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| **IN THE MATTER** | of the Resource Management Act 1991 |
| **AND** | |
| **IN THE MATTER** | of submissions by **Orari Water Society Incorporated** to the Proposed Canterbury Land & Water Regional Plan |

**HEARING THREE**

**ORARI SUB CHAPTER (SECTION 14)**

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**STATEMENT OF EVIDENCE BY GREGORY IAN RYDER**

**MAY 2013**

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## 1. INTRODUCTION

1.1 My full name is Gregory Ian Ryder.

1.2 I am a Director of Ryder Consulting Limited, an environmental consulting business with offices in Dunedin, Christchurch and Tauranga. Prior to this, I held positions at the Otago Regional Council and the University of Otago.

1.3 I am a water quality scientist and aquatic ecologist and hold BSc. Hons. (First Class) (1984) and PhD. (1989) degrees in Zoology (freshwater ecology) from the University of Otago.

1.4 For approximately 25 years, I have conducted a wide variety of studies on freshwater ecology and water quality throughout New Zealand. I have been project manager for major studies on New Zealand river ecosystems and have had a lead role in a number of multidisciplinary studies involving aquatic and terrestrial ecosystems. Regional councils and government departments have engaged me to peer review environmental studies and resource consent applications, and I have held the position of an independent commissioner on a number of major resource consent hearings associated with marine farms, ski-field development, water abstractions and wastewater discharges.

1.5 In 1995 I set up Environment Southland's State of the Environment Freshwater Monitoring Programme and have since been involved in various aspects of its implementation and data analysis. I have assisted both Environment Southland and Otago Regional Council in developing their respective regional water plans, and was the principal author in developing water quality standards for Southland's Draft Regional Water Plan (Ryder 2004). I am currently assisting Environment Southland with developing water quality management zones for Southland.

1.6 I have been associated with flow setting investigations and recommendations for many rivers throughout New Zealand. I am experienced with the techniques used to assess the effects of flow regimes on freshwater ecology and water quality.

1.7 I am familiar with surface waters of the Canterbury region and have undertaken assessments in the Ashburton, Hakataramea, Rakaia, Rangitata, Waimakariri and Waitaki catchments. This work included assessments of water quality and surveys of benthic ecology (e.g., macroinvertebrates and periphyton) and fish habitat in relation to abstractions and discharges.

1.8 I have read the Code of Conduct for Expert Witnesses (Rule 330A, High Court Rules and Environment Court Practice Note) and I agree to comply with it. I have complied with it in the preparation of this statement of evidence.

## 2. SCOPE OF EVIDENCE

2.1 Orari Water Society Incorporated sought my advice in relation to aspects of the Proposed Canterbury Land and Water Regional Plan (hereafter "the Plan" or pLWRP) that relate to the Orari catchment. In particular, I was asked to assess the appropriateness of environment flows in the Plan for the Orari catchment (summarised in Table 15, page 14 – 5 of the Plan) including the robustness of the science behind the minimum flow setting process.

2.2 My evidence includes:

- A summary of the plan change provisions for the Orari catchment as they relate to environmental flows;
- Overviews of the ecology and water quality of the Orari River and main lowland tributaries (particularly Coopers Creek, Ohapi Creek and Rhodes Creek);
- A summary of the instream ecological values that have been identified for these water bodies and the appropriateness of the environmental flows that have been proposed in the pLWRP;
- An assessment of the relationship between instream ecological values and surface flows, including surface flow losses to ground and groundwater contributions to surface flow;
- Comments on the Environment Canterbury reporting officer's Section 42A report;
- Comments on submissions relating to the instream ecological values and environmental flows.

2.3 In preparing this evidence I have read a number of documents that have been prepared on behalf of Environment Canterbury, the Orari-Opihi-Pareora Zone Committee and the Orari Water Society. I have cited these in Appendix One. I also inspected key sections of the Orari River and a number of catchment tributaries in early May of this year. I note that these inspections were undertaken when the flow in the Orari River at the gorge monitoring site was 5-6 $m^3$/sec, and irrigation in the catchment had largely ceased, and so was not viewed under low flow conditions.

2.4 I also note that Mr Richard de Joux has provided evidence on the hydrology of the Orari catchment and I defer to his evidence for detailed analysis of surface flow characteristics and interactions between abstractions and ground and surface waters. Ms Keri Johnston has provided evidence on the origin of “B” Block minimum flows and I will refer to her evidence also when considering effects of B permits on stream ecology.

## 3. PLAN CHANGE PROVISIONS FOR THE ORARI CATCHMENT

### 3.1 Environmental Flow and Allocation Limits

3.2 Section 14 of the pLWRP outlines matters relating specifically to the Orari, Opihi and Pareora catchments. As I note further on in my evidence, the existing minimum flows in the Orari River are widely considered inadequate to support the range of ecological, cultural and economic values considered appropriate for this river. Concerns have also been expressed about minimum flows in some of the Orari’s key lowland tributaries and these are addressed also. Fundamentally, large sections of the Orari catchment below the gorge have physical characteristics that result in rapid losses of surface water to groundwater, resulting in extensive dry sections of river bed. This phenomena is explained in more detail in the evidence of Mr de Joux.

