BEFORE THE COMMISSIONER APPOINTED BY THE OTAGO REGIONAL COUNCIL

Consent No. RM20.039

IN THE MATTER of the Resource Management Act 1991 ("the Act")

VARIOUS – COLLECTIVELY REFERRED TO AT THE PIGBURN WATER USER GROUP

Applicant

BRIEF OF EVIDENCE OF DEAN ANTONY OLSEN ON BEHALF OF PIG BURN WATER USERS GROUP

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STATEMENT OF EVIDENCE OF DEAN ANTONY OLSEN

1. My name is Dean Antony Olsen.

2. I am the owner-operator of Freestone Freshwater, a freshwater science consultancy based in Dunedin.

3. I hold the degrees of B.Sc. (Honours I) in Zoology and Ph.D. in Zoology, both from the University of Otago. Riverine macroinvertebrate communities were the primary focus of both my Honours[1] and Ph.D.[2] theses. I am a member of the New Zealand Freshwater Sciences Society.

4. I worked at the Otago Regional Council from 2013 to 2018. I was the Manager of the Resource Science team between 2015 and 2018. Prior to that, I was a Water Resource Scientist and spent approximately half of my time on water allocation and half on water quality. While at ORC, I led several studies that were intended to support policy development, specifically minimum flow setting, including reports on management flows and water quality. I also undertook numerous technical assessments of applications to replace deemed permits and other resource consents.

5. My first job in freshwater ecology was as a summer Research Assistant in the Zoology Department, assisting on a wide range of projects in the field and laboratory in the summers from 1995 until I began my Ph.D. in 1999. In this role, I undertook numerous macroinvertebrate surveys and processed hundreds of macroinvertebrate samples in the laboratory.

6. After completing my Ph.D. in 2003, I worked for two years as a Post-Doctoral Research Associate at the University of Vermont in Burlington, Vermont, USA on a USDA-funded project considering the effects of agricultural pollutants on macroinvertebrates.

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[1] Olsen DA (1998). Investigating the hyporheic fauna in a gravel-bed stream: Influence of channel geomorphology, sediment structure and sampling technique. Honours Dissertation. University of Otago, Dunedin.
[2] Olsen DA (2003). Patchiness in the Hyporheic Zone of a Gravel-Bed Stream: Roles of Disturbance, Vertical Hydrological Exchange and Physicochemistry. PhD Thesis. University of Otago, Dunedin.

7. I worked as a Freshwater Scientist at the Cawthron Institute in Nelson between 2005 and 2011, where I led the Macroinvertebrate and Biomonitoring team. Following that I was an Associate Director at Ryder Consulting (2011-2013) and Ryder Environmental (2018-2020).

8. I have given evidence at numerous hearings, including four before the Environment Court (Arnold, Wairau, Lindis & ORC's Plan Change 7) and one before a Special Tribunal (Nevis). At these hearings, I have been an expert witness for a range of clients, including farmers, large hydro-electricity companies, Fish & Game Councils (including Otago Fish and Game Council) and the Department of Conservation.

9. I have worked on a variety of projects assessing the effects of flow diversion or abstraction on stream ecology including reviews of assessments of hydroelectric schemes in the Wairau[3] and Arnold Rivers[4] and investigations of the effects of diversions from rivers in the upper Waitaki Catchment[5]. I led assessments for a major hydro-electric power scheme in the Central North Island (although this scheme has not been announced publicly) and was first author of the report presenting assessments of the effects of Meridian Energy's Amuri Hydro Project on aquatic communities in the Waiau River in North Canterbury[6].

10. I was also lead author of a review of information on the effects of water temperature on aquatic biota for Auckland Council, Hawkes Bay Regional Council and Waikato Regional Council[7].

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[3] Olsen (2006). Macroinvertebrates of the Wairau River and the likely consequences of proposed hydro-electric development. Prepared for the Department of Conservation, Nelson-Marlborough Conservancy. *Cawthron Report No. 1124.* 22 p.

[4] Olsen DA; Hay J, Strickland RR, Hayes JW 2006. A Review of the Arnold River Hydro-Electric Power Scheme Assessment of Environmental Effects. Prepared for the Department of Conservation, West Coast, Tai Poutini Conservancy. *Cawthron Report No. 1228*. 24 p.

