BEFORE THE COMMISSIONER APPOINTED BY THE OTAGO REGIONAL COUNCIL

Consent No. RM20.039

IN THE MATTER of the Resource Management Act 1991

Applicant collectively referred to as the Pig Burn water user group (applicant).

STATEMENT OF EVIDENCE OF ROBIN JAMES PATRICK HOLMES ON BEHALF OF THE OTAGO FISH & GAME COUNCIL
7 SEPTEMBER 2021

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1 My full name is Robin James Patrick Holmes. I am a freshwater ecologist at Cawthron Institute.

2 I hold the qualifications of PhD and MSc (freshwater fisheries and macroinvertebrate ecology) from the University of Otago. I am a longstanding member of the New Zealand Freshwater Sciences Society.

3 Since, and during, my education I have accumulated 13 years' freshwater research experience at the Cawthron Institute, where I currently lead the River and Lake Ecology Team. I have specialist expertise in freshwater biomonitoring, ecological impact assessment and freshwater fish ecology and environmental flows. I have been involved in aquatic ecology environmental effects (AEE) assessments for major resource consent applications, including Meridian Energy's Mokihinui and Amuri hydroelectric projects and the Hawke's Bay Regional Council Ruataniwha Water Storage Scheme.

4 I have presented evidence to the Special Tribunal appointed to consider an application for a Water Conservation Order in the Ngaruroro, on behalf of Hawke's Bay Regional Council.

5 I have published 6 peer reviewed papers in the field of stream ecology, freshwater fisheries and stream habitat modification. I have been an expert panel member for the recent flow setting process in the Te Whanganui-a-Tara catchments (Hutt / Te Awa Kairangi, Wainuiomata and Orongorongo rivers) for Greater Wellington Regional Council. I have participated in regional and national ecological advisory roles, including leading an investigation into potential river habitat modification indicators for national monitoring (for the Ministry for the Environment). I have also led tasks under MBIE-funded research programmes.

6 I confirm that I have read and am familiar with the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014. I agree to comply with that Code. Other than where I state I am relying on the evidence of another person, my evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of Evidence

7 My evidence assesses the potential effects of the proposed abstraction regime on the instream ecology of the Pig Burn Stream. Specifically, I assess if the effects of the proposed abstraction regime are likely to be 'no more than minor' with respect to instream ecology.

8 In preparing my evidence, I have reviewed the following documents and evidence:

(a) The Application: Pig Burn collective replacement of permits to take and use surface water (Dicey 2020a)

(b) The Pig Burn water users formally amended application (Dicey 2020b)

(c) Management flows for aquatic ecosystems in the Pig Burn (Xiaofeng and Ravenscroft 2016).

(d) Technical Memorandum: review of hydrological assessments for the resource consent application by the Pig Burn water users (Veendrick 2020).

(e) Statement of evidence of Richard Mark Allibone on behalf of Otago Regional Council, appended to the s42A report (Allibone 2021).

(f) Statement of evidence of Matt Hickey on behalf of Pig Burn water users group (Hickey 2021).

(g) Statement of evidence of Dean Antony Olsen on behalf of Pig Burn water users group (Olsen 2021).

(h) Statement of evidence of John William Hayes for the Otago Fish and Game Council and Central South Island Fish and Game Council in the matter of Plan Change 7 to the Regional Plan: Water for Otago (Hayes 2021).

~~(i) Cawthron Institute advice letter: Default minimum flow and allocation limits for Otago (Hayes et al. 2021).~~

~~(j)~~(i) Regional Water Plan: Plan Change 7 (Water Permits) (ORC 2020).

~~(k)~~(j) National Policy Statement for Freshwater Management (NPS-FM 2020).

Summary

9 My evidence considers the likelihood that adverse instream ecological effects will occur as a result of the allocation regime proposed for the Pig Burn (as presented by Dicey 2020b). I do not explicitly propose an alternative flow / allocation regime, however, I briefly discuss how an alternative flow regime could be determined using existing information.

