Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Memo

Date	22nd March 2018
To	Waimakariri Water Zone Committee
CC	
From	Jarred Arthur

Evaluation of environmental flow regime options for the Ashley River and its tributaries

Summary

This memo provides the preferred minimum flow and allocation options for protecting instream ecological values in the Ashley River / Rakahuri and its tributaries. For the most-part, these are based on maintaining available resident or spawning habitats for species (with an emphasis on threatened indigenous fish), or sufficient fish migration pathways. As it stands, current minimum flows are insufficient for Waikuku Stream, Little Ashley Creek and Taranaki Creek. There is also an issue of inadequate allocation limits, and most streams are over-allocated. In order to protect instream values, these issues need to be addressed.

Instream ecosystem health is susceptible to changing water quality. The water quality of lower reaches in many Waimakariri Water Zone (WWZ) spring-fed waterways is highly responsive to changing flows with tidal pooling common. These flows can result in long water residence times resulting in stagnation. It is important that flow setting maintains water movement and flushing capacity to remove contaminants from the lower reaches of streams. This is of particular significance for Taranaki Creek, where approximately 1 km of the lower waterway is tidal or impounded behind floodgates.

Protecting cultural, recreational and amenity values is also key when managing water use and flows in the Ashley River / Rakahuri and its tributaries. These values (represented in Appendix 1) need to be assessed alongside the ecological minimum flows (EMFs) recommended in this memo, and a moderated recommendation made for each waterway that supports these values.

Purpose

The following memo details preferred options for environmental flow regimes in the Ashley River / Rakahuri and its tributaries for the purpose of protecting instream values. It outlines:

- preferred EMF preferred options, including the methodology used and justification for a reassessment of those previously reported.

- allocation options based on guidelines and reported findings. Until recently, allocation limits in Waimakariri planning processes have received little empirical guidance for protecting instream ecosystem values.
- effects of groundwater abstraction and allocation scenarios (as documented in the memo entitled '*Groundwater allocation modelling results and management options for Ashley River catchment'*) on ecological, cultural, recreational and amenity values (Appendix 1).

The findings of this memo will guide WWZ Committee decisions for recommending minimum flow and allocation limits in their draft Zone Implementation Plan Addendum (ZIPA).

Background

Indigenous flora and fauna evolve and adapt to habitats provided by natural flow regimes in streams and rivers. The availability and quality of these habitats, however, are increasingly compromised as more and more water is abstracted for human use from streams and stream depleting groundwater. It is prudent that the use of water resources is therefore sustainably managed to ensure flows that protect for ecological, cultural, recreational and amenity values. These flow provisions are collectively known as an 'environmental flow regime'. A simple environmental flow regime uses two management tools:

- a 'minimum flow' to manage the effects of abstractions on surface water values at low flow, and;
- an 'allocation limit' to preserve the variability of flows, specifically freshes and smaller flood flows.

Environmental and, more explicitly, ecological flow provisions mitigate the stress effect of low flow conditions on aquatic communities residing in freshwater environments. Low flows can prevent fish passage by exacerbating the spatial and temporal extent of drying reaches, and reduce available habitat for resident and spawning populations. Low flows can also degrade water quality by:

- increasing water temperatures;
- decreasing nutrient dilution potential;
- altering water pH;
- increasing diurnal fluctuations in dissolved oxygen concentrations; and,
- reducing sediment transport.

The above water quality effects can have multiple physiological and behavioural outcomes for aquatic species, and cause shifts in aquatic community assemblages. The indirect ecosystem effects of low flows on aquatic communities can include:

- an increased risk of nitrate toxicity to flora and fauna;
- increased nuisance algal and aquatic plant growths;
- reduced habitat refugia in bed substrates resulting from excessive bed siltation; and,

- increased invertebrate and fish mortality resulting from depleted dissolved oxygen levels and excessive water temperatures.

Neither a minimum flow or allocation limit should be considered independently of one another when setting an environmental flow regime. Each function in different ways, but also complement one another to protect instream values. A minimum flow should be set high enough to guarantee a minimum amount of viable habitat is maintained for a species. It should also provide refuge for invertebrates and fish until higher flows return. An allocation limit requires setting at a low enough value that promotes flow variability. This limits the time spent at low flow conditions and the amount of compounding environmental stress a stream community suffers.

The higher an allocation limit is, the longer a stream is likely to spend at a minimum flow level. Figure 1 illustrates how water allocation can lessen flow variability. Lower allocation limits are arguably more important for hill-fed rivers like the Ashley River / Rakahuri, which is naturally highly variable and highly dependent on freshes and floods to turn over the river bed, remove algal growths, provide fish passage, and maintain braided river function and character. Spring-fed waterways are naturally less variable, but still rely on smaller flood flows to flush contaminants. Minimum flow and allocation limits must be considered collectively when ensuring the low flow protection of instream values. The effect of an excessive allocation limit can be mitigated to some extent by setting a higher and more conservative minimum flow. This is likely to be the case in the WWZ where many streams are over-allocated or contain large allocation limits. Likewise, the effect of a low minimum flow can be offset to some degree by a more constrained allocation limit.