[5] Olsen DA 2009. Ecological Effects of a Micro-Hydro-Electric Power Scheme on Station Stream. Prepared for Lilybank Station Ltd. *Cawthron Report No. 1556*. 4 p; Olsen DA 2008. Station Stream Ecological Survey. Prepared for Lilybank Station. *Cawthron Report No.* 1438. 16 p.; Olsen DA 2008. Mistake River Ecological Survey. Prepared for Lone Star Godley Peaks. *Cawthron Report No. 1437*. 19 p.

[6] Olsen D, Maxwell I, Holmes R, Hay J, Allen C, Doehring K, Hayes J, Young R 2011. Assessment of the Amuri Hydro Project on the Waiau River, North Canterbury. Prepared for Meridian Energy Ltd. Cawthron Report No. 2011. 129 pp. plus appendices

[7] Olsen, Tremblay, Clapcott & Holmes (2012). Water temperature criteria for native aquatic biota. Auckland Council Technical Report 2012/036.

11. I have published thirteen scientific papers in peer-reviewed international journals and one peer-reviewed report in the Department of Conservation *Research & Development Series*. I have peer-reviewed manuscripts for a wide range of international scientific journals.

12. I have been given a copy of the Environment Courts code of conduct for expert witnesses. I have reviewed that document and confirm that this evidence has been prepared in accordance with it and that all opinions that I offer in this evidence are within my expertise. I have not omitted to refer to any relevant document or evidence except as expressly stated. I agree to comply with the code and in particular to assist the Commissions in resolving matters that are within my expertise.

Scope of Evidence

13. This brief of evidence addresses the following:

    1. Fish community of the Pig Burn.

    2. Macroinvertebrates of the Pig Burn.

    3. Assessment of the proposed environmental flow regime.

Hydrological setting

14. Mr Matt Hickey has provided detailed hydrological evidence for this hearing, and I will not duplicate that here. However, the hydrology of the Pig Burn is an important part of the environmental settings for the proposed activities, so I will briefly summarise aspects of the hydrology of the Pig Burn that I believe are relevant to the assessment of the ecological impacts of the application.

15. The upper reaches of the Pig Burn are perennial, but there are two losing reaches: the upper losing reach between the Gorge flow site and

Hamilton Road Ford and a lower losing reach downstream of the Patearoa-Waipiata Road Bridge.

16. The 7-d mean annual low flow at the Gorge flow monitoring site is 53 l/s, and the naturalised 7-d MALF is estimated to be approximately 2 l/s higher than this value.

17. The complexity of the surface water-groundwater interactions in the reach downstream of the Gorge flow site means that the 7-d MALF for areas downstream will be lower than this value and may be zero (dry).

18. During our surveys on 18 March 2020, I took aerial photographs and video of the drying reaches upstream of Hamilton Road (Figure 2-Figure 4), immediately downstream of the Patearoa-Waipiata Road bridge (Figure 6) and downstream of a lane off Pig Burn Road (Figure 7, Figure 8). The locations of these images are shown in Figure 1.