10 My assessment of the likelihood of instream ecological effects leverages the flow setting framework provided by Hayes ~~et al.~~ (2021). This framework was developed to provide guidance for setting residual / minimum flows and allocation limits in the Otago region that are protective of instream ecology and related values. Values considered by the framework include: ecosystem health, instream habitat, life-supporting capacity, mahinga / mahika kai and fisheries amenity values.

11 The assessment framework compares the degree of flow alteration (under a current or proposed~~n~~ allocation regime) relative to the best estimate of the naturalised seven-day Mean Annual Low Flow (7d-MALF) for a given river or stream.

12 Based on the Hayes et al. framework, the proposed allocation regime for the Pig Burn is *extremely likely* to have *more than minor effects* on instream ecology. The applicants' proposed residual flow is around four-and-a-half to nine times lower than a default residual / minimum flow recommended by the Hayes ~~et al.~~ (2021) framework. Likewise, the proposed maximum take / allocation rate is an order of magnitude higher than an allocation rate that would be expected to have no more than minor adverse effects.

Pig Burn instream ecological values

13 I have been advised that under the proposed Otago Regional Council (ORC) Plan Change 7, the rules and policies provided in Sections 10A.2.1, 10A.2.3 and 10A.3.2.1 are relevant for determining the term of the applicants' consent, particularly regarding consideration of applications that may have more than minor adverse effects resulting from abstraction.

14 Below I first outline instream ecological values in Pig Burn and briefly describe key aspects of the applicants' proposed allocation regime. I will then show that the potential adverse effects under the current and proposed allocation regime are likely to be more than minor—with regards to instream ecology and related values.

15 The Pig Burn contains brown trout and longfin eels. There is some confusion over the occurrence of kākahi (freshwater mussels, *Echyridella menziesi*) and koura (freshwater crayfish, *Paranephrops zealandicus*). These two species are listed as present in Xiaofeng and Ravenscroft (2016); however, entries in the New Zealand Freshwater Fish database are recorded as 'n' which denotes 'not present' (as alluded to in Dicey 2020a). Hereafter I consider that kākahi and koura have not been observed in the Pig Burn.

16 The stream is not considered to have significant trout fishery values in its own right. However, it is thought to provide substantial spawning and juvenile rearing habitat to support the regionally significant fishery in the mainstem Taieri River (Xiaofeng and Ravenscroft 2016).

17 The presence of longfin eels is significant because this species is listed as 'At Risk: In decline' in the most recent freshwater fish threat classification document (Dunn et al. 2017). Furthermore, longfin eels (tuna) are of exceptionally high cultural importance as taonga and mahinga / mahika kai species (Egan et al. 2020). No other fish species have been observed in the catchment.

Key aspects of the flow and allocation regime

18 Xiaofeng and Ravenscroft (2016) estimated key flow statistics for the Pig Burn and provide a naturalised 7-day Mean Annual Low Flow (7d-MALF) estimate of 79 l/s. This estimate is in part based on flows from the neighbouring Sow Burn catchment because of the short flow record in

the Pig Burn (i.e., 6 years of monitoring in total). In the applicant's evidence, Hickey (2021) uses observed flows at the Pig Burn gorge (temporary) flow recording site to determine a 7-MALF of 53 l/s, an annual mean flow of 335 l/s and an annual median flow of 221 l/s. Hickey notes that 'minimal' abstraction occurs above the Gorge flow recording site, meaning that he considers observed flows at this point to be close to naturalised flows. Hickey (2021) identified segments within the Pig Burn that lose and gain water to ground longitudinally. He also shows that the flow of the Pig Burn at its confluence with the Taieri River is roughly equivalent to the flows at the Gorge recorder site, under a 'no-take' scenario during low flows (See Figure 4 in Hickey 2021).