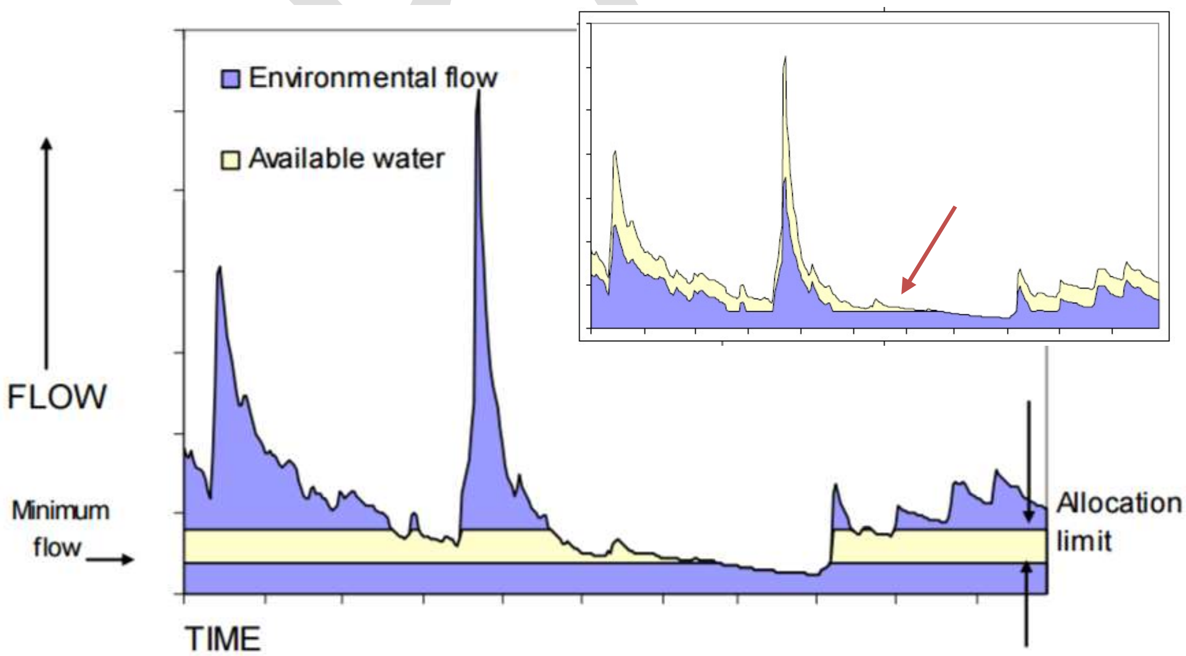

Figure 1. Example of how an allocation limit can affect a stream's flow regime (adapted from MfE, 2008). Red arrow indicates how a stream's flow can 'flat line' under allocation.

Ecological minimum flow reporting

Until recently, minimum flow setting in the Ashley / Rakahuri catchment considered no flow-based habitat assessments that empirically calculate the flows required to protect instream values. Instead, minimum flow setting in the Ashley River / Rakahuri mainstem and its spring-fed tributaries was dependent on expert panel opinion. To resolve this, Environment Canterbury contracted Waterways Consulting Ltd. in late 2016 to complete flow-related habitat assessments at and below existing minimum flow gauging sites (Waterways Consulting, 2017a & 2017b). These assessments compare flow with bed substrates and channel geometries to model species-specific habitat availability at different flows. As a result, Waterways Consulting (2017a & 2017b) provide EMF recommendations for the Ashley River / Rakahuri and its spring-fed tributaries.

A key component for assessing an EMF is the naturalised 7-day mean annual low flow ($7dMALF^{natural}$) of a stream. That is, the 7dMALF once anthropogenic effects of groundwater and surface water abstractions or recharge are removed. In the WWZ this includes the effects of consented water takes for irrigation, stock water, and drinking water, and the influence of water losses to ground via unlined Waimakariri Irrigation Limited (WIL) races and Waimakariri District Council (WDC) stockwater races. A shortfall of previous EMF assessments is that suitable data did not exist to adequately quantify the effect of such anthropogenic effects on stream flows. Instead EMF estimates were calculated using 7dMALF as measured in the environment regardless of abstraction and 'new water' ($7dMALF^{measured}$). This resulted in a discrepancy between EMF recommendations, as they are currently presented in Waterways Consulting (2017a and 2017b), and those that are suitable for protecting aquatic species under the scenario of a natural flow regime.

A recently developed groundwater model has provided a means to approximate the effects of groundwater abstraction and anthropogenic land surface recharge on spring-fed streams in WWZ. As a result, $7dMALF^{natural}$ values have been estimated for streams and rivers, which account for both surface water and groundwater anthropogenic effects. In light of these new findings, and considering the shortcomings of reported EMF recommendations, there is justification to reassess existing EMF values based on newly available $7dMALF^{natural}$ data.