3.3 A three stepped approach to managing flow and allocation in the catchment was developed by the Orari Environmental Flow and Allocation Regime Steering Committee that revolve around increasing environmental flows and reducing allocation limits. The approach is described in more detail in the evidence of Ms Keri Johnston, but in summary, and as described in Section 14 of the Plan, the first step caps current allocation, the second increases the minimum flow in the lower Orari River in the shoulder seasons from 200 L/sec to 300-400 L/sec then, three years after the Plan becomes operative, to 500 L/sec year round, and the final step is a vision for 2040 which includes a further increase in the summer minimum flow to 900 L/sec year round. The last two steps are also accompanied by the introduction of 1:1 flow sharing for river flows between 500 and 1,500 L/sec, then between 900 L/sec and 1500 L/sec from 2040.

3.4 During the current regime there are also proposed changes to how the minimum flow is assessed for Coopers Creek and Petries Creek going onto mainstream Orari.

While the status quo flows are maintained for Ohapi Creek and Rhodes Stream with the addition of conjunctive use zone[1]. The Plan encourages the off-stream storage of water as a means of increasing reliability for irrigation while reducing total allocation and improving environmental flows relative to the current situation.

3.5 It is acknowledged by most parties that some rivers suffer from a lack of information on hydrological relationships and associated effects or influence on instream ecology. This is due partly to the complexity of surface and groundwater interactions within the lower catchment, as described by Mr de Joux. This lack of information is recognised in the Plan and is part of the reason behind a staged approach to flow and allocation management, along with an addition of a review policy being suggested. In this respect, I support the staged approach as it provides time to assess interim changes and gain a better understanding of the relationships described above, and how they affect local ecology and water quality. The Plan acknowledges that the 2040 environmental flow and allocation regime is a 'vision' that may change along with new scientific information.

3.6 The limits are to be achieved through managing transfers of water permits, storage, metering, reasonable use, water user groups, augmentation and efficiency. Alongside the policies and rules in this Plan, there is also an accord between the Orari Environmental Flow and Allocation Regime Steering Committee and the Zone Committee to implement other actions to achieve the vision for the catchment. The 2040 environmental flow and allocation regime is a vision that may change along with new scientific information. Actions include a collaborative approach to improving water quality through fencing and planting waterways and investigating other practical on the ground solutions to achieve outcomes.

3.7 Allocation and minimum flows are central to the Plan's management of water resources and associated values in the Orari catchment. I have summarized these for the Orari catchment in the table below:

[1] Conjunctive use zones refer to groundwater takes which are 30 metres deep or less and are considered to have a direct hydraulic connection with surface water. The Orari catchment has three conjunctive use zones; Coopers Creek, Ohapi Creek and Orari mainstem.

## Orari River Environmental Flow and Allocation Limits (adapted from Table 14 of the dLWRP, page 14 – 5).

| River/Stream | Location of recorder | Min. flow for A permits (L/sec) | | | Allocation limit for A permits (L/sec) | | | Min. flow for B permits (L/sec) | | | Allocation limit for B permits (L/sec) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Current | 3yrs from Operative Plan | 2040 | Current | 3yrs from Operative Plan | 2040 | Current | 3yrs from Operative Plan | 2040 | Current | 3yrs from Operative Plan | 2040 |
| Orari | Upstream Ohapi | Dec-Apr: 200<br>May-Jul: 900<br>Aug-Oct: 400<br>Nov: 300 | 500<br>1:1 Flow sharing 500-1500 L/sec | 900<br>1:1 Flow sharing 900-1500 L/sec | 1542 | 1400 | 800 | - | 3800 | 3800 | - | 1400 | 1400 |
| Ohapi Creek | Ohapi Creek @ Houston's | Oct-Jan 570<br>Feb-Sep 730 | | | 2055 | | | - | | | - | | |
| Rhodes Creek | Rhodes Stream @ Parke Road | 60 | | | 501 | | | - | | | - | | |

3.8 A key management component of the plan is the tying in of allocation setting and minimum flows to limits on abstraction of both shallow ground and surface water. The Orari Environmental Flow and Allocation Regime Steering Committee has developed a framework for this and this has been incorporated into the Plan as set out in the table above.

### 3.9 Water quality outcomes

3.10 Table 1a of Policy 4.1 (page 4 – 2) lists fresh water outcomes for Canterbury rivers and these represent default outcomes for rivers of the Orari catchment given outcomes have not been established specifically for this catchment. While these will be very familiar to you by now, I have identified rivers, creeks and springs of the Orari Catchment and identified what management unit they fit into in the Table below.