19 The flow statistic estimates and longitudinal patterns in permanently flowing and ephemeral segments derived for the Pig Burn were reviewed by Veendrick (2020). He notes there is considerable uncertainty around these estimates because of the short flow record and complicated ground water-surface flow interactions. Nevertheless, Veendrick suggests the key flow statistic estimates were determined appropriately but should be interpreted with caution. Veendrick (2020) specifically notes that the naturalised 7d-MALF is likely to be 'slightly higher' than the observed 7d-MALF of 53 l/s used by Hickey (2021).

20 During 'low flows' the applicants are proposing to take a cumulative 262 l/s though a series of 8 takes and propose maximum take rates (allocation rates) of between 7 - 60 l/s at the various individual water takes. The definition of low flow with respect to the proposed allocation regime is not clearly defined in the application. At maximum rates of take, low flows could be flows that occur somewhere around the naturalised median flow and below, as measured at the flow recorder.[1] They also propose to leave a residual / minimum flow of 10 l/s below some of the abstraction points. The applicants also wish to take up to 110 l/s from Concept / Sophic South and Mulholland's proposed combined take point, when a residual flow of 200 l/s can be maintained to enable the filling of storage dams (Dicey 2020b).

[1] Calculated the maximum extent of 'low flows', defined by Hickey in the application (Dicey 2020b) as <70l/s flowing past the Herlihy Ford Take, by summing the maximum allocation sought at the Herlihy Gorge Take, the Weirs Take and the Herlihy Ford Take, plus a 70l/s residual at the latter. The total is 238l/s, which is between the naturalised median and mean flows calculated by Hickey.

21 While acknowledging that the proposed allocation regime significantly alters the natural hydrology of the Pig Burn, Hickey (2021) suggests that the proposed allocation regime will improve instream ecology—relative to the current allocation regime (status-quo) for the following reasons:

(a) The proposed allocation regime will increase the current (non-existent) residual flow by instating a residual / minimum flow of 10 l/s in parts of the Pig Burn.

(b) The length and duration of drying in the ephemeral reaches (caused, in part, because of current water abstraction activities) will be reduced under the applicants' proposed allocation regime.

(c) The proposed allocation regime will 'place a cap on abstraction' at low flows. In other words, instate a maximum allocation limit of between 7 and 60 l/s at the various abstraction points during low flows.

22 Hickey's and Olsen's (2021) assessments of hydrological and ecological effects are largely based on a comparison of the proposed allocation regime with the *status quo* allocation regime. They omit a detailed analysis of the alteration of flows relative to the *naturalised* flow regime. Hickey's comparison of hydraulic alteration, relative to naturalised flows, is largely limited to assessing the pattern of permanently flowing and ephemeral reaches (e.g. see Figure 4 of Hickey 2021).

23 Consideration of the severity of the ecological effects of any allocation regime requires an assessment of proposed flows relative to *naturalised flows,* as well as *status quo* flows, to determine how the ecosystem is, and will continue to be, affected. Below I suggest that the significant alteration of the Pig Burn hydrology, as proposed in the application, will in turn result in more than minor adverse effects on instream ecology.

Assessment framework for severity of instream ecological effects

24 To aid my assessment I have applied the flow setting framework provided by Hayes (2021) in his evidence for the ORC Plan Change 7. ~~This framework and rational was later refined by Hayes et al. (2021) in collaboration with leading hydrological and ecological flow experts from NIWA. These~~ This document~~s~~ provide~~s~~ guidance for setting residual / minimum flows and allocation limits in the Otago region that are

protective of instream ecology and related values. I personally endorse the rationale behind the framework.

25 The assessment framework is simple, it is based ~~solely~~ on the degree of flow alteration relative to the best estimate of the naturalised 7d-MALF for a given river or stream ~~(Appendix 1)~~. This approach is appropriate for guiding decisions about flows in small streams where there is often limited information on hydrology and / or instream ecology—such as the Pig Burn. The framework can also be used to gain a sense of the severity of ecological effects of an existing or proposed flow regime. The framework is based on the international presumptive environmental flow standards provided by Richter et al. (2012), proposed (New Zealand) National Environmental Standards (MFE 2008) and methods to determine ecological flows in Beca (2008). It adapts these frameworks to the Otago region using a risk-assessment approach.