Ecological minimum flow reassessment methods

River Hydraulics and Habitat Simulation (RHYHABSIM) methods were used for determining stream- and species-specific weighted usable area (WUA) curves (i.e. habitat availability). These are detailed in the reports by Waterways Consulting (2017a and 2017b). Revised EMFs were calculated by applying newly modelled $7dMALF^{natural}$ values to the reported WUA curves. Aquatic species presence/absence at each stream was then used to calculate ecologically appropriate flows.

Waterways Consulting (2017a) applied an expert opinion approach for determining EMFs and the percentage of species-specific habitat retention required from WUA curves for the Ashley

River / Rakahuri spring-fed tributaries. In contrast, EMF recommendations for northern Waimakariri River tributaries (which will be reassessed in a later memo) were based on fish community significance criteria outlined in Golder Associates (2009) (

Table 1**Error! Reference source not found.**). These criteria select the minimum flow necessary to retain a percentage of habitat area that an individual species has available at or below $7dMALF^{natural}$ conditions. The precise percentage of habitat retained is usually, but not always, determined by the flow preference of the most threatened species present in a stream. The more significant or threatened a fish population or community is, the higher the recommended percentage of habitat retention. For example, the presence of "chronically threatened" longfin eel requires the retention of flows that provide at least 95 percent of usable longfin eel habitat in a stream. To ensure methodological consistency across all waterways in the WWZ, this memo reassesses EMF values by applying the fish community significance criteria to all WUA curves generated by Waterways Consulting (2017a). An exception is the Ashley River / Rakahuri, which has a recommended EMF greater the $7dMALF^{natural}$, which is based on providing environmental flows for fish passage in the drying reaches of the river downstream of the Ashley Gorge.

The use of the RHYHABSIM method for calculating ecological flow requirements was not feasible or appropriate for all spring-fed tributaries assessed in the Ashley River / Rakahuri catchment. In some cases, it was difficult to establish habitat versus flow relationships because water levels in spring-fed streams are strongly influenced by abundant aquatic macrophyte beds. In these circumstances, the method for developing EMF recommendations were based on a percentage of $7dMALF^{natural}$, whilst still weighing the validity of the recommendation in Waterways Consulting (2017a and 2017b). The default value of 90 percent 7dMALF was used as per the draft proposed National Environmental Standard (NES) on ecological flows and water levels (MfE, 2008).

Taranaki Creek and Little Ashley Creek EMF recommendations were based on the provision of flows necessary to sustain water depths for longfin eel (Waterways Consulting, 2017a). These flows were recommended on the proviso that macrophyte growth is maintained instream. Macrophyte beds increase water depth and the removal of these through instream weed clearance or other mechanisms (e.g. die-off) can cause water levels and available fish habitat to decrease. It is therefore considered appropriate to adopt an alternative minimum flow value recommendation, to that suggested by Waterways Consulting (2017a), that is consistent with all scenarios of aquatic plant growth for each stream. Each "alternative" recommendation adheres to the NES default of 90 percent $7dMALF^{natural}$ as a value for protecting instream values (MfE, 2008). This provides added protection for Taranaki Creek, as a highly valued cultural landscape with a high diversity of taonga species (Te Ngāi Tūāhuriri and Tipa & Assoc., 2016) and Little Ashley Creek, which is significant in contributing to the flows and instream health of Waikuku Stream.

Table 1 Fish community significance criteria for determining percentage of maximum habitat retained when setting minimum flows. Adapted from Golder Associates (2009).

Significance criteria		Habitat retention (% of max. habitat)
1	Acutely threatened species e.g. Canterbury mudfish, lowland longjaw galaxias	100%
2	Chronically threatened and regionally threatened species e.g. longfin eel, banded kokopu	95%
3	Locally or regionally significant brown trout fisheries, plus habitat on which these fisheries depend for spawning and rearing.	90%
4	Diverse and abundant native fish communities Includes those with high recreational (e.g., whitebaiting) or cultural/mahinga kai values (e.g., eels).	85%
5	Non-diadromous species of native fish	80%
6	Sparse and unfished trout populations	60%
7	Streams with few fish or aquatic fauna present	50%
8	Other fish communities	70%

Revised ecological minimum flow results

Table 2 details the previously reported and newly revised EMF preferred options for minimum flow sites in the Ashley River / Rakahuri and its spring-fed tributaries. The table shows that $7dMALF^{measured}$ values have decreased from those used in previous assessments at all spring-fed tributary sites. Flow data records in these streams are poor and revised $7dMALFs^{natural}$ may be the artefact of recent dry seasons. For this reason, EMF options as calculated from revised $7dMALFs^{natural}$ may be underestimated. Opting to set a higher, more conservative minimum flow for each spring-fed tributary would compensate for any uncertainty in $7dMALF^{natural}$ values and potentially be more representative of that appropriate under a "normal" flow season. However, any trends suggested by the reductions in $7dMALF^{measured}$ values are tenuous due to the poor data availability and inherent modelling complexities.

Table 2. Ashley River / Rakahuri & spring-fed tributary ecological minimum flow preferred options as revised using naturalised 7dMALFs.

