IN THE MATTER OF The Resource Management Act 1991

AND

IN THE MATTER OF The Proposed Waipara Catchment Environmental Flow and Water Allocation Regional Plan 2010

STATEMENT OF EVIDENCE OF HENRY ROLAND HUDSON

ON BEHALF OF RICHARD FORBES, MAUNGATAHI FARM

---

1. INTRODUCTION

Background and Qualifications

1.1 My name is Henry Roland Hudson and I am a scientist and Director of Environmental Management Associates. I have a BA and MA in Geography from the University of Canterbury and PhD specialising in river systems from the University of Alberta. I worked in research and environment agencies for 20 years overseas and as a consultant in New Zealand since 1996.

1.2 Over the least two years I have undertaken a series of streamflow measurements (with Doug McMillan) and observations of processes and river characteristics on the Waipara River. I have authored more than 200 technical reports and presented keynote addresses to international meetings on matters related to this hearing.

1.3 Recent investigations of relevance include instream flow reviews in the Cardrona, Mangaotea, Mokihinui, Pomahaka, Shag, Taieri and Tongariro rivers for the Department of Conservation; the Hutt River for Greater Wellington Regional Council; the Waitaki River for Ngai Tahu; and the Ashburton, Charwell, Conway, Rangitata, Wairau and Waimakariri rivers for irrigation/power companies.

1.4 Other recent relevant peer reviewed works include an invited paper to the Hydrological Sciences Journal on quality assurance in hydrological measurements; a keynote address on river management for the International Gravel Bed Rivers Workshop; a keynote address on linking the physical form and processes of rivers with ecological responses for the IAHS-UNESCO International Symposium on the Structure, Function, and Management Implications of Fluvial Sedimentary Systems; a keynote address on instream flow modelling to the Australasian Hydro Power Conference 2008; and a monograph on instream flow habitat modelling.

1.5 The evidence I will present today is within my area of expertise, except where I state that I am relying on information provided by another party. I have not knowingly omitted facts or information that might alter or detract from the opinions I express. I am familiar with the Code of Conduct for Expert Witnesses and I agree to comply with this code.

Scope of Evidence

1.6 My evidence is presented on behalf of Richard Forbes, Maungatahi Farm.

1.7 I have been asked to present my findings regarding instream habitat effects of the change in surface flow of the Waipara River in the proposed Waipara Catchment Environmental Flow and Water Allocation Regional Plan 2010.

1.8 In this regard I discuss effects of taking water on:

a. River morphology

b. Surface water flows

c. Amenity values

d. Aquatic life

e. Tangata Whenua values.

1.9 My evidence relies on the scientific literature, technical reports that accompany the resource consent application and my own work. I evaluated hydraulic geometry and habitat availability on the Waipara River from data provided by Mr Jowett.

2. RIVER MORPHOLOGY

2.1 The 72 km long Waipara River can be divided into three main segments (headwaters, 'upper' and 'lower') with various sub-segments.

2.2 Much of the irrigation abstraction (80%) directly influences a short segment of river (km 20 to the Omihi confluence at km 12), before flows greatly increase with Omihi inflows.

2.3 I concur with Mosley (2003) that the exposed gravel bed characteristics of the Waipara River are determined by flood flows and river management not low flows.

2.4 Jowett (2006) indicates a flow of 350 L/s at Teviotdale is needed to provide a continuous flow to the lagoon;

a. Limited data in Chater (2002) suggests that flows are likely to exceed 350 L/s at Teviotdale (river km 6.8) about 50% of the time;

b. This would suggest the river is dry downstream of Greenwoods Bridge (river km 3.8) about half the time;

2.5 Even if the river is flowing into the lagoon, there is not necessarily a connection to the sea for fish passage:

a. The river mouth is often closed because seepage flow through the gravel bar at the mouth exceeds the flow in the river;

b. Jowett (2006) considers that the mouth will opened by a flow of about 8-9 m^3/s, and it will close at a flow below 4-5 m^3/s;

c. Mosley (2003) shows that for the period 1988-2002 flows exceed 4 m^3/s for 18% of the time. For a shorter period of record at Teviotdale, flows exceed 4 m^3/s about 20% of the time (Chater 2002; Ritson 2008). Thus, for about 80% of the time fish passage to the sea cannot occur.