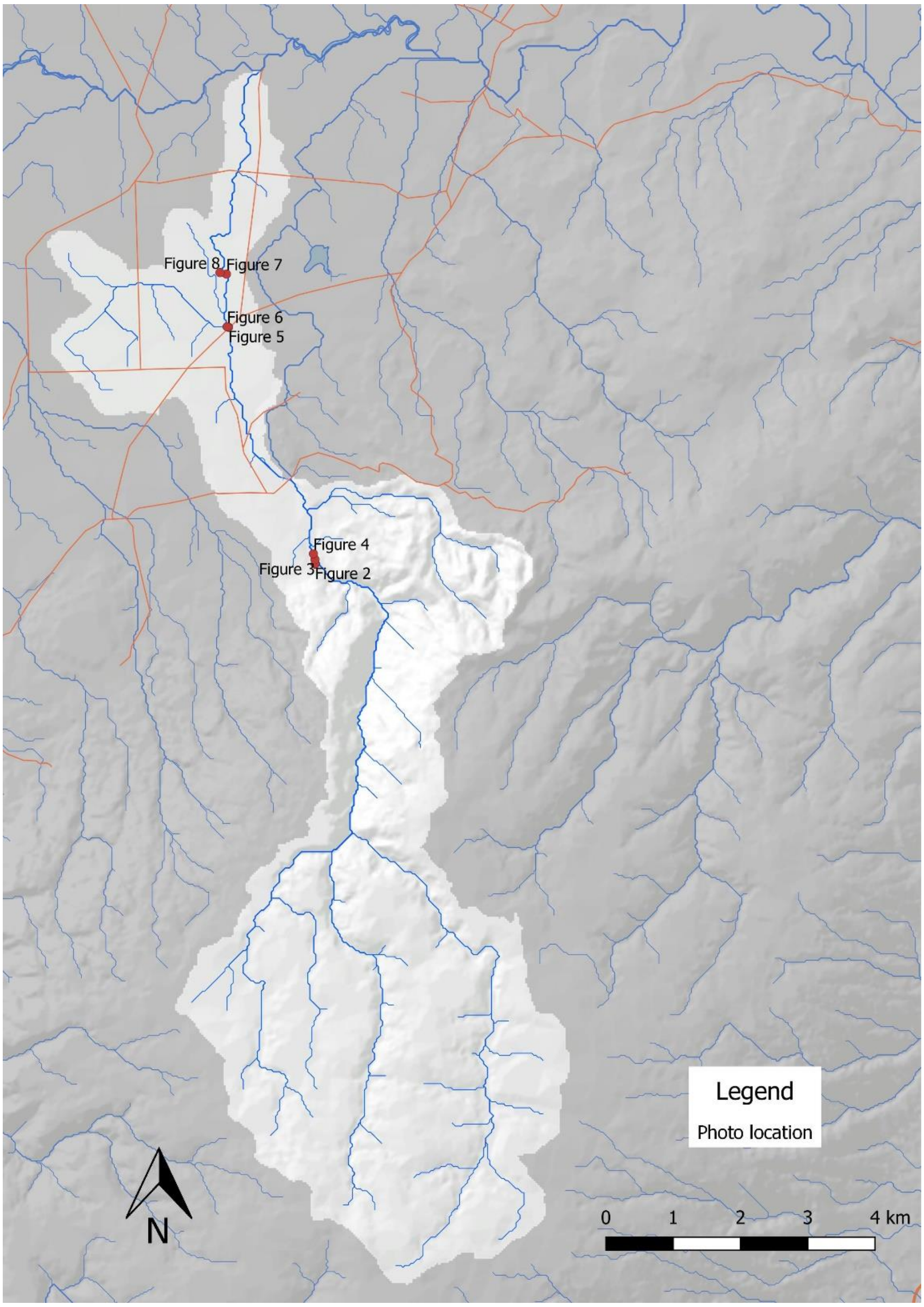

Figure 1 Locations of aerial photographs of drying reaches of the Pig Burn on 18 March 2020.

Figure 2 Aerial photograph of the upstream end of the upper drying reach of the Pig Burn on 18 March 2020. This is the area where flows became disconnected. Flow direction is from the bottom-left to the top-right of the frame.

Figure 3 Aerial photograph of the upstream end of the upper drying reach of the Pig Burn on 18 March 2020. Flow direction is from the bottom to the top of the frame. This photo is taken approximately 60 m downstream of Figure 2 and shows the point at which flows completely ceased.

Figure 4 Aerial photograph of the downstream end of the upper drying reach of the Pig Burn on 18 March 2020. Flow direction is from the bottom to the top of the frame.

Figure 5 Aerial photograph of the Pig Burn at the Patearoa-Waipiata Road bridge (visible at the top of frame) on 18 March 2020. Flow direction is from the top to the bottom of the frame.

Figure 6 Aerial photograph of the upstream end of a drying reach of the Pig Burn immediately downstream of the Patearoa-Waipiata Road bridge on 18 March 2020. Flow direction is from the top to the bottom of the frame.

Figure 7 Aerial photograph of the upstream end of the lower drying reach of the Pig Burn on 18 March 2020. Flow direction is from top to bottom.

Figure 8 Aerial photograph of the downstream end of the lower drying reach of the Pig Burn on 18 March 2020. Flow direction is from left to right. Two isolated pools are evident on the left hand side of the frame, while continuous flow was evident from the area in the middle of the frame downstream to the confluence with the Taieri River.