Stream	Site	Current minimum flow (L/s)	Previous assessment		Revised assessment			Justification
			7dMALF$^{meas.}$ (L/s)	Recommended ecological min flow (L/s)	7dMALF$^{meas.}$ (L/s)	7dMALF$^{nat.}$ (L/s)	Preferred ecological min flow option (L/s)	
Ashley River / Rakahuri	Ashley Gorge	A block: 2500 – 4000 B block: 3200 – 4700 C block: 6000	2040	2500	2050	2050	A block: 2500 B block: 5000 C block: n/a	Unchanged from Waterways Consulting (2017b) recommendation. 2600 L/s based on maintaining flows in downstream drying reaches to promote fish passage. Suggestion to increase 'B' block minimum flow to 5000 L/s to provide gap between top of 'A' and 'B' block allocations. This will wet the full length of the Ashley River / Rakahuri and facilitate fish passage of indigenous species and salmon.
Waikuku Stream[1]	Waikuku Beach Rd	100 (150 at weekends)	286	200 - 250	243	264	250	Revised 7dMALF$^{nat.}$ is less than that previously assessed. Advise to retain recommendation of Waterways Consulting (2017a) pertaining to the maintenance of salmon passage in this reach. 250 L/s will maintain >97% of longfin eel habitat (as per WUA curve) below 7dMALF$^{nat.}$ meeting the "chronically threatened" significance criteria (Golder Associates, 2009). 95% longfin eel habitat provided at 235 L/s.
Little Ashley Creek[1]	SH1	50 (30 at 4 days per month)	96	70	66	76	70	Revised 7dMALF$^{nat.}$ is less than that previously assessed. Draft NES 90% 7dMALF$^{nat.}$ default value results in similar minimum flow recommendation as that made by Waterways Consulting (2017a). Advise to retain recommendation of Waterways Consulting (2017a) pertaining to the maintenance of deep habitat for eels. This is while ensuring that prolific macrophyte growths maintain increased water depths.
Taranaki Creek[1]	Preeces Rd	120	170	120	155	175	158	Revised 7dMALF$^{nat.}$ is similar to that previously assessed. Waterways Consulting (2017a) advice of 70% 7dMALF as applied to revised 7dMALF$^{nat.}$ is 123 L/s. This is to maintain habitat depth for indigenous aquatic species, but is dependent on retention of instream macrophyte growth. Technical team preferred option of 158 L/s based on draft NES 90% 7dMALF$^{nat.}$ default value. Higher minimum flow advised to allow for macrophyte removal, promote water movement in lower reaches, and protect indigenous taonga species.
Saltwater Creek[1]	Toppings Rd	150	260	200	161	173	148	WUA curves in Waterways Consulting (2017a) established that available habitat for eel species and all size-classes of brown trout decrease considerably below 0.2 m^3/s. Revised 7dMALF$^{nat.}$ is below this flow. Advise that minimum flow is set at the point where 95% of longfin eel habitat is available (as per WUA curve) below 7dMALF$^{nat.}$ according to the "chronically threatened" significance criteria (Golder Associates, 2009).

[1] Increasingly conservative (higher) minimum flows will help offset the low certainty of 7dMALF^{natural} values, which have resulted from poor data records. This will provide greater protection to instream values.

Allocation limit options for protecting instream values

The draft proposed NES (MfE, 2008) suggests a default allocation limit of 30 percent of 7dMALF^{natural} for streams and rivers with a mean flow less than 5 m^3/s. This is applicable to all WWZ waterways except for the Ashley River / Rakahuri mainstem, which has a mean flow of 12.3 m^3/s (Megaughin and Hayward, 2016). For rivers and streams with a mean flow greater than 5 m^3/s, the NES suggests a default allocation limit of 50 percent of 7dMALF^{natural}, or the "*total allocation from the catchment less any resource consents surrendered, lapsed, cancelled or not replaced*". Waterways Consulting (2017b) recommends that the Ashley River / Rakahuri has an 'A' block allocation set between 400 – 500 L/s to minimise drying in the middle reaches of the river and increase the opportunity for fish passage (Table 3). Appendix 2 outlines the complete justification for this recommendation. Ashley River / Rakahuri spring-fed tributary allocation limit preferred options are set out in Table 3 below.

Table 3. Ashley River / Rakahuri and spring-fed tributary allocation recommendations. 'Current allocation limit' column is based on LWRP adjusted max rate of take method. Bracketed values are based on average rate of take method (see memo entitled *'Environmental flow regime for the Ashley River catchment'*).

Stream	7dMALF^{natural} (L/s)	Current allocation limit (L/s)	Preferred allocation limit (L/s)	Justification
Ashley River / Rakahuri	2050	700	400 - 500	Recommendation of Waterways Consulting (2017b) pertinent to the prolonging of higher flows to allow for fish passage during peak migration periods in the typically drying middle reaches of the Ashley River / Rakahuri. Alternatively, NES default guideline results in an allocation of 1025 L/s (50% 7dMALF$^{nat.l}$).
Waikuku Stream	264	831 (460)	80	Draft NES default value of 30% of 7dMALF$^{nat.l}$ (for streams with mean flows less than 5 m^3/s) is equal to 79 L/s.
Little Ashley Creek	76	344 (172)	25	Draft NES default value of 30% of 7dMALF$^{nat.}$ (for streams with mean flows less than 5 m^3/s) is equal to 23 L/s.
Taranaki Creek	175	149 (61)	60	Draft NES default value of 30% of 7dMALF$^{nat.}$ (for streams with mean flows less than 5 m^3/s) is equal to 53 L/s. Given MALF uncertainty, advise leaving at current allocation of 60 L/s.
Saltwater Creek	173	417 (408)	50	Draft NES default value of 30% of 7dMALF$^{nat.}$ (for streams with mean flows less than 5 m^3/s) is equal to 52 L/s.