3. SURFACE WATER FLOWS

3.1 The Waipara River has highly variable flows in time and space.

a. Sections of river above the irrigation takes are dewatered at flows exceeding the proposed minimum flows at White Gorge (Figure 1);[1]

b. Monthly flows range from 26 L/s to 280 m^3/s at White Gorge (1989-2007 records), with a MALF of 99 L/s;

c. In February 1998, the river nearly went dry just above the Omihi confluence (Chater 2002). Water restrictions were in force at that time so the low flow was not caused by abstraction;

d. While concurrent flows on the Waipara River below White Gorge and above the Omihi confluence are similar (MALF 117 L/), there is variability in surface flows in the intervening reach (see footnote and Table 1);

e. Omihi Stream (MALF 150 L/s Scarf 2007s) provides a large input of water to the lower Waipara River at river km 12;

---

[1] In January 2009 Doug McMillan and I found dry sections of riverbed between the Forbes intake (river km 20.4) and Stringers Bridge (river km 23.4). At that time the flow at White Gorge was 60 L/s; Stringers Bridge 64 L/s; mid way Stringers-Forbes intake 54 L/s were discontinuous dry segments downstream; above Forbes Intake 30 L/s; below Forbes Intake 27, 35, 52 and 0 L/s; Fiddlers Green 46 L/s; HT lines 36 L/s; above Boys Brigade intake 53 L/s; below Boys Brigade outfall 38 L/s; SH1 45 L/s; above Omihi 23 L/s and below Omihi 153 L/s. We also found a dry section of river bed at the Boys Brigade intake where the entire streamflow was diverted into the Boys Brigade pond.

f. Additional flows emerge as the Waipara flows through the lower gorge with a MALF at Teviotdale (river km 7) of 299 L/s;

g. The lower river below Greenwoods Bridge (river km 3.8) and the hapua dewaters when flows at Teviotdale are less than around 350 L/s (Mosley 2003).

3.2 With the existing water abstractions, concurrent flows are similar at White Gorge and above the Omihi confluence (i.e. there is not a one for one loss in surface flow with the abstractions):

a. This is attributed to inputs from Boby Stream (MALF 20 l/s), subsurface flow emergence from the gravel bed, and groundwater inputs (e.g. from the terraces);

b. As well abstractions are less than the consented takes (Scarf 2007)(Table 1); and

c. While flows may decrease immediately downstream of the point of take, the flows are generally restored a short distance downstream.

3.3 Regarding the role of groundwater, Scarf (2007) notes the large capacity of the Waipara alluvial basin with respect to surface flows:

a. "Lloyd (2002b)... describes annual recharge from rainfall [in the Waipara alluvial basin] averages about 12.6 million cubic metres per year..."

b. Based on Scarf's calculations, this equates to a constant flow of 388 L/s, but only a portion of this emerges as surface flow.

3.4 Regarding abstractions being less than consented takes, there are significant implications for the assessment of reliability and instream flow requirements:

a. There is uncertainty in the flow estimates in Table 1, because it appears that measurements were not always taken in the same location above the Omihi confluence, and flows are spatially variable as discussed in footnote[1]. Flows are also variable over short periods (Figure 2), so to some degree differences may be a timing issue;

b. Recent ECan estimates of the effects of abstractions on reliability of supply are problematic. Mr Leftley assumes full consented takes occur, with high rates of water application based on regional water use.

c. Mr Scarf (2007) estimates abstraction based on consent conditions (e.g. period and volume limits), consented application rates which are much lower than regional rates for vineyards, and longitudinal gaugings.

d. My view is that Scarf's estimates of abstraction look reasonable (Table 1);

e. In recommending partial restrictions or a higher minimum flow, Mr Jowett does not appear to take the Scarf estimates of abstraction into account.

3.5 Regarding recovery of flows below the Forbes extraction, two sets of experiments were undertaken by ECan to assess downstream effects:

a. It is my understanding that North Canterbury Catchment Board (NCCB) measured the Forbes abstraction (river km 20.4) and the affects of the abstraction on the river. (The Forbes intake can abstract 57 L/s). Mr Forbes informs me that NCCB found there was very little affect on the Waipara flow at SH1 (river km 15.0) when periods of irrigation and no irrigation were compared. The minimum flow site was Stringers Bridge. We are unable to obtain the NCCB report from ECan;

b. From ECans data set, I found 8 coincident gaugings in the period October 1983 to January 1985. Five gauged flows five gauged flows were greater at SH1 than Stringers Bridge. On the three occasions that flows decreased downstream by 200 L/s, 170 L/s and 60 L/s. The 60 L/s decrease on 15 November 1984 occurred with a Waipara at Stringers Bridge flow of 469 L/s. The difference is within the accepted bounds of measurement accuracy; and may represent natural variability in downstream flows or abstraction.[2] .

3.6 Results of the second Waipara experiment are summarised in Figure 3 (from an ECan presentation by Topelen in 2009):

---

[2] In February 2009 with steady relatively high flows (~470 L/s at White Gorge) and no abstraction at Forbes intake, flows varied downstream. With the same locations described above for the low flow conditions we gauged Stringers Bridge at 455 L/s; mid point 387 L/s; above Forbes intake 383 L/s; with 57 L/s going into the adjacent old channel at the intake and being lost into the bed; below Forbes intake 313, 337, 339 and 323 L/s; Fiddlers Green 344 L/s; HT lines 357 L/s; above Boys Brigade 360 L/s; below Boys Brigade 315 L/s; SH1 349 L/s; above Omihi 269 L/s; below Omihi 437 L/s. I note there was considerable gravel excavation in the area immediately above the "above Omihi" gauge site.

a. Figure 3 shows a decrease in surface flow at the point of abstraction whether irrigation abstraction is occurring or not. As noted in footnote[2], I observed flow into the bed in the intake channel when there was no abstraction.

b. In three of four measurements, there is a recover in flows downstream (Figure 3). Dewatering below the take is illustrated in Figure 4.