26 Hayes ~~et al. ((~~2021) provide~~d~~ default residual / minimum flow and allocation rate~~s~~ limits (expressed as a percentage of the naturalised 7d-MALF), ~~-~~ that if exceeded, would indicate ~~a *low risk* of~~ an allocation regime that is likely to result~~ing~~ in more than minor effects on: ecosystem health, ~~instream habitat,~~ life-supporting capacity, mahinga / mahika kai and fisheries amenity values in Otago's streams / rivers (Table 1).

27 In the ~~third~~ right hand column of Table 1, the applicants' proposed residual flow and combined maximum allocation rate for the Pig Burn is expressed as a percentage of the naturalised 7d-MALF. The values are presented as a range, based on the different estimates of the naturalised 7d-MALF provided by Hickey (2021) and Xiaofeng and Ravenscroft (2016). This provides a lower and upper bound naturalised 7d-MALF estimate, respectively, ~~of the naturalised 7d-MALF~~ to account for uncertainty surrounding flow statistics in the Pig Burn.

Table 1. Adapted from Hayes ~~et al. (~~2021), *full table provided in Appendix 1*: ~~*Proposed default R*~~*residual / minimum flow and primary allocation limits, expressed as % of naturalised 7-d mean annual low flow (MALF),* *that if exceeded would cause* ~~*for maintaining flow regimes that present a low risk of*~~ *more than minor effects on instream ecological values. The right-hand column shows the deviation from the naturalised 7d-MALF that could occur under the applicants' proposed minimum flow and allocation limits. The deviation is presented as a range using two naturalised 7d-MALF estimates: 53 l/s and 79 l/s. This to account for uncertainty inherent within flow statistic estimates for the Pig Burn.*

Limit	Abstraction from surface water body with mean flow ≤500 l/s	Abstraction from permanently flowing reaches of intermittent streams Containing threatened indigenous species; Or Significant spawning and juvenile rearing habitat for regionally or nationally important salmonid fisheries downstream	**Proposed flows expressed as a percentage of the estimated range of the Pig Burn naturalised 7d-MALF**
Minimum / residual flow	Minimum flows (or residual flows) less than 90% of 7-day MALF	Minimum flows (or residual flows) less than 90% of 7-day MALF	13 – 19%
Allocation rate	flow allocations of more than 20% of 7-day MALF	flow allocations of more than 20% of 7-day MALF	332 – 494%

	~~Limit for surface water bodies with mean flow ≤ 500 l/s~~	~~Proposed flows expressed as a percentage of the estimated range of the Pig Burn naturalised 7d-MALF~~
~~Minimum Flow~~	~~>90% of naturalised 7d-MALF~~	~~13 – 19%~~
~~Allocation rate limit~~	~~<20% of naturalised 7d-MALF~~	~~332 – 494%~~

28 Based on the Hayes (2021)~~et al.~~ framework, the proposed allocation regime for the Pig Burn is *extremely likely* to have *more than minor effects* on instream ecology. The applicants' proposed residual flow is around four-and-a-half to nine times lower than a default residual /

minimum flow recommended by the ~~Hayes et al. (2021)~~ framework. Likewise, the proposed allocation rate is an order of magnitude higher than an allocation rate that would be expected to have no more than minor adverse effects. I am not aware of any information regarding the ecology of Pig Burn that would suggest that this stream is exceptionally resilient to the effects of extremely high levels of water abstraction or extremely low minimum flows.

Potential effects of abstraction on instream ecology in the Pig Burn

29 Allibone (2021) assessed the consent application on behalf of ORC; I agree with his suggestion that flood flows in the Pig Burn will largely be unaffected by the proposed abstraction regime. Accordingly, channel forming flows, as well as flows sufficient to flush periphyton and fine sediment ought to be maintained under the proposed abstraction regime. Furthermore, the winter flow provisions mean that from the 1st of May till spring, around the time trout spawn in the catchment, fish passage and spawning habitat will be maintained. However, the upstream spawning migration of adult trout can occur in April (Smith 2014). It is possible that adult trout passage will be impeded by the lower drying reach during this period.