## Outcomes for Canterbury rivers (adapted from Table 1a of the pLWRP, page 4 – 2).

| Management unit | Sub-unit | Ecological health indicators | | | Macrophyte indicators | | Periphyton indicators | | Siltation indicator | Microbiological indicator |
|---|---|---|---|---|---|---|---|---|---|---|
| | | QMCI* (min. score) | Dissolved oxygen (min. saturation) (%) | Temperature (max.) (°C) | Emergent macrophyte (max. cover of bed) (%) | Total macrophytes (max. cover of bed) (%) | Chlorophyll *a* (max. biomass) (mg/m$^2$) | Filamentous algae >20mm (max. cover of bed) (%) | Fine sediment <0.0625mm diameter (max. cover of bed) (%) | Suitability for contact recreation (SFRG) |
| **Natural state** | | Rivers are matinained in a natural state | | | | | | | | |
| **Alpine - upland** | | 5 - 6 | 90 | 20 | No value set | No value set | 50 | 10 | 10 | Good |
| **Alpine - lower** | | | | | | | 120 | 20 | | Good to Fair |
| **Hill-fed - upland** | | | | | | | 50 | 10 | 15 | Good |
| Hill-fed - lower<br>Lower Coopers Creek<br>Scotsburn Stream<br>Kowhai Stream<br>Orari River | | | | | | | 200 | 30 | | Good to Fair |
| | urban | 3.5 | | | | | | | 20 | No value set |
| **Lake-fed** | | 6 | | | | | 200 | 30 | 10 | Good |
| **Banks Peninsula** | | 4 - 5 | | | | | 120 | 20 | 20 | No value set |
| **Spring-fed -upland** | | 6 | | | 20 | 30 | 50 | 10 | 10 | Good |
| **Spring-fed - lower basins** | | 5 | | | 30 | 30 | 200 | 30 | | Fair |
| Spring-fed - plains<br>Upper Cooper Creek<br>Ohapi Creek<br>Petries Creek<br>Rhodes Creek | | 4.5 - 5 | 70 | | 30 | 50 | 200 | 30 | 20 | No value set |
| | urban | 3.5 | | | 30 | 60 | 200 | 30 | 30 | No value set |
| All river management units | | Toxin producing cyanobacteria shall not render the river unsuitable for recreation or animal drinking water.<br>Fish shall not be rendered unsuitable for human consumption by contaminants in a river.<br>The natural colour of the water in a river shall not be altered.<br>Natural frequency of hāpua, coastal lake, lagoon and river openings is not altered.<br>Passage for migratory fish species is maintained unless restrictions are required to protect populations of native fish.<br>Natural continuity of river flow is maintained from source to sea, without reaches being induced to run dry.<br>Variability of flow, including floods and freshes, avoids "flat-lining", enables fish passage and mobilises bed material. | | | | | | | | |

*Key:
QMCI = quantitative macroinvertebrate community index
SFRG = Suitability for Recreation Grade from Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas 2003
Suitability for Recreation Grade from Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas 2003

3.11 The water quality regime for the catchment is already in the initial stages of getting underway, with Environment Canterbury having started this process off and some farmers obtaining further data in the meantime through water quality monitoring of local surface waterways.

**3.12 The role of hydrology**

3.13 The hydrology of surface waters of the Orari catchment is relatively complex due to the spatial variability of surface runoff and groundwater contributions and interactions throughout the catchment. This is compounded further by a lack of hydrology data for some surface waters (e.g., Rhodes Stream). Mr de Joux provides more detail on hydrology in his evidence. In some instances the lack of detailed hydrological information has necessitated a staged approach to environmental flow setting which I consider to be pragmatic while further information can be gathered, along with the proposed policy review.

## 4. INSTREAM ECOLOGICAL VALUES

4.1 In this section of my evidence, I summarise the instream ecological values of important surface waters of the Orari catchment that are subject to the effects of abstraction and flow losses.

**4.2 <u>Orari River</u>**

4.3 The Orari River is the largest surface water body in the catchment. It is fed primarily by rain from the hill country and by spring-fed tributaries in the lower reaches. The middle and lower reaches of this river flow across the Canterbury Plains and it is known to lose water to ground in these reaches (typically 6,000 L/sec). Historically, the most reliable flow information for the Orari River has been derived from a flow recorder situated at the downstream end of the Orari Gorge as the river exits the hill country. However, flow data from that site has limited use for assessing flows in the lower reaches, due to losses to groundwater as already noted. Under the pLWRP, minimum flows for the Orari River and several tributaries including upper Coopers Creek are tied in to the Orari River Upstream Ohapi flow recorder site, which is situated approximately 1.5 km from the coast. The rationale for switching to the Upstream Ohapi recorder site for minimum flow management is discussed in the evidence of Mr de Joux and Ms Johnston, and it is fair to say the ecological benefits of this approach are yet to be fully understood (the Upstream Ohapi site is relatively new and so has generated a limited amount of data only to this point in time).

4.4 The Orari Gorge flow monitoring site is also questionable as an appropriate site for assessing the effects of flow on instream ecology, again particularly for reaches in the lower catchment.

4.5 Like many rivers that flow across the Canterbury Plains, the channel of the Orari River (and its tributaries) has been modified to control its spread and limit flooding of surrounding land. While a major focus of my evidence and the provisions of Chapter 14 of the Plan is related to flow effects, these other modifications undoubtedly have also affected the river's ecology over time and, in some instances, will continue to affect the river's ecology regardless of the size of the minimum flow.

4.6 The water quality, aquatic ecology and associated instream habitat of the Orari River has been documented in the Golder Associates report for Environment Canterbury (Golder Associates 2013), which I have reviewed. Water quality is what I would expect given the type of river and catchment it flows through. Water quality in the upper catchment is high, but declines downstream of the Orari Gorge. Temperatures in reaches where the channels are exposed to sunlight can exceed recommended guidelines under fine weather summer conditions. Oxygen levels are typically adequate for aquatic life, but do drop to lower levels at times. The concentration of dissolved inorganic nitrogen is much higher at the lower catchment site (median of 1.61 mg/L compared with 0.05 mg/L at the other monitoring site 30km upstream) while phosphorus is moderately low and does not increase markedly between the two monitoring sites.