Ecological effect of groundwater use scenarios

The memo entitled '*Groundwater allocation modelling results and management options for Ashley River catchment'* examines changes in stream flow resulting from different groundwater use scenarios. These scenarios are as follows:

- Full abstraction (**full_abs**):
  - assumes all consented wells use 100% of consented volume (excludes permitted activity wells).
- Full abstraction and full allocation (**full_abs_allo**):
  - Assumes all consented wells use 100% of consented volume in Groundwater Allocation Zones (GAZs) (except in Loburn and Lees Valley) and groundwater is fully allocated up to current Land and Water Regional Plan (LWRP) limits.
- Full allocation and current usage (**full_allo_cur_use**):
  - groundwater is fully allocated up to current LWRP limits, but assumes consent holders use the same percentage of water as currently used (55% based on metering data).

Under each scenario, a decrease in stream flows is modelled for the Ashley River / Rakahuri and its tributaries (

Table 4). Flow reductions greater than or equal to 10 percent are deemed to be significant, whereas flow reductions less than 10 percent are within the groundwater model margin of error. For this memo, all stream reductions less than 10 percent are considered negligible and are therefore not assessed for their impact to instream values. All percentage reductions displayed in

Table 4 are assumed to apply to all flow types including low flows, which is when stream communities are typically under the greatest stress. There are no groundwater use scenario results for Little Ashley Creek as there was insufficient data to model the stream-effect accurately.

Table 5 summarises the low flow (7dMALF value) estimation for streams with significant modelled flow reductions (≥ 10%) under each groundwater use scenario. The following sections highlight the ecological, cultural, recreational and amenity impacts likely to result from modelled low flow reductions in Taranaki Creek and Waikuku Stream.

Table 4. Modelled changes in stream flows as a result of different groundwater use scenarios (adapted from memo entitled '*Groundwater allocation modelling results and management options for Ashley River catchment*'). Little Ashley Creek was not modelled due to insufficient data availability. Red highlights significant flow decreases.

Scenario name	Stream	[1]Median flow decline
full_abs	Ashley River / Rakahuri	1%
	Saltwater Creek	5%
	Taranaki Creek	**14%**
	Waiuku Stream	8%
full_abs_allo	Ashley River / Rakahuri	3%
	Saltwater Creek	9%
	Taranaki Creek	**33%**
	Waiuku Stream	**21%**
full_allo_cur_use	Ashley River / Rakahuri	1%
	Saltwater Creek	2%
	Taranaki Creek	**10%**
	Waiuku Stream	7%

[1] An assumption is made that the modelled percentage decline in median flow is proportional to the decrease in all flow types (e.g., mean and low flows) at each stream under each scenario.

Table 5. Effect of modelled flow reductions on low flows in Taranaki Creek and Waikuku Stream.

Stream	Current 7dMALF[meas.] (L/s)	Ecological minimum flow (L/s)	Scenario name	Predicted 7dMALF (L/s)
Taranaki Creek	155	158	Full_abs	**133**
			Full_abs_allo	**104**
			Full_allo_cur_use	**140**
Waikuku Stream	243	250	Full_abs_allo	**192**

Taranaki Creek

A reduction in 7dMALF is estimated in Taranaki Creek under all scenarios of groundwater use (Table 5). Maximum flow reduction would occur under full abstraction and allocation (full_abs_allo) and result in a 7dMALF of 104 L/s. Low flows of this magnitude would likely result in a considerable loss of fish habitat. Waterways Consulting Ltd. (2017a) states that 120 L/s will retain desired water depths and habitat for a range of native fish in the macrophyte dominated environment. The risk of losing available habitat for species, such as shortfin and longfin eels, inanga and bully species, increases as flows decrease below this point. Taranaki Creek is also subject to slow water velocities in the lower reaches of the stream. A flow of 104

L/s would exacerbate the impoundment and stagnation of water in these reaches as water velocities decrease. This may have further implications for instream health as dissolved oxygen levels drop, pH changes, water temperature increases, and sediment and other contaminants settle out.

Under the scenarios of ‘full abstraction’ (full_abs) and ‘full allocation and current usage’ (full_abs_cur_use), 7dMALF is expected to decrease to between 133 and 140 L/s (Table 5). Low flows in this range will likely retain water depths for the maintenance of indigenous fish habitat when macrophyte growth instream is high. However, flows of this magnitude are below the NES default and the preferred EMF of 158 L/s. This increases the risk of lost habitat and fish passage when instream macrophyte clearance or die-off occurs. Lower flows will also further impair the stream’s capacity to flush contaminants in the lower reaches.