30 The principal effect of the large allocation and low residual flow will be a reduction in the amount and quality of available habitat for macroinvertebrates and fish during low to mid-range flows (from spring through to the onset of winter). The capacity of the river to transport macroinvertebrates and other particles and seston (drift transport capacity) will also be severely diminished under flow reductions of this magnitude. This will reduce feeding opportunities for juvenile trout rearing in the stream. The large allocation limit will also affect flow variability over low to mid-range flows; the river could effectively be 'flatlined' for substantial periods (weeks to months). This is likely to have more than minor adverse effects on fish growth and survival. If stream habitat area is reduced for extended periods, river fish are subject to increased competition and predation (Hayes ~~et al.~~ 2021). In turn, these effects will impact the ability of the Pig Burn to provide recruitment to the regionally significant fishery present in the Taieri River.

31 There is not enough information to determine if the Taieri River trout fishery is recruitment limited and therefore necessarily impacted by the current and proposed abstraction regime in the Pig Burn. A study to

determine if the trout population in the Taieri River is recruitment limited would be beyond the resources available to the OF&GC. Nevertheless, a reduction in the supply of recruits from the Pig Burn could reduce the resilience of the main-stem fishery. Fisheries with high levels of recruitment are better able to withstand both angling pressure and the adverse effects of land use pressures. If the reduced flow and recruitment potential of the Pig Burn is considered in conjunction with effects occurring in other heavily abstracted tributaries, the proposed allocation regime may be contributing to the cumulative effects of land use and abstraction within the wider Taieri River catchment.

32 The amount of habitat available for longfin eels will be substantially reduced under the current and proposed allocation regime—relative to the natural flow regime. During the day, large longfin eels prefer deep water with structural cover where they seek refuge. During the night, they use relatively shallow and productive riffle habitat to feed (Jowett and Richardson 2008, McDowall 1990). Both these habitat types, particularly the latter, will be reduced substantially under the current and proposed abstraction regime. Reduced habitat for eels was also indicated by both Allibone (2021) and Xiaofeng and Ravenscroft (2016).

Ecosystem health and Te Mana o te Wai

33 The NPS-FM provides guidance how to consider ecosystem health, as well as a hierarchy of obligations under the principle of Te Mana o te Wai. Interpretation of these concepts within a resource management setting is an ongoing process. However, it is hard to imagine a scenario where an allocation limit ~~and a residual flow~~ in the order of 300-400% of the naturalised 7d-MALF and a residual flow of 10-20% of the 7d-MALF ~~of the naturalised 7d-MALF (respectively)~~ prioritises first, the health and well-being of water bodies and freshwater ecosystems.

34 In my opinion the current and proposed allocation regime will have more than minor adverse effects on aquatic ecosystem health. The NPS-FM also directs that habitat of trout (and salmon) are protected (Policy 10), as long as this is consistent with the protection of indigenous species habitat (Policy 9). In the case of the Pig Burn, protecting the habitat of trout is consistent with protecting the habitat of indigenous species. The current and applicants' proposed allocation regime is likely to have more than minor adverse effects on the habitat of both trout and longfin eels.

35 I have shown that the current and proposed allocation regime can be considered extremely likely to be having adverse effects with respect to instream ecology. The high allocation rate and low residual flow does not seem consistent with putting the ecological needs of the river first. I understand this to be highly relevant when considering the hierarchy of obligations under Te Mana o te Wai.

Consideration of alternative flows in the Pig Burn

36 Relative to the *status quo* allocation regime, I acknowledge that the proposed abstraction regime may result in improvements to ecosystem health in the Pig Burn. The application, as presented in Dicey (2020a and b), represents a small step towards flows that are protective of instream values. A residual flow and an allocation limit will be put in place, these limitations have been absent in the past. However, the gulf between the current and proposed allocation regime and an allocation regime that is likely be protective of ecosystem health is extreme—as shown in Table 1. This gives me confidence in my assessment that there is, and will continue to be, more than minor adverse effects on instream ecology if the consent is granted as proposed. This assessment can be made without needing to invoke more complicated methods of determining potential effects of abstraction, such as instream flow-habitat modelling.