Fish community of the Pig Burn

19. Longfin eel and brown trout are the only two fish species to have been recorded from the Pig Burn catchment. No non-migratory galaxiids have been collected from the Pig Burn, despite Mr Hickey and I undertaking targeted surveys in the upper catchment (upstream of the gorge).

20. Longfin eel (*Anguilla dieffenbachii*) have been collected from the lower Pig Burn (Figure 9) and from the Taieri mainstem. Longfin eels are classified as "at risk, declining"[8].

21. Brown trout (*Salmo trutta*) are widely distributed in the Pig Burn catchment downstream of the Gorge hydrological site (Figure 9). Schedule 1A of the Regional Plan: Water identifies trout spawning, juvenile rearing and the significant presence of trout as ecosystem values supported by the Pig Burn.

22. The Pig Burn flows into the upper Taieri River and will contribute to recruitment to the broader upper Taieri River fishery. The upper Taieri River (above Kokonga) is recognised as a regionally significant trout fishery[9], with 5,080 angler days recorded in the 2014/15 season[10].

[8] Dunn et al. (2018). Conservation status of New Zealand freshwater fishes, 2017. New Zealand Threat Classification Series 24. Department of Conservation, Wellington. 11 p.
[9] Otago Fish & Game Council (2015). Sports Fish and Game Management Plan for Otago Fish and Game Region 2015-2025. Otago Fish & Game Council, Dunedin.
[10] Unwin (2016). Angler usage of New Zealand lake and river fisheries: Results from the 2014/15 National Angling Survey. Prepared for Fish & Game New Zealand. NIWA Client Report 2016021CH. NIWA, Christchurch.