The above outcomes will impair the ecological, cultural, recreational and amenity values of Taranaki Creek (Appendix 1). Reduced flows will result in lost habitat and therefore lost community diversity or species densities. Taranaki Creek communities are composed of taonga species and those important for mahinga kai gathering. The stream is also highly valued in terms of wahi tapu with culturally sensitive sites, such as Kaiapoi Pā, being situated nearby. Degraded water quality will affect these qualities as well as its recreational and amenity values. The stream, for example, is an esplanade ‘priority river’ in the Waimakariri District Plan.

Waikuku Stream

Significant stream flow reduction only occurs in Waikuku Stream under the scenario of full abstraction and full allocation (full_abs_allo) (Table 5). Under these groundwater use conditions, 7dMALF is estimated to decrease to 192 L/s, and small flood and flushing flows will reduce. Shortfin and longfin eels, giant bully, brown trout and chinook salmon are recorded to be present in Waikuku Stream (Waterways Cosulting, 2017a). Significant salmon spawning runs have also been known to occur in the stream, but evidence for this is anecdotal. Although a flow of 192 L/s will retain a reasonable amount of resident and spawning brown trout and salmon habitat, it will more-or-less eliminate fish passage for salmon throughout Waikuku Stream. The majority of available habitat will be retained for a variety of indigenous fish species, but only 87 percent of longfin eel habitat, below the 95 percent recommended (235 L/s) by the ‘chronically threatened’ criteria outlined in Golder Associates (2009). By comparison 94 percent of shortfin eel habitat would be retained.

Water in Waikuku Stream does not impound or stagnate to the same extent as it does in Taranaki Creek; however, habitat degradation due to excessive bed sediment is a significant issue at present. Decreased low and median flows will likely result in greater bed sedimentation over extended reaches, while smaller flood flows will reduce sediment flushing capacity. Waikuku Stream will also be more susceptible to a degradation in water quality such as that described for dissolved oxygen, pH and water temperature for Taranaki Creek above. Decreased nutrient dilution potential coupled with increased temperatures will increase the risk of nuisance periphyton growth in gravel bedded areas, and macrophyte growth in soft-bottomed areas. Nitrate toxicity risk to invertebrates and fish may also increase.

The ecological impact of a 21 percent reduction in stream flows will be mirrored by degraded cultural, recreational and amenity values in Waikuku Stream (Appendix 1). The stream is valued for the presence of taonga species, mahinga kai, and provision of refuge for resident Ashley River / Rakahuri fauna. Unlike many spring-fed tributaries in the WWZ, Waikuku Stream still contains riffle reach of high ecological importance that will decrease under the influence of lesser flows. Its propensity to serve as trout and especially salmon spawning habitat contributes to catchment-wide sports fish stocks, as well as the stream itself being useful for recreational fishing. A flow of 192 L/s will undermine these values as salmon passage will be prevented and therefore spawning inhibited.

References

Golder Associates, 2000. Minimum flows and aquatic values of lower Waimakariri River tributaries. Technical report no. 07813138 prepared for Environment Canterbury.

Megaughin, M. and Hayward, S. 2016. Waimakariri land and water solutions programme: hydrology current state report. Technical report no. R16/68. Environment Canterbury, Christchurch.

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Te Ngāi Tūāhuriri and Tipa & Associates (2016). Cultural health assessments and water management for the Rakahuri – Waimakariri Zone. Draft report supplied to Environment Canterbury.

Waterways Consulting, 2017a. Ecological assessments for minimum flows of spring fed tributaries of the lower Ashley River / Rakahuri. Technical report no. 37-2017A prepared for Environment Canterbury.

Waterways Consulting, 2017b. Ashley River / Rakahuri: ecological minimum flow assessment for Ashley Gorge. Technical report no. 37-2017A prepared for Environment Canterbury.

Appendix 1

Summary of preliminary Ashley River / Rakahuri catchment ecological, cultural, recreational and amenity values. Values have been established based on an evaluation of community feedback, current state and trend data, the Cultural Opportunity Mapping Assessment and Response (COMAR) report (Te Ngāi Tūāhuriri and Tipa & Associates, 2016), other reports, and anecdotal evidence. **These are preliminary findings only and intended to aid WWZ Committee environmental flow setting discussions.**

Stream	Overall waterway value	Subset value				Justification
		Ecological	Cultural	Recreation	Amenity	
Ashley River / Rakahuri	Very high	Very high	Very high	Very high	Very high	Largest river in the Waimakariri Zone supporting braided river characteristics. Important native fish habitat and passage to upper hill-fed tributaries. Diverse aquatic communities, including presence of threatened fish species (e.g. longfin eel, bluegill bully, torrentfish, Canterbury galaxias) and braided river bird (e.g. wrybill, black fronted tern, banded dotterel) nesting sites. Native forest and remnant wetlands (including regionally significant wetlands) in upper catchment, good quality aquatic habitat, and mostly high water quality state. Important ecosystem function values including flushing and preserving water quality in the Ashley River / Rakahuri – Saltwater Creek Estuary. Highly valued for its important landscape features, particularly upstream of the gorge. Culturally valued particularly in terms of mahinga kai, high number of taonga species and spawning grounds, clear water, central to the identity of Te Ngāi Tūāhuriri, ki uta ki tai and connection to flood plain, braided character, adds to sense of wellbeing. Highly valued for swimming (particularly at the gorge - LWRP Schedule 6), kayaking, camping, bird watching and other recreational activities. Numerous parks and reserve areas including Fenton reserves and in the vicinity of the estuary. Some salmon spawning areas, extensive trout spawning, regionally iconic backcountry fishery.