37 That said, flow-habitat modelling has been undertaken for the Pig Burn by Xiaofeng and Ravenscroft (2016). While there may be considerable uncertainty regarding the accuracy of this modelling, I suggest that this study could still be used to guide decisions on a flow regime that is more protective of ecological values. Reassuringly, Xiaofeng and Ravenscroft (2016) recommend a residual flow of 46 l/s. This is close to a residual flow that would be considered protective of ecosystem health under the Hayes ~~et al. ((~~2021) framework (i.e. a residual flow that is at least 90% of the naturalised 7d-MALF). Applying the Hayes ~~et al. ((~~2021) framework to the Pig Burn, using the applicants' naturalised 7d-MALF of 53 l/s, gives a recommended residual flow of 48 l/s.

38 In his statement of evidence, Allibone (2021) considers the hydrological information and flow-habitat modelling results for the Pig Burn. He suggests a staged approach towards a residual flow of 30 l/s. Based on the information available, I support consideration of a residual flow in the order of 30 to 50 l/s. However, in addition to a higher residual flow, a

lower allocation rate (that is closer to that recommended by the Hayes ~~et al.~~ (2021) framework) is required before the water allocation regime could be considered to have no more than minor effects on instream ecology.

39 As a matter of conscience, I understand that a higher residual flow and lower allocation rate would reduce the security of water supply for landowners. I would support a planning process that is compassionate towards the needs of the catchment's farmers, for example, one that takes a staged approach to instating flows that are more protective of ecological values.

Robin Holmes

7 September 2021

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Appendix 1. The f~~F~~ull '~~O~~one page summary' and table excerpt from the Hayes (2021) framework for setting minimum flows in the Otago region, provided as Plan Change 7 evidence.

I (John Hayes) provide in the table below default minimum flow and allocation limits for regional water plans, based on the values and risk-based framework commonly applied in assessing environmental flows. The limits are intended for the test of "more than minor effects" on life-supporting capacity, ecosystem health, mahika kai and fisheries amenity. The limits are based on percentage of MALF, but the minimum flow limits could also be applied to flow-related habitat and/or ecological flow relationships where these have been determined.

Table. Minimum flow and allocation limits that would cause more than minor flow alteration and effects on habitat, life-supporting capacity and ecosystem health[2].

Limit	Abstraction from surface water body with mean flow ≤5m³/s	Abstraction from surface water body with mean flow >5 m³/s	Abstraction from permanently flowing reaches of intermittent streams	
			Containing threatened indigenous species; Or Significant spawning and juvenile rearing habitat for regionally or nationally important salmonid fisheries downstream	**Not containing threatened indigenous species; Or significant salmonid spawning and juvenile rearing habitat**
Minimum / residual flow	Minimum flows (or residual flows) less than 90% of 7-day MALF	Minimum flows (or residual flows) less than 80% of 7-day MALF	Minimum flows (or residual flows) less than 90% of 7-day MALF	Minimum flows (or residual flows) less than 80% of 7-day MALF
Allocation rate	flow allocations of more than 20% of 7-day MALF	flow allocations of more than 30% of 7-day MALF	flow allocations of more than 20% of 7-day MALF; Or > 15% instantaneous flow at point of take if MALF estimates cannot be made	flow allocations of more than 25% of 7-day MALF; Or > 20% instantaneous flow at point of take if MALF estimates cannot be made

[2] Table caption amended from the original PC7 evidence on receiving advice from John Hayes. The original table caption read: "Proposed minimum flow and allocation limits for avoiding more than minor flow alteration and effects on habitat, life-supporting capacity and ecosystem health". The original caption contained a mistake in reference to 'avoiding' effects. The intent of the caption and table was to present limits that if exceeded would *cause* more than minor effects. This matter was addressed during the PC7 hearing.