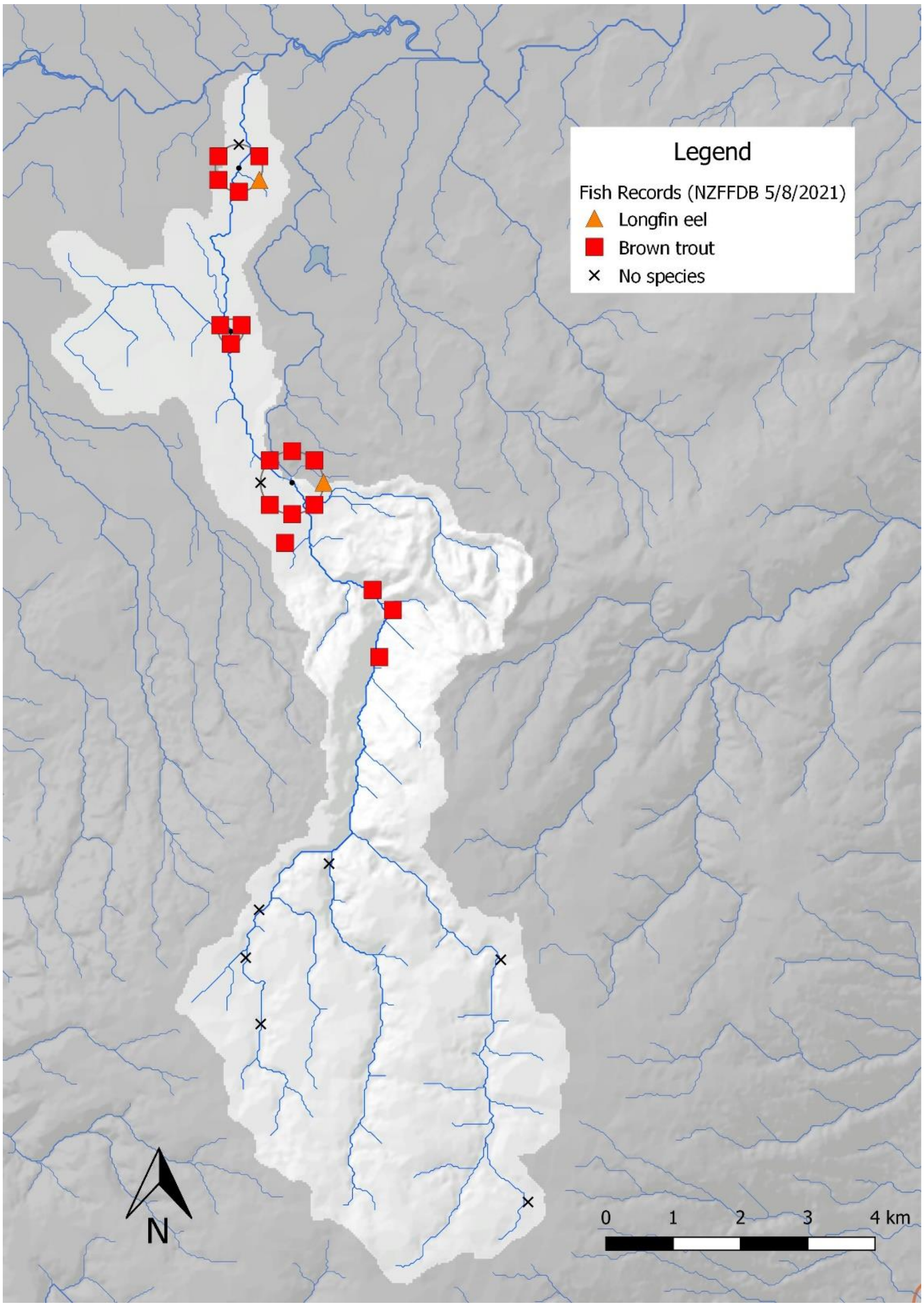

Figure 9 Distribution of fish in the Pig Burn catchment.

Macroinvertebrates of the Pig Burn

23. The diversity and abundance of EPT[11] taxa is used as an indicator of water quality as EPT taxa are typically associated with sites with good water quality. This is particularly the case for stoneflies, which are usually found in sites with cold, well-oxygenated water and good water quality. The exception to this are the micro-caddis flies (Hydroptilidae[12]), which can be extremely abundant in enriched streams when algae and macrophytes are abundant.

24. Macroinvertebrate samples were collected from two sites in the Pig Burn as part of ecological surveys undertaken in tributaries of the upper Taieri[13]. The upper sampling site in the Pig Burn was upstream of Hamilton Road while the lower site was close to its confluence with the Taieri River.

25. These surveys found that the macroinvertebrate community at the upper Pig Burn site was dominated by EPT taxa (65%) and the macroinvertebrate community was indicative of excellent water and habitat quality (MCI=134, SQMCI≈8). In comparison, EPT taxa were also abundant (~45%) at the lower Pig Burn site, but the MCI score for this site was indicative of fair water/habitat quality (~95) while the SQMCI was indicative of excellent water and habitat quality (SQMCI≈7).

26. Habitat quality, particularly gravel size is significantly different between Hamilton Road and the lower Pig Burn with large course gravel at the top site and fine gravels downstream.

27. The apparent discrepancy between the MCI and SQMCI scores for the lower Pig Burn site suggests that sensitive taxa (i.e. EPT taxa) were abundant at this site. In this case, it is my opinion that SQMCI better reflects the "health" of the macroinvertebrate community in the Pig Burn.

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[11] E = Ephemeroptera (mayflies), P = Plecoptera (stoneflies) and T = Trichoptera (caddis flies). These three orders are typically associated with clean, oxygenated water and are favoured prey for trout.
[12] In New Zealand, this family of caddis flies includes the genera *Oxyethira* and *Paroxyethira*
[13] Kitto. J. 2012. Water quality and ecosystem health in the Upper Taieri.

Instream habitat modelling

28. Golder Associates (2008) present the results of instream habitat modelling undertaken in the reach downstream of Hamilton Road. It should be noted that during the pre-hearing meeting, Dr Allibone, the author of this report, stated *"that the habitat model should not be relied upon as it has a lot of errors."*[14]. Given this, little weight should be given to the results of instream habitat modelling, and I present it here for the sake of completeness.

29. The Pig Burn habitat model predicts that habitat for large longfin eels (>300 mm) is highest between 50-200 l/s, while habitat for small longfin eels (<300 mm) rose across the modelled flow range (0-800 l/s).

30. The instream habitat modelling predicts that habitat for brown trout is greatest at flows between 150-300 l/s for spawning, 150 l/s for fry and 150-200 l/s for yearlings.