Stream	Overall waterway value	Subset value				Justification
		Ecological	Cultural	Recreation	Amenity	
Waikuku Stream	High	Very High	High	High	Moderate	Degraded habitat state in many areas, but still contains reaches of gravelled runs and riffles, and therefore a range of high quality habitat. Contains indigenous fish populations including longfin and shortfin eels, and bullies. Cultural values include connectivity to lower Rakahuri (regulates temperature and dissolved oxygen), presence of taonga species, native fish refuge when Rakahuri is low and mahinga kai. Waipuna (springs) are tapu. Supports salmon and trout spawning habitat thus providing ecological and recreational (angling) value. Whitebait fishery. Limited amenity values being situated in private farmland.
Little Ashley Creek	Low-moderate	Moderate	Moderate	Low	Low	Highly modified waterway network consisting of mostly farm drains, but contributes flows to Waikuku Stream thus has an important role in ecosystem function in lower reaches. Degraded habitat state with lesser ecological and cultural values than other zone waterways. Supports limited indigenous fish life (e.g. common bullies and eels), but a capacity to provide refuge for Ashley River / Rakahuri fauna. Cultural values noted to be connectivity to Waikuku Stream and mahinga kai gathering when Rakahuri is low/unusable. Waipuna (springs) are tapu. Mahaanui identifies as cultural landscape. Limited recreational or amenity values.
Taranaki Creek	Very high	Very high	Very high	Moderate	High	Suggested by iwi to be one of the most significant cultural waterways in Canterbury with the presence of Kaiapoi Pā. Highly valued for its cultural landscape, high diversity of taonga species, mahinga kai, situated near wahi tapu sites, and connected to estuary. Waipuna (springs) are tapu. Flows directly into the Ashley River / Rakahuri – Saltwater Creek Estuary contributing to estuary water and habitat quality. Degraded habitat state, but presence of diverse indigenous and threatened aquatic species including longfin eel, inanga and Canterbury galaxias. Critically threatened populations of

Stream	Overall waterway value	Subset value				Justification
		Ecological	Cultural	Recreation	Amenity	
						Canterbury mudfish in catchment wetlands. Supports populations of threatened indigenous flora (e.g. *Urtica linearifolia* – swamp nettle). Wetland habitat of regional significance. Provides inanga spawning habitat. Esplanade strip and walkway along stream edge. “Priority river” for esplanade under Waimakariri District Plan. Amenity values associated with Kaiapoi Pā, Pegasus Golf Club and Ravenswood development.
Saltwater Creek	High	High	Very high	High	High	High cultural values with significance to Te Ngāi Tūāhuriri. Mahaanui identifies as cultural landscape. Supports high diversity of taonga species, connected to estuary, feeds wetland of immense cultural significance, important for whitebait and mahinga kai, presence of harakeke as resource for whanau. Degraded habitat state and intermittent flows in many reaches, but supports many indigenous and threatened fish fauna including lamprey, longfin eel, inanga, bluegill bully and redfin bully. Inanga spawning habitat. Contributes flows to the Ashley River / Rakahuri – Saltwater Creek Estuary and thus affects estuary water and habitat quality. High proportion of indigenous salt marsh vegetation and flax swamp. Recreation and amenity values extend from estuary. Trout spawning habitat and fishery. Highly used whitebait fishery.

Appendix 2

Waterways Consulting Ltd. memo

To: Jarred Arthur, Environment Canterbury

From: Richard Allibone, Water Ways Consulting Ltd

Date: 13 March 2018

Subject: Ashley River, water allocation

Dear Jarred,

Water Ways' 2017 report (Water Ways Consulting 2017) provided advice on minimum flow and water allocation for the Ashley River and recommended a primary water allocation of between 0.4 m^3/s and 0.5 m^3/s. As the report notes this allocation is recommended for the protection of migratory fish passage. Larger flow allocations will lead to more extended periods of river drying, both in duration and extent in the lower Ashley River. The river has several native freshwater fish and Chinook salmon that have migratory life histories. Limiting the duration of drying periods allows for fish migration to occur over greater periods of the year. Furthermore, limiting the allocation also retains more habitat for fish and invertebrates in the river.

General Habitat Conditions

As the primary water allocation band increases the extent to which the river is flat lined extends in duration. Maintaining a river at an artificially low level for extended periods increases the effects of crowding, the potential for undesirable algal blooms, and reduction or loss of fish passage.