4. AMENITY VALUES

4.1 In terms of water abstraction effects on amenity values, Mosley (2003) has noted:

a. Scenic values are regarded as low and influenced by flow to a minor extent;

b. Recreational fishery values are considered limited, with current rates of abstraction unlikely to have had a significant adverse effect; and

c. Recreation (e.g. off-road vehicle operation, camping, picnicking) are considered to be affected by water resource management to a minimal extent compared with riparian land management.

d. I note that a major recreation use of the Waipara River is the Boys Brigade off channel swimming hole upstream of the rail bridge. Water is diverted from the Waipara River to flush and to fill this pond.

5. EFFECTS OF TAKING WATER ON AQUATIC LIFE

Periphyton

5.1 Hayward (2003) reported that "Prolific growths of nuisance periphyton occurred at the three lower sites (below the upper gorge). These nuisance growths were most pronounced during dry summers when prolonged periods of low flows occurred in the river. Considerably less periphyton was found at the upper site even during low flow periods. Differences in nutrient enrichment along the length of the river were major controlling factors in the development of periphyton."

5.2 Previously ECan proposed minimum flows of 100 L/s (80 L/s at White Gorge and 20 l/s from Boby Stream) to avoid creating ideal conditions for periphyton bloom (Staff Report 2009).

5.3 I found optimum modelled habitat availability for short and long filamentous algae increases as flows increase from 50 to 60 to 80 to 100 L/s.

5.4 High flows are required to remove periphyton. Hayward (2003) found Waipara freshes of10 m^3/s can, but do not always, remove periphyton cover.

Water quality

5.5 Mosley (2003) notes water quality is better than other hill country fed rivers, but notes the river is eutrophic, but there is no evidence that present water management has affected periphyton cover and biomass. Bacterial water quality is generally better than guidelines for contact recreation.

Water temperature

5.6 Mosley (2003) notes water temperature may be limiting native fish and exceed lethal levels for trout, but any increase in temperature attributable to abstraction (about 0.1 °C per 1 m^3/s) is unlikely to have an ecological effect.

Macroinvertebrates

5.7 Surren & Jowett (2006) examined the role of flood and low flow periods in the Waipara River over a 2.5 year period. To quote:

a. Five discrete flood and low flow events were identified and changes to invertebrate communities before and after these events examined.

b. Invertebrate densities decreased more commonly after floods than after low flows, and there was a significant positive relationship between the number of taxa showing reductions in density and flood magnitude.

c. Densities of most invertebrates either remained unchanged, or increased after low flow events, except for four taxa whose densities declined after a very long period (up to 9 months) of low flow. This decline was attributed to autogenic sloughing of thick periphyton communities and subsequent loss of habitat for these taxa.

Sport fish

5.1 Mosley (2003) notes that flooding, low flows, and high water temperatures are all environmental factors contributing to poor Waipara trout habitat.

5.2 I found that optimum habitat for adult trout occurs at about ten times the minimum flow in Jowett's Waipara Reach 1, and at far greater flows in Waipara Reach 2 and 3.

5.3 Further, fish passage to the headwaters, where trout may go to spawn and to avoid high water temperatures (Staff Report 2009), is impeded:

a. I measured thalweg water depths (deepest continuous flow path) over several hundred metres in the reach between Stringers Bridge and the Forbes intake.

b. At a White Gorge flow of 60 L/s the reach had discontinuous pools of water and extensive dry sections.

c. At a flow of 470 L/s at White Gorge, the minimum depth criterion for unimpeded brown trout passage was not achieved. Similarly, other segments of river appeared too shallow for unimpeded trout passage.

Native fish

5.4 Table 1 of Jowett (2006) provides flow estimates to provide 90% of maximum habitat suitability for the Waipara River:

a. Upland bully: 40 L/s;

b. Canterbury galaxias: 10 L/s;

c. Longfin eel: 60 L/s;

d. Bluegill bully: 900 L/s;

e. Torrentfish: 900L/s.

5.5 Jowett (2006) notes lower flows may also be adequate in maintaining fish populations.

5.6 In evidence, Mr Jowett describes his fish abundance investigations and makes further flow recommendations that differ from Jowett (1994; 120 L/s at Teviotdale). He comments on the effectiveness of his flow recommendation in a number of publications (cited in Jowett 2006).

5.7 In these reports, and in evidence, there is little or no reference to the extensive discussion of the role of river mouth closure in the fish abundance study reported by Jowett (2000).

5.8 Mouth closure would appear to explain recruitment and size frequency distribution of diadromous fish (notably torrentfish and bluegilled bullies) that were reported to have the greatest declines

5.9 I note that Jowett (2006) refers to detailed field observations and states "...bluegill bullies and torrentfish numbers were unaffected when flows at White Gorge were greater than 62 L/s." These species have the greatest flow requirements (paragraph 5.4).