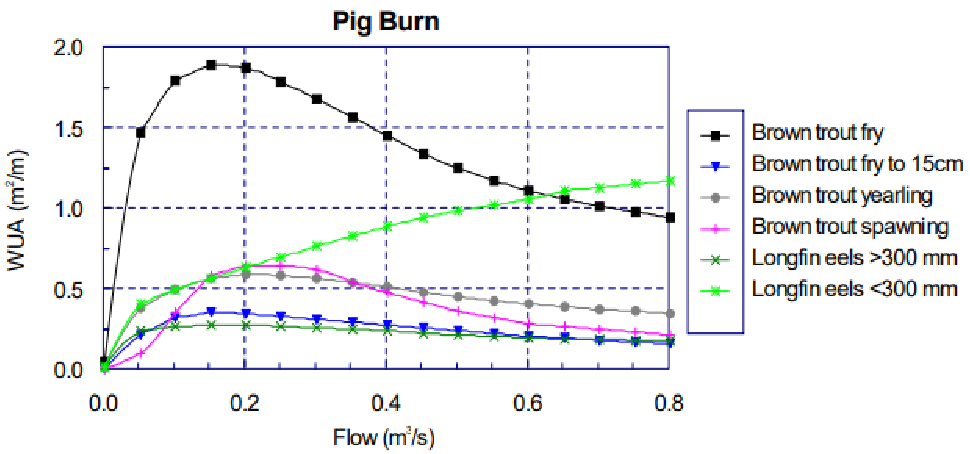

Figure 10 Relationship between habitat (WUA, m^2/s) and flow in the Pig Burn from Golder Associates (2008).

31. In the Section 42A report, when justifying an increase in the residual flow from 10 l/s to 20 l/s, Ms King cites Dr Allibone, stating *"The*

[14] Report on a pre-hearing meeting on 30 July 2020 at OtagoRegional Council's offices, 70 Stafford Street, Dunedin. Resource consent application RM20.039.

existing habitat model has been built to model this reach and the 10 L/s residual flow provides little habitat for any fish species.”. This statement is inconsistent with Dr Allibone’s position that *“that the habitat model should not be relied upon as it has a lot of errors.”*[15].

Assessment of proposed environmental flow regime

32. The proposed environmental flow regime will reduce the abstraction pressure in the Pig Burn compared with existing abstraction.

33. Habitat modelling suggests that at flows of less than 150 l/s, habitat for both brown trout and longfin eels will increase with increasing flow. Therefore, based on the hydrological analysis presented by Mr Hickey, the proposed environmental flow regime is predicted to enhance habitat compared with existing flows.

34. Given the complexity of surface water-groundwater interactions downstream of the Gorge flow site, the natural baseline of habitat will vary depending on location. This makes it extremely difficult to assess what the environmental outcomes may be for different locations at different residual flows.

35. Both drying reaches appear to dry naturally, with the upper drying reach drying naturally more frequently and for longer than the lower losing reach as the losses are up to twice that of the lower losing reach. Therefore, both these reaches have reduced habitat value for aquatic species during low flows than perennial reaches.

36. Based on the hydrological analysis provided by Mr Hickey at inflows below 168 l/s, the proposal will result in a substantial increase in flow, and consequently habitat availability, in the section between the Weir take and Combined Take relative to existing flows.

37. While the predicted increase in flow between the Combined Take and the Patearoa-Waipiata Road Bridge is less than in the reach

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[15] Report on a pre-hearing meeting on 30 July 2020 at Otago Regional Council’s offices, 70 Stafford Street, Dunedin. Resource consent application RM20.039.

immediately upstream, it is also expected to improve habitat over the existing flow regime.

38. The proposed flow conditions will not affect habitat availability in the lower drying reach a short distance below the Patearoa-Waipiata Road Bridge, as it will continue to dry at the flows considered.

39. In the downstream gaining reach down to the Taieri confluence, the proposed regime will improve instream habitat for brown trout and longfin eels relative to existing flows.

40. Passage for brown trout will be similar or slightly enhanced relative to existing flows due to the predicted higher flows maintaining or increasing water depths. However, drying reaches will restrict passage into and out of some reaches, with only those below the lower drying reach able to migrate to the Taieri River during flows of less than the median flow.

41. The effects of increasing the residual flow at the Combined Take to provide for habitat downstream is complicated by the surface water-groundwater interactions downstream. A higher residual may provide more habitat immediately downstream of the take, but it is unclear whether this positive effect will extend below the lower drying reach.