4.7 The Orari River has reasonably good instream habitat characterized by a bed dominated by coarse, silt-free material (cobbles and gravels) and a high diversity of aquatic habitats. The middle and lower reaches, downstream of the gorge, are considered sensitive to reduced flow, due to the generally good instream habitat present and the river's relatively broad and shallow channel profile. I discuss this matter further below.

4.8 Periphyton (algae attached to the river bed) is typically present but appears to comply with guidelines associated with the management of nuisance growths. Macrophytes (aquatic weeds) are uncommon and this probably reflects the shallow, cobble-bed, nature of this river coupled with occasional floods that disturb the bed and scour plant growths. Macrophytes are typically more prominent in aquatic habitats with slow flowing, deeper water and soft sediments on the bed allowing root development. Lowland springs support abundant macrophyte growths for these reasons.

4.9 Benthic invertebrate communities in the Orari River are dominated by taxa typical of stony bed rivers. Some degradation in the composition of the fauna is observed as the river flows out of the hill catchment and across the plains. The comment in the Golder Associates (2013) report that "*… hill-fed rivers such as the Orari River and up per Coopers Creek are considered the most sensitive to reduced flow, as they have a relatively high abundance of mayflies, which are generally intolerant of poor water quality and high temperatures*" is one that I do not agree with as it is inaccurate to say that reduced flows *per se* affect the abundance of mayflies. Very small streams can support high densities of mayflies.

4.10 The fish community of the Orari River is dominated by native fish species including longfin eel, torrentfish, inanga, koaro and lamprey. A brown trout and salmon fisheries are locally valued in the gorge and lower reaches. I understand there has been a decline in reported angler usage over the past two decades (national angler survey records). Not unexpectedly, fish diversity is greatest in the reach downstream of SH1, near the coast.

4.11 All major abstractions in the Orari River are located in the lower reaches downstream of the gorge and this section is of most concern for managing instream ecological values. Key instream values in this section include:

- salmon spawning & rearing habitat (Badham Bridge to mouth; Schedule 17 of Canterbury Land & Water Regional Plan);
- brown trout fishery (locally significant);
- native fisheries (Canterbury galaxias, inanga, upland bully, common bully, torrentfish, Stokells smelt, common smelt, black flounder).

4.12 I also note that the lower river is considered to be a regionally significant habitat for birds and the Orari River mouth is considered to be nationally significant bird habitat.

4.13 Many of the native fish species as well as salmon require access to and from the sea to complete their life cycles, and some undertake significant migrations inland and into tributaries. Therefore, surface water connectivity is a key concern for these species. While the majority of native fish species require relatively little water depth for passage, adult trout and salmon have more demanding requirements due to their larger size.

**4.14 Flow considerations for the Orari River**

4.15 Flow intermittency, resulting in dewatered reaches, is a natural feature of the Orari River, as noted in the evidence of Mr de Joux. Surface water is lost in alluvium gravels downstream of the gorge resulting in dry reaches under summer low flow conditions. Abstraction is thought to contribute to this dewatering effect by increasing the duration and extent of dewatering, however the extent of contribution is as yet not clearly defined. In my opinion, the staged approach to flow setting proposed in the Plan will provide time to undertake studies to better define the relationship between abstractions and flow intermittency. I also note that the proposal to use the 'Upstream Ohapi' site as the minimum flow site for Orari River abstractions will reduce flow intermittency relative to current levels, and this must be beneficial for instream ecology.

4.16 Studies to assess flow requirements to sustain fish communities have concluded that the existing minimum flow for the lower Orari River (200 L/sec at the Upstream Ohapi site over the period December to April) is insufficient to sustain instream values, and I agree with this conclusion based on the information I have viewed on instream habitat. The principle reasons for this assessment is that a 200 L/sec flow results in a reduction of potential physical habitat for many fish species, restricts passage for trout and salmon (although this assumes they migrate during low flow situations which is not necessarily the case), and exacerbates the extent of natural dewatering events in the mainstem. The Plan proposes that the minimum flow under the Current regime increases from 200 L/sec to 300-400 L/sec in the shoulder season as a first step to enhance fish passage and instream values. The second step is an increase to 500 L/sec (year round) within three years of the Plan becoming operative. The Plan also ties in shallow, connected groundwater abstractions that currently have no minimum flow restrictions (conjunctive use zone). Consequently, the Current regime consisting of a 200 L/sec minimum flow and increased shoulder flows represents an immediate improvement.

4.17 I have reviewed the technical information behind these flow recommendations. Habitat modelling was undertaken at the Orari River upstream of the confluence of Ohapi Creek. Based on the in-stream habitat modelling, predicted habitat for all species and life-stages modelled increases or remains steady from flows of 200 L/sec to 500 L/sec. Maximum habitat for adult brown trout occurs at flows >2,000

L/sec, maximum spawning habitat at 400-500 L/sec and maximum juvenile brown trout at 500-700 L/sec.