5.10 I evaluated the proposition that increasing the minimum flow from 50 to 60 L/s at White Gorge would materially benefit the life supporting capacity of the river:

a. As previously noted, I found that with a flow of 470 L/s at White Gorge, passage was impeded for large trout in the reach between White Gorge and the Forbes take;

b. The riverbed upstream of the irrigation take was dewatered at a White Gorge flow of 60 L/s;

c. Using the hydraulic habitat model RHYHABSIM and the data from Mr Jowett, and contemporary habitat suitability curves (Jowett & Richardson 2008), I found there is no material difference in the hydraulic geometry at a flow of 50 or 60 L/s in the reach below White Gorge:

    i. Average width increases from 5.0 m to 5.2 m;

    ii. Average depth remains 0.06 m; and

    iii. Average velocity increases from 0.18 m/s to 0.19 m/s.

d. There is no material benefit in habitat suitability (HSI where 0 is not suitable and 1.0 is ideal) as flows increase from 50 to 60 L/s in the reach below White Gorge:

    i. Upland Bullies: remains 0.77;

    ii. Canterbury galaxias: remains 0.73;

    iii. Torrentfish: essentially unsuitable at both flows (peak suitability (HSI 0.33) occurs at over 800 L/s; and

    iv. Bluegill bully: essentially unsuitable at both flows (peak suitability (HSI 0.39) occurs at over 500 L/s).

5.11 I evaluated the proposition that increasing the minimum flow from 110 to 200 L/s at Teviotdale would materially benefit the life supporting capacity of the river:

a. There is no material difference in the hydraulic geometry

i. Average width increases from 12.4 to 12.8 m;

ii. Average depth increases from 0.36 to 0.39 m; and

iii. Average velocity increases from 0.03 m/s to 0.05 m/s.

b. There is no material benefit in habitat suitability:

i. Upland Bullies HSI remains 0.18;

ii. Canterbury galaxias: remains 0.11;

iii. Torrentfish: essentially unsuitable until flows exceed 1000 L/s; and

iv. Bluegill bully: essentially unsuitable until flows exceed 800 L/s).

5.12 In addition, when considering changes, the number of fish involved and their location is important. I base my opinion on the following observations over a three seasons (Table 1 & 2 of Mr Jowetts evidence):

a. 11,531 Upland bullies were caught from all three study reaches;

b. 2,197 Bluegill bullies were caught, primarily in the lower reaches (80% of sites; and 20% of sites in the White Gorge-Omihi reach);

c. 1,699 Canterbury galaxias were caught, primarily in the upper reaches (100% of sites; with 80% and 40% in the lower tow reaches).

5.13 Also, in my view there is probably a fair degree of uncertainty in counting fish such as torrentfish and bluegill bullies that flee to riffles in low flows (Jowett 2000).

5.14 The objective of partial restrictions is ostensibly to improve the life supporting capacity of the river

a. It is unclear how this improvement will be achieved in terms of instream habitat suitability for the present actual water takes;

b. There may be merit in partial takes if more water is abstracted in the future. This has been raised previously by an ECan expert, but not at this hearing as far as I am aware.

c. Specifically, in consideration of an application for a new take of 9.6 L/s in the 'upper Waipara' the commissioners noted Dr Vattala of ECan made the following statement (Donaldson decision, McGarry & Kane 2010):

'Recommended "partial restrictions" are valid under the provisions of the RPS and are the only way to allocate <u>further surface water</u> while protecting instream values and reliability of supply;' [my emphasis].

6. EFFECTS OF TAKING WATER ON TANGATA WHENUA VALUES

6.1 Tangata Whenua values include aspects pertaining to aquatic life described above, but also the mahinga kai and mauri of the river.

Mahinga kai

6.2 As discussed by Zygadlo- Kanara and Te Runanga o Ngai Tuahuriri (2004) "There was a large mahinga kai resource along the coast between the Waipara River and the Kowai River. Waipara is referenced to a fish caught in the river. The river was used to catch eel and raupo and harakeke were collected from the surrounding area. At the mouth of the Waipara River is the Waimaiaia Reserve (MR 899). Next to this reserve is a lagoon which was used to catch both fish and waterfowl.... (Tau et al, 1990, p.5-13)."

6.3 In my opinion, changing the minimum flow will not have a significant affect on raupo and harakeke.

a. I believe riverine vegetation, such as raupo and harakeke, is more influenced by river corridor and land management practices than by minimum flow in the river.

b. The reality is that more than doubling the minimum flow from 50 to 110 L/s will raise water levels by 13 to 23 mm for the three hydraulic habitat survey reaches.

6.4 In my opinion, eel habitat is largely determined by river corridor and land management practices (e.g. riparian vegetation, land drainage, loss of off channel ponds), and eel harvest. Jowett (2000) noted there was little change in the number of longfinned and shortfinned eels during the lowest flow season (1998/1999 summer). Local flows in the survey reach dropped to 20 L/s.

