Canterbury rivers such as the Waipara, Pareora, Orari, Opihi and Waihao are Hill-fed at the coast. Many others are lowland-fed, for example the Hinds River at the coast.

3. INTERACTIONS

3.1 The classifications described above were derived as an aid to understanding important drivers of flow variability. Other lower levels of the REC relate to geology, land-cover, network position and valley landform, and the complete system provides a guide to river similarity or difference from the perspective of the river as a habitat.

3.2 However there are physical interactions between different water bodies that need to be accounted for in water management. The major type of water body not considered in the REC, because of its river focus, is groundwater. Water moves between groundwater systems and rivers in a variety of ways.

3.3 Spring-fed rivers are in general the result of groundwater intersecting the ground surface. Examples are the lowland streams that feed in to Te Waihora, and the Avon and Heathcote. This intersection is related to groundwater levels which are affected by groundwater abstraction.

3.4 All the Canterbury rivers that flow from mountains and hills onto the Canterbury Plains have surface water-groundwater interactions. They have river reaches that lose water into the groundwater systems on either side. This generally occurs higher on the plains. They also can have reaches than gain water from the groundwater systems on either side. This tends to occur lower down the plains. These losing and gaining reaches can alternate along the river and depend upon the nature of the underlying alluvial layers.

3.5 As well as the deep groundwater that is a feature of large alluvial systems like the Canterbury Plains, there is shallow groundwater in the vicinity of every river, even in hill country or mountains. These smaller groundwater systems can be larger like the alluvial deposits above the Rakaia Gorge, or smaller, consisting simply of the soil and rock layers around the stream in a valley.

3.6 In the upper Rakaia, tributaries such as Little River lose nearly all their water into gravel fans before they reach the main river, but this water seeps into the larger groundwater body under the Rakaia, and emerges to the surface when the river flows through the Gorge.

3.7 In the lower Waitaki River below Waitaki Dam, local groundwater levels are important in maintaining water levels in wetlands beside the main river.

3.8 The baseflow of most rivers (the flow when there has been no rain in the catchment for some time) is derived from these shallow groundwater stores, which gradually release water, accounting for the slow decline of river flow over many weeks without rain. When rain comes again these shallow sources of soil and groundwater are replenished. This replenishment can have an effect on flow response if the preceding drought has been severe.

3.9 Shallow groundwater is also moving below the river bed and in rivers such as the Selwyn can be the only flow over long reaches in the summer. While these dry reaches can be a natural phenomenon, they can be expanded and prolonged by groundwater extraction[6], which has implications for the flows in the downstream reach where surface water re-emerges.

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[6] McKerchar, A. I. and J. Schmidt (2007). "Decreases in low flows in the lower Selwyn River?" J HYd (NZ) 46(2): 63-72.

4. PLAN MATTERS

4.1 The classification of river types provided by the REC raises a question about the zone boundary between Waitaki and South Coastal Canterbury (Section 15) and the Orari-Opihi-Pareora (Section 14). The rivers of the South Canterbury coast are all of similar nature to those of section 14 (hill- and lowland-fed rivers), and not at all similar to the Waitaki, a large braided lake-fed and managed river with alpine headwaters. It would be logical to combine the rivers north of the Waitaki into a single South Canterbury zone.

4.2 The management zones for the alpine rivers (section 12) are very narrow across the plains. They may not include all the areas from which groundwater extraction would potentially have effects on river flow or within which the river flow would have an effect on groundwater levels and flows. This division across active interaction areas makes integrated management more difficult. At the least it would seem sensible to ensure that collaboration between adjacent zones is recommended so that decisions made in neighbouring areas do not have deleterious consequences over the boundary.

4.3 For example, intensification of development in Waimakariri District could lead to further groundwater extraction north of the Waimakariri River in section 8, leading to effects on the rate of recharge to the aquifers underlying Christchurch-West Melton zone (section 9), and possibly effects on groundwater in the Selwyn-Waihora zone (Section 11). The rules set for abstraction of Waimakariri water could be rendered ineffective by increases in groundwater extraction in neighbouring zones.

4.4 The separation for historical and administrative reasons, of the catchment of the Clarence River between Canterbury Region and Marlborough District makes integrated management of the Clarence difficult. For example while the LWRP has an outright ban on damming of the Clarence, there is no guarantee that a similar provision would hold with Marlborough. A joint region effort on a management plan for the Clarence would be one way of remedying this situation.

5. CONCLUSION

5.1 The classification of rivers via the REC provides a consistent framework that could lead in some instances to redrawing of zone boundaries for river management and allocation purposes. Two examples are the similarities between the Waihao and the other South Canterbury rivers to the north, and the differences between the Waimakariri (Mountain) with the Rangitata and Rakaia (both Glacial Mountain).

5.2 The nature of interactions between groundwater and surface water in catchments means that consideration should be given to the presently defined zones having interactions with each other. This is especially true for the designated alpine rivers which have very narrow zones where they cross the Canterbury Plains. In particular the Waimakariri River and its groundwater sources and recharge areas are in four different zones at present.

5.3 The cross-regional nature of the Clarence River has the potential to create inconsistencies in the management of this river, and consideration should be given to a joint approach.

Roderick Donald Henderson

4 February 2013