4.18 Increasing the minimum flow from 200 L/sec to 500 L/sec is predicted to increase adult brown trout habitat by 30% and a further increase in minimum flow to 900 L/sec, as proposed by the Plan as a minimum flow objective for 2040, is predicted to increase it by a further 55%. Indeed, for most fish species modelled, maximum habitat in the lower Orari River occurs at flows between 500 L/sec and 900 L/sec. I regard these proposed increases as being appropriate in that they should result in a significant improvement in instream habitat for key species while still being able to be accommodated by existing abstractors once the full allocation regime, which includes a 'B block' for abstraction at higher, is implemented.

4.19 The 500 L/sec minimum flow proposed will be instigated with 1:1 flow sharing over the flow range 500 L/sec – 1,500 L/sec. The purpose of flow sharing is to maintain some of the variability in flows in order to preserve the functions of these variable flows (such as flushing build-ups of fine sediment and periphyton on the river bed) and to avoid "flat-lining", or holding the river at or close to the minimum flow for extended periods of time. In some river systems, flat-lining can cause significant ecological issues, although in my experience these effects are highly variable and the degree of effect dependent on a number of environmental features in addition to flow. However, I accept that, in the case of the Orari River, flow sharing should have positive ecological benefits for fish in particular, given the lower river loses water to ground and that it is subject to prolonged low flow events that can occur during critical times of the year for fish growth and migration.

**4.20 Flows for flushing**

4.21 Hydrological analyses have shown that the Plan's proposed environmental flow and allocation limits have little effect on the frequency of freshes and floods. The introduction of B Block allocation permits and an associated minimum flow is discussed in the evidence of Ms Johnston. She describes how they were derived through the Orari Steering Committee process. B Block water is available when the river carries higher flow. Historically, flow management for instream ecology focused almost solely on minimum flows with little regard for freshes and floods. It is now realised that these higher flows can affect instream ecology, for example, by triggering migrations associated with life stages, removing nuisance algae and plant growths through flushing or scouring of the river bed, and by shaping the morphological character of the river channel (e.g., maintaining braiding pattern). Most environmental flow and allocation setting processes now have regard to how abstraction at higher flows may affect these ecological and physical process.

4.22 In the Orari catchment situation, hydrological analyses were undertaken to determine whether allocation limits for B permits would affect the frequency of floods and freshes[2] (Ritson and Stapleton 2013). This process is described in more detail in the evidence of Ms Johnston. From my perspective, the critical finding from this analysis was that there was no impact on freshes or floods between the 3 year flow sharing with storage at flow between 500 – 1500 L/sec (A Block allocation only), or the A Block allocation as well as a B Block allocation. Consequently, I am satisfied that the structure of the B allocation will not adversely affect the instream ecology of the Orari River. That is not to say that nuisance plant and algae growths and accumulation of fine sediment will not continue to occur periodically, as natural prolonged low flow events will continue to occur in the catchment, regardless of abstraction.

4.23 It is also not possible to manufacture additional flushing flows without considerable storage (in the form of a large dam in the upper catchment) and this prohibited in the Plan. However, even if this were possible, a large storage option in the upper catchment could result in fewer floods and freshes in the lower catchment due to the need to harvest such events.

**4.24 Flows for mouth opening**

4.25 The Orari River mouth reportedly now seldom closes because it is artificially held open by stopbanks that line the lower river. This situation has meant that river mouth closures are not regarded as a key catchment issue for setting environmental flows and allocation caps.

**4.26 Flows and water quality**

4.27 The Golder Associates (2013a) review of the Orari catchment for Environment Canterbury stated that it was recognised that lower minimum flows could result in degraded water quality, particularly elevated temperatures and depleted dissolved oxygen concentrations. I consider this statement is too broad brush and needs to be put into context. To my knowledge, currently no relationship has been established between water quality and minimum flows in the Orari River. While it is correct that elevated temperatures typically occur during summer low flow situations, the effect of abstractions is typically overstated. While low flows can result in more shallow water

[2] The analyses defined a “fresh” as FRE1.5 (a flow of 1.5 times the median flow) and a “flood” FRE3 (a flow of 3 times the median flow).

depth and slower water movement, which are factors that affect the rate of water heating, surface water temperatures are driven primarily by climatic and geographic conditions including air temperature, solar radiation, wind speed and shade. Most New Zealand studies have found that abstractions cause only minor increases (up to 1-2 °C) in river water temperatures (e.g., Jowett and Mosley 1983).

4.28 Elevated nutrient concentrations in the lower Orari River are a concern, particularly when they coincide with prolonged summer low flow situations. Such a situation will almost certainly result increase the potential for nuisance periphyton (algae) growths to develop, although surveys in February 2010 by Golder Associates (2013a) found that MfE periphyton guidelines were met. However, I see little likelihood of a change to the minimum flow significantly affecting nutrient concentrations in the lower river. These are driven primarily by catchment land use and the contributions of surface runoff (from the upper hill catchment and lowland tributaries) and groundwater gains (directly from the underlying gravels and indirectly from lowland tributaries). It could be argued that water sourced from the upper hill catchment is lower in nutrients (and possibly other contaminants) and so acts to dilute water sourced from the lowland tributaries and groundwater. However, the concentrations of nitrate in the lower river are such that 'tinkering' with the minimum flow would have no meaningful effect on that particular nutrient in terms of its effect on algae and plant growth. As for phosphorus, in rural catchments, most phosphorus in rivers is derived from surface runoff and so management of overland flow and riparian margins is the most practical way of reducing phosphorus concentrations in lowland rivers.