6.5 A flow of 60 L/s in the Waipara will provide 90% of the maximum suitable habitat for longfin eels (Table 1, Jowett 2006); but eels were

6.6 Zygadlo- Kanara and Te Runanga o Ngai Tuahuriri (2004: 11) states: "The whole river system is important for the fisheries. The lower reaches and the upper reaches provide significant habitats for the mahinga kai fish species. For example, the lagoon in the lower reaches provides an important spawning area for inanga (whitebait). Also migratory fish species are dependent on downstream and upstream passage of the river system. The drying out of the lower reaches over summer has hindered upstream fish passage. The abstraction of water exacerbates the drying out of the river."

6.7 As discussed previously, there are significant water losses in the lower reaches, so that the lagoon is isolated from the river at flows less than about 350 L/s at Teviotdale, and the river does not maintain passage to the sea unless flows are 4-5 m^3/s.

6.8 In my opinion, changing the minimum flow at White Gorge from 50 to 60 L/s, or implementing partial restrictions, will not change this naturally occurring situation. Nor will it reverse dewatering above the water takes.

6.9 In terms of bird habitat Zygadlo- Kanara and Te Runanga o Ngai Tuahuriri (2004: 14) state "The abstraction of water from the river and the adverse actual and potential effects on mahinga kai bird habitat is of concern to Ngai Tuahuriri." Several potential effects are cited.

6.10 In my opinion, increasing the minimum flows from 50 to 60L/s at White Gorge, or implementing partial restrictions, is unlikely to significantly change any of these factors. I base my opinion on the following from my previous analysis:

a. There is little change in the hydraulic geometry of the River or habitat suitability;

b. Aspects of water quality and periphyton are largely dependent on maintenance of freshes that are not affected by the minimum flow regime;

c. Water temperature (hence dissolved oxygen) is unlikely to be significantly affected by minimum flows;

d. Predation is unlikely to be affected by minimum flows. At low flows the river is largely single channel and the concept of "safe islands" is not relevant. Further, many of the predators are independent of flow (e.g. black back gulls); or would not be put off by the widths, depths and velocities of secondary channels in the Waipara River (e.g. feral cats, hedgehogs);

e. Terrestrial habitat and encroachment are related to riverine and land management and maintenance of flood flows, not minimum flows;

f. Freshes and floods are required to maintain a riverbed clear of vegetation, but it is unlikely that trees will be cleared from the bed by floods. A deliberate policy of vegetation removal is required. This is not a minimum flow related issue; and

g. The dimension of the hapua is more related to sea state conditions and the history of floods than minimum flows.

Mauri of the Waipara River

6.11 The mauri of a river can be tangibly represented in terms of elements of the physical health of a river ecosystem (Pauling, 2002, p.13)" including natural character, life supporting capacity, water quality flow continuity, productive capacity and fitness for cultural usage (Zygadlo-Kanara and Te Runanga o Ngai Tuahuriri (2004: 17-18). Each of these facets of mauri is related to minimum flows in my comments below and in other sections (e.g. river morphology).

6.12 Zygadlo- Kanara and Te Runanga o Ngai Tuahuriri (2004) state: "The high growth of filamentous green algae at low flow over summer in the Waipara River is also seen as an important factor by Ngai Tuahuriri in affecting native fish habitat quality." I concur, but as discussed previously, increasing the minimum flows from 50 to 110 L/s at White Gorge is unlikely to improve the current situation, which is a multi faceted problem.

6.13 Rebecca Larking (2001), with assistance from Ngai Tuahuriri Runanga, used the Waipara River to establish a relationship between Maori values for water and hydrologic monitoring of river flow. She noted:

a. "Flow indicators that were important included the movement of water, the sound of water moving and the depth of the water. However, non-flow indicators were also important in assessing the health of a river reach. At the White Gorge site, even in February when flow was low, comments by Runanga representatives were generally positive, for example an observer of the White Gorge site in February commented "*I can feel the mauri, it's so pleasant and quiet. Very low flow, but water is clear and looks clean. Mahinga kai would still be able to be gathered*". The comments at Teviotdale regarding mauri were also very positive even at low flows. Non-flow factors used in the assessment of mauri included the presence of birdlife, the presence of structures and non-native vegetation, landuse, rubbish and pollution."

b. Mauri appears to be perceived as lowest between the three observation sites at SH1. The perception was largely related to infrastructure (bridges etc), trash and litter, exotic vegetation.

7. CONCLUSIONS

7.1 The 72 km long Waipara River can be divided into three main segments (headwaters, 'upper' and 'lower') with various sub-segments.

7.2 Much of the irrigation abstraction (80%) directly influences a short segment of river (km 20 to the Omihi confluence at km 12), before flows greatly increase with Omihi inflows.

7.3 The exposed gravel bed characteristics of the Waipara River are determined by flood flows and river management not low flows.