Torrentfish

A key fish species considered in this allocation recommendation was torrentfish (*Cheimarrichthys fosteri*). This species is the most significant freshwater fish in terms of its biodiversity value in New Zealand. It is the only freshwater fish in its family of fishes and its is restricted to North and South Island in New Zealand. In contrast, all of the other New Zealand freshwater fish genera are presented by multiple species and are parts of larger freshwater fish families found around the southern hemisphere and Asia Pacific region. Torrentfish are also recognised as being in declining, although the reasons for the decline are unknown (Allibone et al 2010, Goodman et al 2014).

In the Ashley River torrentfish are present from the river mouth upstream to areas upstream of Ashley gorge. Recent studies by Warburton (2016) have confirmed previous observations that the fish segregates by sex in an upstream direction. Fish in the upper reaches are exclusively female while in the lower reaches they are predominately male. For breeding purposes, the female fish must undertake a downstream migration. Breeding habitat has also been concluded to be present in the lower reaches of river, just upstream of the tidal reaches and male fish present in the mid-reaches also have to migrate downstream to this habitat. The studies to date do not provide a complete picture of the torrentfish migratory behaviour, but Warburton (2016) expects that following spawning adult fish are likely to migrate upstream again to adult habitat areas. Spawning occurs in summer and early autumn (Warburton 2016, Jarvis & Closs 2017, Scrimgeour & Eldon 1989) and it can be expected that fish passage for both downstream and upstream moving fish is required through this period. This migratory period occurs during the time when low flows are present, and the impact of water abstraction induced additions to the length and duration of drying reaches will be most severe.

Warburton (2015) also conducted population genetic studies and found that regional populations of torrentfish occur. He further concluded that movement between river regions and river system is limited while larval torrentfish are at sea. Therefore, protection of populations in a river system is important for the retention of the fish in that river.

As the Ashley River can naturally dry there is already some restriction on fish movement. Additional drying will further limit the opportunities for torrentfish to move upstream or downstream. As the extent of river drying increases it will also impact on the habitat quality of reaches and the ability of areas of the Ashley River to support torrentfish. Furthermore, as this fish is a fast water riffle specialist it is also more vulnerable to habitat loss as flow drops than the pool and run dwelling fish species.

The aim of the of the water allocation limit is to restrict the additional drying of the Ashley River, to provide periods in the summer when flow connection is present allowing the fish migration to occur. Given our current state of knowledge on torrentfish migratory behaviour is limited we do not know the effect of delaying downstream migration, and there is the potential on dry summers or with high water allocation that females in the upper reaches are prevented from migrating downstream to spawn. In addition, as the extent of drying increases with water abstraction permanent torrentfish habitat in the mid reaches is lost. This will have direct impacts on the male torrentfish habitat and will also lead to migrating individuals being trapped and stranded in the drying reaches.

An additional impact of river drying is that it inhibits the upstream migration of juvenile fish. Male fish do generally inhabit the lower and mid-reaches of rivers and juvenile female fish migrate much further inland before settling to grow to adulthood. This segregated habitat and differential migration is believed to reduce intraspecies competition for food and habitat and allow female torrentfish to attain larger sizes with the associated benefits for fecundity that large size gives. Dry reaches that prevent the juvenile fish migration will lead to crowded torrentfish habitat in the lower reaches of the river and a reduction or absence of torrentfish from the upper reaches. It is also likely that female fish, both adult and juvenile individuals will suffer greater mortality as they are more exposed to stranding as they have to migrate through the drying reaches. Disproportional mortality is likely and a resulting drop in torrentfish reproduction and survival will occur.

Chinook salmon

There is a small Chinook salmon run in the Ashley River and the individual fish will be seeking to move upstream from January to April each year. These large fish need water depths of 25 cm or deeper to migrate upstream. For much of the summer the natural low flows will restrict Chinook salmon migration. Water abstraction will increase the duration of the summer and early autumn restriction on upstream migration. Delays in migration can lead to a decline in salmon condition and early mortality. These factors reduce the spawning success of the salmon and will lead to a decline salmon population in the river.

Other fish species

The New Zealand Fish Database reports other migratory fish present in the mid and upper reaches of the Ashley River. Movement both upstream and downstream for other fish species will be occurring. Longfin eel, bluegill bully, common bully and black flounder are other species that will migrate upstream to the gorge and further. For longfin eel, the elver migration occurs between December and March and will be directly affected by river drying.

Allocation assessment

With respect to any analysis of the effect of different water allocation limits on river drying this should be restricted to assessing the change in the duration and extent of drying in the periods when fish species are migrating. The summer and autumn periods are the critical periods for fish migrations are occurring during low flow conditions. It is important to consider the potential effect of frequent short drying periods, when the river is connected fish can move up and downstream. However, water abstraction is likely to cause more rapid drying and if there are more short-term dry periods the potential for fish to be trapped and stranded in drying reaches increases. The 0.4 m^3/s to 0.5m^3/s recommendation for water allocation was made to protect the fish migrations. It also has the additional benefit to water abstractors of being a relatively reliable allocation. As the allocation increases reliability of supply will decrease.

If you have queries regarding this assessment please contact Richard Allibone by phone 03-4544849, 021 904950 or by email at waterwayscon@gmail.com.

Regards

Richard Allibone