**4.29 <u>Ohapi Creek</u>**

4.30 The Ohapi Creek is a lowland tributary of the Orari River. Its confluence with the Orari River is located near the coast. Flows in Ohapi Creek are primarily fed by groundwater recharged by the Orari River and is classed as a "spring-fed plains" river.

4.31 The upper Ohapi Creek supports high macrophyte (aquatic plant) cover and macroinvertebrate communities are variable throughout the system and indicative of mild to moderate pollution. This is not unusual for lowland spring-fed creeks as their invertebrate communities are strongly influenced by soft sediment and presence of macrophytes – attributes encouraged by stable flows and a lack of flushing flows.

4.32 Water quality in the Ohapi Creek catchment indicates the strong influence of groundwater on water temperature (peak temperatures are much lower than in nearby rain-fed rivers) and nutrients (nitrate levels are typically high although not as high as some spring-fed tributaries of the Orari River).

4.33 I inspected sections of the Ohapi Creek system in May of this year and noted a number of farmer initiatives associated with riparian fencing. Some sections in particular have been well planted for a number of years to the point that they now clearly offer benefits in the form of shading, bank stability and filtering of overland flow, as shown in the photo below. These environmental factors will benefit instream ecology over and above any benefits provided by minimum flows.


4.34 Key ecological values identified for Ohapi Creek include:

- salmon spawning & rearing habitat (South, Middle and North Branches at 20m contour to mouth of Orari River; Schedule 17 of dLWRP);
- brown trout fishery (locally significant);
- native fisheries (lamprey, upland bully, longfin eel, shortfin eel).

**4.35 Flow considerations for the Ohapi Creek**

4.36 The Plan proposes that the minimum flow regime for Ohapi Creek remain in its current state with the addition of the conjunctive use zone, namely:

- 570 L/sec (Oct-Jan);
- 730 L/sec (Feb-Sep); with the flow to be recorded at the Houston's site.

4.37 Unfortunately, attempts to develop an instream habitat model for Ohapi Creek were unsuccessful due to difficulties in applying the methodology to spring-fed streams (Golder Associates 2013a). This has left an information gap in the science linking flows to ecological values for this creek. However, the current flow regime of the creek is supporting important ecological values and so there is no compelling reason to conclude that the existing minimum flows are inappropriate, also considering the added protection of the conjunctive use regime. I have found no evidence to indicate that these values are declining in this system. Aspects such as flushing flows and flows to dilute contaminants are less of an issue in a spring-fed creek like the Ohapi as there is limited ability to influence the dominance of groundwater and the associated stable flow regime.

4.38 **Coopers Creek**

4.39 The Coopers Creek system lies to the north of the Orari River and discharges into the Orari River approximately 6 km upstream from the coast. Flow in the creek is sourced from springs on the Orari River floodplain and there is thought to be a hydrological connection flows in the Orari River and up-welling in upper Coopers Creek. The upper section of creek is also fed by the Kowhai and Scotsburn flood channel which is ephemeral. Flows in Coopers Creek are normally lost by the time they reach SH79 and re-emerge 18km downstream just above the confluence with the Orari River (Ritson and Stapleton 2013), with recharge from the Fitzgerald drain. Mr de Joux describes in more detail the hydrology of the Coopers Creek system.

4.40 Water quality of Upper Coopers Creek has been a concern. Monitoring by Environment Canterbury and on behalf of abstractors (Irricon) indicate nitrate concentrations can be relatively high on occasions and exceed proposed pLWRP water quality standards, as can bioavailable phosphorus and *E. coli* concentrations. Very low dissolved oxygen concentrations have been recorded by Environment Canterbury at the SH72 site.

4.41 Given elevated nutrient conditions and a generally stable flow regime (particularly in the short section upstream of the Scotsburn flood channel), the creek is vulnerable to nuisance algae and plant proliferations.

4.42 The source of contaminants to Coopers Creek appear to be varied and include groundwater-derived nitrate, stock having access to water, surface runoff from surrounding farm land and riverine birds. From my recent observations of the creek, some of these sources can be managed more effectively than is the current situation, for example through fencing and riparian planting strategies. I am aware that farmers in the Upper Coopers Creek area are in the process of developing and implementing Farm Environmental Plans.

4.43 Macroinvertebrate communities in upper Coopers Creek have been assessed as having relatively high mean QMCI scores (between 5 and 6, out of a possible 10) indicating clean-water taxa dominate the community. However, this can vary with location and some sites closer to the springs indicate lower QMCI scores consistent with soft sediments, abundant plant growth and lower dissolved oxygen.

4.44 Coopers Creek supports some ecological values, although the fishery values are low and no species of conservation concern are known from these streams. Ecological values identified for Coopers Creek include:

- Brown spawning & rearing habitat;
- native fisheries (upland bully, Canterbury galaxias, black flounder in lower reaches).

4.45 Fish abundance and diversity is reportedly highest downstream towards SH72, but fish habitat further downstream is limited by flow intermittency. Fish strandings have occurred over a number of years.

4.46 When I inspected the Coopers Creek system in May of this year (after irrigation had ceased) there were three aspects of its character that caught my attention: 1) the Coopers spring network which in my opinion has potential for enhancement through fencing and riparian planting, 2) the section of Coopers Creek between the confluence of the spring outlet with the Scotsburn flood channel and the SH72 bridge, and 3) the completely dry Coopers Creek channel between SH72 and Canal Road.