7.4 Fish passage in the river is problematic:

a. The river mouth is frequently closed for prolonged periods. The mouth opens with flows of 8-9 m^3/s and is maintained with a flow of 4-5 m^3/s;

b. Upstream fish passage is impeded because the depths are too shallow for large trout at flows well above MALF;

c. Sections of river above the irrigation takes are dewatered at flows exceeding the proposed minimum flow at White Gorge.

7.5 With the existing water abstractions, concurrent flows are similar at White Gorge and above the Omihi confluence (i.e. there is not a one for one loss in surface flow with the abstractions). This is problematic:

a. Recent ECan estimates of the effects of abstraction on streamflow and reliability of supply do not take this into consideration. Estimates by Scarf (2007) appear to be more realistic; and

b. In recommending partial restrictions or a higher minimum flow, observed streamflows do not appear to be taken into account.

7.6 Effects of the largest abstractor (Forbes) on streamflow have been rigorously evaluated:

a. ECan measurements, and my measurements, show a decrease in surface flow at the point of abstraction whether irrigation abstraction is occurring or not; and

b. In three of four measurements, and in my measurements, there is a recover in flows downstream, with little or no effect on flows in the Waipara above the Omihi confluence. .

7.7 Amenity values such as aesthetics, recreation and fishing, were not influenced, or were influenced to a minor extent, by irrigation abstraction.

7.8 Increasing minimum flows will increase algal growth in the Waipara, and large flows are required to remove much of the periphyton (10 m^3/s or more). The river is nutrient rich naturally, but there is no evidence that present water management has affected periphyton cover.

7.9 Very small increases in water temperature are likly to result from abstraction, and the increase due to abstraction is unlikely to have an ecological effect.

7.10 For the Waipara River, flows of 10 L/s (Canterbury galaxias) to 40 L/s will provide 90% of the maximum suitable habitat for the most abundant species. Bluegill bullies and torrentfish, which comprise a small portion of the total fish population, require flows of 900 L/s to provide 90% of suitable habitat.

7.11 In extreme low flow conditions (local flows of 20 L/s) in 1998/1999 there was little change in the number of long finned eels, shortfinned eels and upland bullies.

7.12 Increasing minimum flows doe snot materially change the hydraulic geometry of the river (i.e. width, depth and velocity), or the habitat suitability.

7.13 Several aspects of Tangata Whenua values were discussed in detail and it was concluded that many of the issues are related to riparian management and infrastructure rather than low flows.

Dr Henry Roland Hudson

04 April 2011

REFERENCES

Chater, M., 2002. Waipara River Water Resource. Technical Report U02/84, Environment Canterbury, Christchurch.

Hayward S. A., Meredith, A.S., Lavender, R.M., 2003. Waipara River: assessment of water quality and aquatic ecosystem monitoring 1999 to 2002. Technical Report U03/11, Environment Canterbury, Christchurch.

Jowett, I.G. 2000. Effects of floods and droughts on fish in a New Zealand gravel-bed river. Pages 451-464 in Gravel-bed rivers V, edited Mosley, M.P., New Zealand Hydrological Society, Wellington.

Jowett, I. G., 2006. Minimum flows to sustain fish values in the Waipara River. ECan correspondence PL5C/52.

Larking, R.; with assistance from Ngai Tuahuriri Runanga, 2001. Establishing a relationship between Maori values for water and hydrologic monitoring of river flow. A case study of the Waipara River. Environment Canterbury Report u01/61. 39 pages.

McGarry, S.A.; Kane, J. 2010. Decision of hearing commissioners Resource Consent Application CRC041892 by Pegasus Bay Vineyards and Winery Limited to take and use water for irrigation from the Waipara River.

Mosley, M. P. 2003. Waipara River: Instream values and flow regime. Report R03/1, Environment Canterbury, Christchurch.

Ritson, J. 2008. Water demand in the Waipara mainstem catchment. Technical Report R08/78, Environment Canterbury, Christchurch.

Scarf, F. 2007. Seven day mean annual low flow and mean annual flow mapping of the Waipara River catchment, North Canterbury. Technical Report U08/10, Environment Canterbury, Christchurch.

Surren, A.M, Jowett, I.G. 2006. Effects of floods versus low flows on invertebrates in a New Zealand gravel-bed river. Freshwater Biology 51 (12): 2207–2227.

Zygadlo-Kanara, F., Te Runanga o Tuahuriri. 2004. Waipara River Tangata Whenua values. Technical Report R04/01, Environment Canterbury, Christchurch.