42. Given that Dr Allibone considers his model for the Pig Burn to be unreliable, only general statements can be made regarding the likely relationship between flow and instream habitat. Habitat for juvenile trout is likely to increase with increasing flows across the low flow range.

43. Based on this, I expect an increase in residual flow from 10 l/s to 20 l/s would provide more habitat for all life stages of brown trout and longfin eel in the reach immediately downstream of the combined take, but this benefit would extend less than 400 m downstream of this take and less than 200m further than the proposed residual flow[16]. I do not expect an

[16] Based on Paragraph 26 of Mr Hickey's evidence in chief.

increase in residual flows at the Combined Take to affect flows downstream of the lower drying reach.

44. An increase in residual flow downstream of the Kirkwood North take (referred to as Concept Farms in the s.42A report) would increase habitat for brown trout in the short segment between this take and the confluence with the Taieri, although I do not anticipate any effect to meaningfully increase juvenile recruitment from the Pig Burn to the upper Taieri. There is an abundance of tributaries that provide trout spawning habitat for the upper Taieri, and I have not seen any information that indicates that the trout fishery of the upper Taieri is recruitment limited. In addition, I note that the deemed-permit renewal process has provided environmental flows on major tributaries that have previously not had any, such as the Kye Burn and Sow Burn.

45. I do not anticipate that an increase in residual flow will meaningfully affect habitat for longfin eel in the lower Pig Burn, given that large eels prefer pool habitats and I expect pool habitat to be very similar at these flows.

Fish Screening

46. I generally agree with the fish screening recommendations of Dr Allibone in the Section 42A report. Fish screens are not necessary on the shared take above the gorge, due to the lack of fish.

47. The mesh screen on the Bradfield/En Hakkore Take is likely adequate given the small size of the take relative to the flow.

48. I concur with the recommendation for the Herlihy Gorge Take and the Weir Take is *"Less substantial fish screens may be more appropriate at these locations. These screens should be capable of preventing the majority of juvenile salmonids entering the takes".*

49. As for the Herlihy Ford and Combined Take, these takes feed into the East Side Race, which flows into the Mathias Dam and other smaller dams along the race which support trout fisheries, so juvenile trout

entrained by these takes will contribute recruits to these fisheries. This, along with the uncertain fate of downstream passage given the drying reaches downstream of these takes at low flows, leads me to recommend that fish screens are not required on these takes.

50. I support Dr Allibone's recommendation for 3 mm screens on the lower take (Kirkwood North), with appropriate design parameters (approach & sweep velocities) to prevent the entrainment or impingement of small fish.

Summary

51. The Pig Burn naturally has both a perennial and losing/drying reaches. The upper and lower losing reaches are expected to frequently be dry, particularly in summer.

52. The macroinvertebrate community of the upper Pig Burn indicates excellent water and habitat quality. The macroinvertebrate community of the lower Pig Burn is numerically dominated by sensitive taxa and is generally consistent with good water and habitat quality.

53. The proposed environmental flow regime will provide for more habitat in the lower Pig Burn than existing flows and will particularly enhance flows/habitat availability for trout and longfin eels in the section from just upstream of Hamilton Road down to the Patearoa-Waipiata Road bridge compared to existing flows.

54. The proposed environmental flow regime will maintain or enhance existing fish passage, although only those fish that are below the lower drying reach will be able to migrate to the Taieri River during flows of less than the median flow.

55. There is an abundance of tributaries that provide trout spawning habitat for the upper Taieri, and I have not seen any information that indicates that the trout fishery of the upper Taieri is recruitment limited. Recent environmental flows on other major tributaries are expected to

improve recruitment to the upper Taieri compared with historical conditions.

56. I generally agree with the fish screening recommendations in the Section 42A report, although I suggest that given that the Herlihy Ford Take and the Combined Take flow into the East Side Race (and therefore into Mathias Dam) and the uncertain fate of downstream passage given the drying reaches downstream of these takes at low flows, fish screens are not required on these takes.

Dr Dean Olsen

27 August 2021

References

Dunn NR, Allibone RM, Closs GP, Crow SK, David BO, Goodman JM, Griffiths M, Jack DC, Ling N, Waters JM, Rolfe JR (2018). Conservation status of New Zealand freshwater fishes, 2017. New Zealand Threat Classification Series 24. Department of Conservation, Wellington. 11 p.

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