4.47 Mr de Joux notes that continuous surface flow seldom occurs downstream of SH79 Bridge (located approximately 5 km downstream of the Coopers springs confluence), and that during most dry periods, flow ceases below Pit Road (approximately 3.2 km downstream of the Coopers springs confluence), while in drought periods, flow ceases below SH72 Bridge (approximately 1.5 km downstream of the Coopers springs confluence). There is an extensive section of the Coopers Creek channel which typically remains dry between the SH79 bridge and Canal Road (approximately 20km in length). This section only conveys surface flow during flood events. Around this area (Canal Road), the Coopers Creek channel receives water via groundwater recharge. I note that Mr Webb in his evidence on behalf of the Orari Environmental Flow and Allocation Regime Steering Committee states that flow in this section generally occurs only once or twice a year for no more than a week at a time.

4.48 Given the above, there is only a relatively short section of mainly spring-fed channel in upper Coopers Creek that perennially flows and provides instream habitat of potential value. Flow connectivity is highly important for many fish species that inhabit lowland streams, and Upper Coopers Creek will always have limited habitat potential due to the lack of flow connectivity in reaches downstream of the Coopers Creek spring network.

4.49 It is also apparent that from the confluence with the Scotsburn flood channel, the Coopers Creek water course is affected by flood events that carry significant quantities of gravel. I understand that Environment Canterbury has recently removed and ‘contoured’ the channel downstream of the SH72 bridge to assist with flood conveyance. This work, while necessary to protect adjacent land from flooding, creates highly modified, uniform, stream habitat of limited value for many stream dwelling species of fish and invertebrates. I refer you to photos attached to the evidence of Mr de Joux to provide a visual description of the sections of Coopers Creek I have referred to above (Figure 4 and Plates 1 to 11).

**4.50 Flow considerations for Upper Coopers Creek**

4.51 Mr de Joux in his evidence notes that flow in the Coopers Creek springs is largely influenced by flows in the Orari River, however the exact time of delay in response to recharge is uncertain. Flow information for Coopers Creek has been confounded by weed growth in the channel causing backwater effects, which results in inaccurate assessments of flow. This issue also affects the ability to assess the availability of instream habitat with changes in flow and, as with the Ohapi Creek, attempts to develop an instream habitat model for Coopers Creek have been unsuccessful. Consequently, the robustness of the science behind the setting minimum flows to support instream values is not strong. I discuss this issue further in my evidence.

4.52 Consents allowing the abstraction of groundwater that is hydraulically connected with Upper Coopers Creek have had a range of minimum flow conditions on consents from none, to the Orari River gorge flow recorder site, to 50L/sec at the Coopers Creek SH72 site. The 50L/sec minimum flow has proven to be problematic and was recently removed from the relevant consents to be consistent with the pLWRP.

4.53 It is widely acknowledged by all parties that establishing an appropriate minimum flow for Upper Coopers Creek has been difficult to achieve and this difficulty remains. Instream flow assessments to date have not been successful in my opinion, and minimum flow recommendations for sustaining key ecological values have been based on limited information and are inconclusive. The pLWRP states "*Orari mainstem permits are attached to the Upstream Ohapi minimum flow site and allocation block. The Orari mainstem contains the mainstem conjunctive use zone and the Coopers Creek conjunctive use zone. Given the lack of hydrological data and scientific understanding with the upper section of Coopers Creek and the Upstream Ohapi, mainstem minimum flow will apply to users within this catchment.*".

4.54 I regard the proposal in the pLWRP to manage abstraction based on flows in the mainstem Orari (Upstream Ohapi) as an appropriate interim step until a more reliable hydrological record for Coopers Creek is established that can be used to set minimum flows based on sustaining key ecological values. This approach is supported by the Cawthron review (Young 2013, Appendix 4 of the S42A report) of Environment Canterbury's Coopers Creek requirements flow requirements for ecological values (Golder Associates 2013b). In saying this, I also acknowledge the considerable uncertainty associated with this approach in terms of effects on Coopers Creek ecological values. However, I do not consider those ecological values are of such local or regional significance that an immediate increase in the minimum flow of this creek is justified given the clear direction in the Plan to obtain more conclusive information on relationships between flow and ecological values. I note that all abstractors within the Coopers Creek conjunctive use zone will have to move onto the current minimum flow regime including those with no current minimum flow requirements. I also consider there are more immediate steps that can be taken to improve the habitat of upper Coopers Creek. For example, fencing to exclude stock access to water would aid in reducing nutrient and sediment concentrations, improve riparian cover and improve edge habitat.

**4.55 <u>Rhodes Stream</u>**

4.56 Rhodes Stream is a short tributary (6.5km long) of the Orari Lagoon, which joins the mouth of the Orari River via tidal gates. The stream is now a complex of spring-fed drains, and is classified as a “spring-fed plains” river under the pLWRP.

4.57 Rhodes Stream has very high nitrate concentrations and moderately elevated bioavailable phosphorus concentrations and exceed guidelines for protection of nuisance algae and plant growths. Both nutrients exhibit seasonal fluctuations in concentration. Low dissolved oxygen levels have been recorded on occasions.