Tables

Table 1: Comparison of flows Waipara River at White Gorge and upstream of the Omihi confluence (data from Scarf 2007)

	Waipara River Flows (L/s)			
Date	White Gorge	Above Omihi	Above Omihi naturalised	Estimated Abstraction
18-Jan-01	139	137	201	64
02-Apr-01	53	35	53	18
11-Dec-03	291	316	384	68
15-Jan-04	101	54	118	64
17-Feb-04	2103	2267	2336	69
17-Mar-04	411	408	457	49
23-Apr-04	545	622	649	27
27-May-04	2847	3550	3554	4
24-Jun-04	2235	2407	2412	5
20-Jul-04	1455	1553	1559	6
25-Aug-04	4156	5035	5040	5
24-Sep-04	1326	1369	1388	19
03-Nov-04	1007	1147	1203	56
12-Jan-05	911	1171	1235	64
02-Feb-05	109	76	135	59
02-Mar-05	81	56	105	49
24-Mar-05	124	126	175	49
14-Mar-06	95	92	141	49
12-Apr-06	261	337	364	27

FIGURES

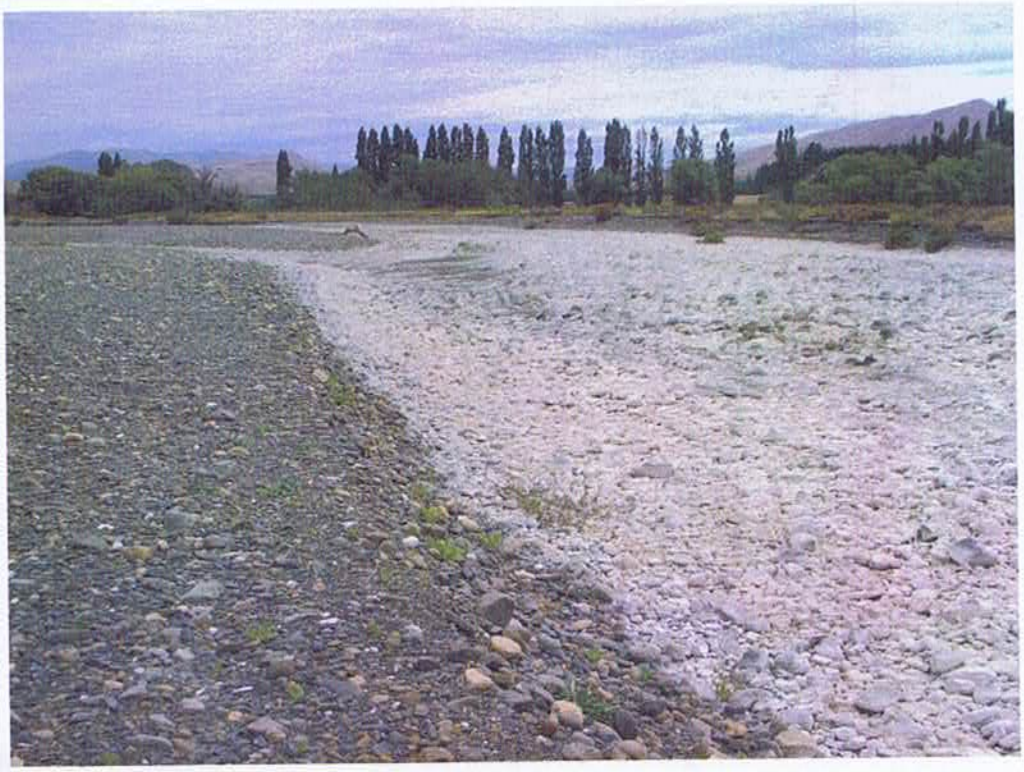

Figure 1: Waipara River above the Forbes take at a White Gorge flow of 60 L/s (local flow 0 L/s; top) & 470 L/s at White Gorge (local flow 387 L/s; bottom)