4.58 Benthic macroinvertebrate communities are indicative or poor water quality and habitat.

4.59 While the physical habitat of Rhodes Stream is highly modified (channelised), it supports some ecological values, although the fishery values are low and no species of conservation concern are known from these streams. Key ecological values include:

- brown trout spawning and rearing (with limited resident fish);
- native fisheries (eel, upland bully, Canterbury galaxias, black flounder in lower reaches).

4.60 Eels are reportedly abundant in some deeper sections with good cover.

**4.61 Flow considerations for Rhodes Stream**

4.62 There is lack of a reliable hydrological data for Rhodes Stream such that key flow statistics (e.g., 7 day MALF and the median flow) are not known with any certainty. The instream habitat model that was created for this stream (Golder Associates 2013a) should be treated with caution given the difficulties in building a hydraulic model in spring-fed, weed infested waterway. In my opinion, it is not possible to use this instream habitat model to determine an appropriate minimum flow and allocation regime for this stream or to set the minimum flow as a proportion of MALF.

4.63 The current minimum flow for Rhodes Stream is 60 L/sec (measured at Parke Road). The Plan proposes to maintain this minimum flow with the addition of the conjunctive use zone. I am of the view that this is a reasonable and pragmatic approach until a reliable hydrological record is attained. The current ecological values of this creek will not be adversely affected by maintaining the current minimum flow. Whether or not an increase in the minimum flow will enhance these values cannot be determined from the existing data.

## 5. SECTION 42A REPORT

5.1 I note that the Section 42A report for Hearing Group 3 recommends that the environmental flows as drafted in the Plan be retained without amendment. Given my comments above on flow recommendations, I consider this report to be reasonable in terms of management of instream ecological values.

## 6. SUBMISSIONS

### 6.1 Department of Conservation

6.2 I understand that the Department of Conservation submission is concerned about the effects on instream ecology resulting from the introduction of a B Block allocation. Specifically, the Department is concerned that high flow events are required for ecosystem functioning and are likely to be seen as important during the nutrient limit setting process. I agree with the general tone of this comment, but I consider that the Department's concerns for the Orari catchment are unfounded. As I note in paragraph 4.22 (and in the evidence of Ms Johnston), the frequency of freshes and floods are not affected by the Plan's proposed flow regime. Flows in key tributaries of the Orari River (below the gorge) are largely influenced by groundwater and so are less sensitive to floods and freshes (with the possible exception of Coopers Creek which requires floods to provide surface flow connectivity between the lower reaches of this system and the Coopers Creek spring system in the upper reaches).

### 6.3 Mr James Jolly

6.4 Mr Jolly expresses concern about the number of days that the river runs dry and that this should be reduced to reduce effects on riverbed nesting birds. While I defer to My Jolly's expertise on riverbed dwelling birds, I think he may have misunderstood the hydrology of the Orari catchment and its natural tendency to lose water as it flows across the plains. Further, the staged approach to minimum flow setting, as set out in the pLWRP along with the proposed review policy, will enable the gathering of additional information on relationships between surface flow and abstraction, that are currently unrefined. This staged approach does not degrade minimum flows.

**6.5 C and A Sintenie**

6.6 C and A Sintenie have a property that sits adjacent to Coopers Creek in the section between the Coopers Creek springs and SH72. Their submission expresses concern that eels and trout "*that used to be common sight, are hardly ever seen*", and that "*Cockabullies* [bullies]*, which our children used to catch in abundance, seem to have disappeared*". On my site visit of Coppers Creek in May of this year, I observed many juvenile bullies in the reach not far downstream of the Sintenie property (just upstream of the SH72 bridge).

6.7 I also refer to Mr Webb's evidence on behalf of the Orari Environmental Flow and Allocation Regime Steering Committee where he states there is no indication that fish salvage from Coopers Creek has been required more frequently in recent years, however the number of fish salvaged has become less. Mr Webb goes on to state that in a stream the size of upper Coopers Creek, the removal of a significant proportion of the stream's natural [fish] production over 40 years is likely to be "*as much a contributor to the current low population status as any decline in habitat quantity or quality*".

## 7. CONCLUSION

7.1 In my opinion the pLWRP has applied a minimum flow and allocation limit regime that provides some immediate benefits to instream ecology while acknowledging a number of limitations to the current understanding of relationships between groundwater, surface flow and abstractions in the Orari catchment.

7.2 The Plan has a timeframe that will enable information to be gathered that will address the information gaps on the relationships I note above. Importantly, from an instream ecology and water quality perspective, the Plan provisions will not in my opinion compromise the existing values of the Orari River and its tributaries, but indeed provide opportunity to enhance those values.

7.3 There are aspects of this catchment that will always limit the ecological potential of surface waters, namely natural losses to ground resulting in dewatered sections of streams and rivers, and physical modifications to watercourses for the management of erosion and flooding. The effects of these activities will continue regardless of the minimum flow regime.

## 8. REFERENCES

Golder Associates. 2013a. Orari River catchment. Ecological values and flow requirements. Prepared for Environment Canterbury.

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Young, R. 2013. Review of report on ecological values and flow requirements of Cooper Creek. Cawthron Institute letter to Tim Davie, Surface Water Resources & Ecosystems Section Manager, Environment Canterbury. Appendix 4 of the Section 42A report, Hearing 3.