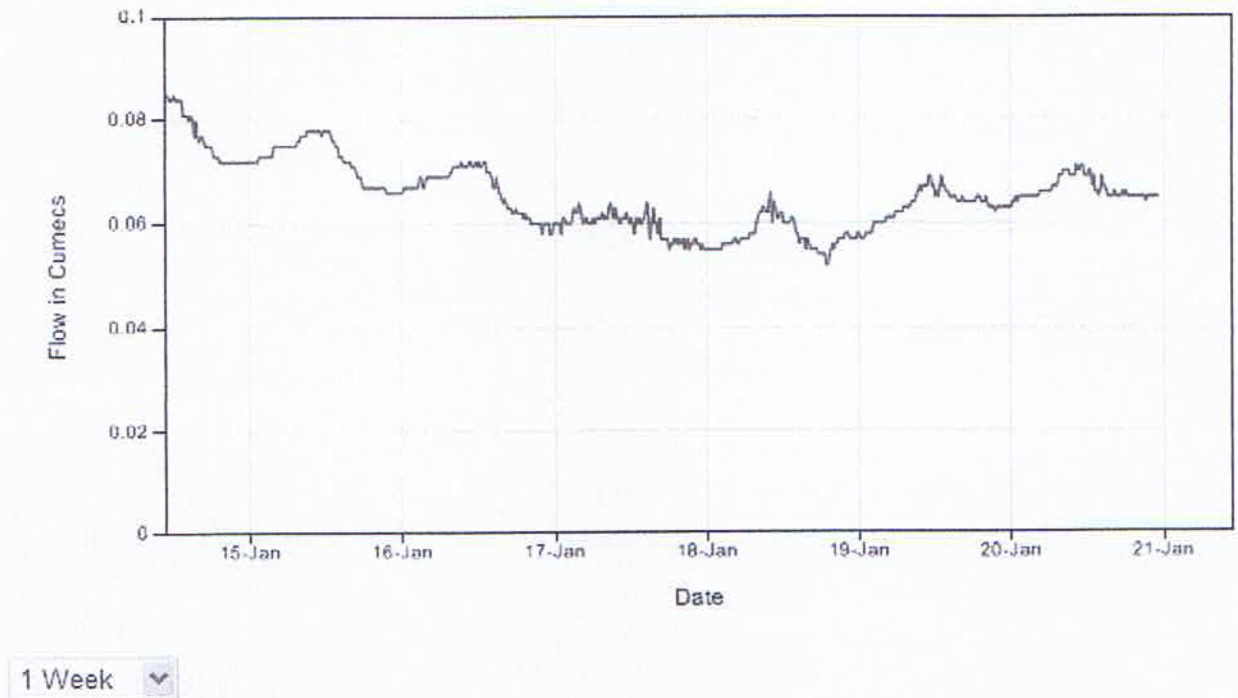

Figure 2: Unexplained diurnal flow variability at While Gorge

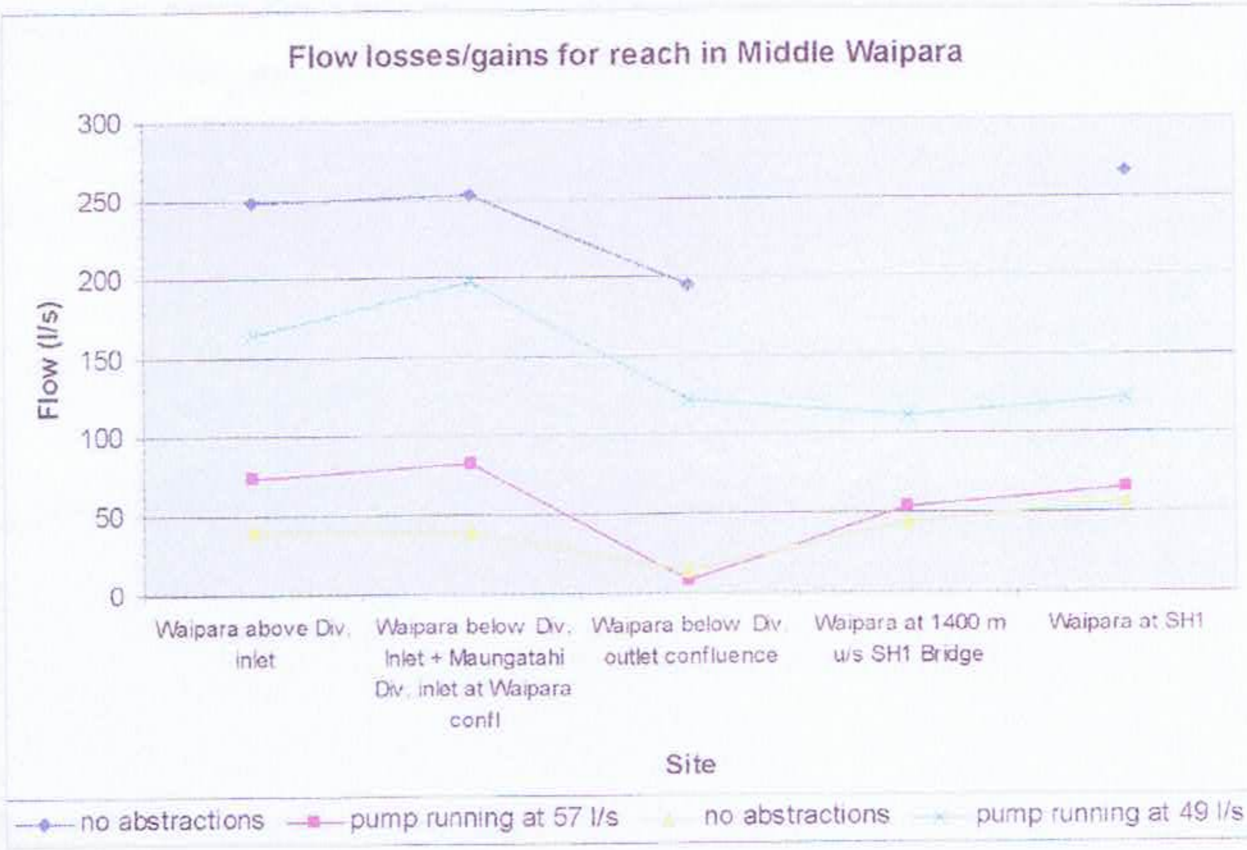

Figure 3: Comparison of flows Waipara River with and without Forbes abstraction (Topelen 2009 ECan presentation)

Figure 4: Dewatering below the Forbes take. White gorge flow 60 L/s, flow above the take 30 L/s, flow below the take 52 L/s, flow 300 m downstream 0 L/s