

**BEFORE THE COMMISSIONERS ON BEHALF OF  
THE OTAGO REGIONAL COUNCIL**

Water Permit Application No. RM19.151

**BETWEEN**

BTS GT LIMITED AND THE A.P.  
MCQUILKIN FAMILY TRUST

**Applicant**

**AND**

OTAGO REGIONAL COUNCIL

**Consent Authority**

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**EVIDENCE OF BRYONY MILLER**

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## **Introduction**

1. My full name is Bryony Miller.
2. I am a Principal Freshwater Ecologist at e3Scientific Limited. I hold the following tertiary qualifications; a Bachelor of Applied Science in Environmental Science from AUT and a Diploma in Marine Science from Toi Ohomai Institute of Technology.
3. I am currently employed as the Technical Director of Freshwater and Marine Ecology at e3Scientific Ltd (e3s) whereby I have completed numerous ecological technical reviews of resource consent applications on behalf of the Otago Regional Council. These include applications for water take, instream works, discharge to waterways, and removal of benthic habitat among others. I have also been involved in completing ecological assessments and impact assessments for freshwater developments such as marinas and wharves and proposed water takes. I have prepared ecological evidence for hearings and provided expert technical evidence at Environment Court.
4. I have over 12 years' experience providing ecological assessments in the freshwater and marine environs predominantly within the Otago, Southland and Bay of Plenty catchments and prior to working for e3s was employed by Fisheries New Zealand (FNZ), NZ Marine Science Centre, Antarctica NZ and the Institute of Geological and Nuclear Sciences (GNS Science).
5. I confirm that I have read and agree to comply with the Environment Court Code of Conduct for Expert Witnesses (Consolidated Practice Note 2014). This evidence is within my area of expertise, except where I state that I am relying on the evidence or information provided by other parties. I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

## **Scope of Evidence**

6. My evidence addresses:
  - An assessment of the ecological values identified in the Royal Burn and New Chums Creek.
  - An assessment of the hydrological characteristics regarding the ecology of Royal Burn and New Chums Creek.
  - Consideration of fish screens.

- Considerations for residual flows at point-of-take on the Royal Burn and New Chums Creek.
- A brief site visit undertaken on 13 May 2021.

7. To inform my assessment, I have used the following:

- Freshwater fisheries data provided by the New Zealand Freshwater Fish Database (Crow, 2017) - henceforth referred to as NZFFD.
- Schedules 1A and 9 of the Regional Plan: Water for Otago (RPW).
- BSTGT and the AP McQuilkin Family Trust Application to replace deemed water permits RM14.364.01, 96285, 3073B, 97029.V1 and 95696 (RM19.151).
- Memorandum from Matt Hickey (Water Resource Management Limited (WRM)) to Hilary Lennox (Ahika Consulting Limited) regarding Fish Survey of the Royal Burn and New Chums Creek, 30/01/2019 (please note; it is assumed that the stated year is an error in the memorandum and the reporting date is 30/01/2020, it will be hereafter referred to as this).
- ORC Resource Science Unit (RSU) Assessment of RM19.151 prepared by Pete Ravenscroft, 13 June 2020 (Document ID: A 1247273).
- Technical Memorandum from Pattle Delamore Partners Limited (PDP) to Otago Regional Council regarding Review of Royal Burn North Branch and New Chums Gully abstraction, 15 September 2020.
- Amendments to Application RM19.151 since lodgement from Ahika Consulting on behalf of the applicant, 27 November 2020.
- Further Amendments to Application RM19.151 from Ahika Consulting on behalf of the applicant, 3 March 2021. Includes Attachment 2 – Proposed Consent Conditions.
- Royal Burn – Gauging results for work completed 22 February 2021 by NIWA, 26 February 2021.
- A site visit to the Royal Burn accompanied by Kit Gordon completed on 13 May 2021.
- Submission – Barry Hodges, 27/07/2020
- Submission – Angus Sutherland and Dinal Eastwood, 25/01/2021
- Submission – Aukaha Ltd., 03/09/2020
- Submission – B Wolter, 14/01/2021
- Submission – Clarke P and Mason N, 24/01/2021

- Submission – Glencoe Station and Glencoe Land Development Company Ltd., 03/09/2020
- Submission – Jef Desbecker and Robina Bodle, 02/01/2021
- Submission – John Baker and Bridget Steed, 31/07/2020
- Submission – Philip Blakely and Mary Wallace, 28/07/2020
- Submission – Trustees of Mylore Family Trust, 24/01/2021
- Submission – Weldon and Elliot, no date
- Submission – James and Lynn Campbell, 25/01/2021
- Submission – Bloomsbury Stud NZ Ltd, 03/08/2020
- Submission – Patrick and Liisa Garceau, 29/07/2020
- Submission – Glenn and Kerryn Russell, 02/08/2020

### **Ecological Values – Royal Burn and New Chums Creek**

1. NZFFD records were accessed by Pete Ravenscroft (RSU Assessment, 13/06/2020) to consider the ecological values of the site. Findings from the NZFFD showed three surveys have been completed within the Royal Burn catchment and records from these surveys indicate no fish species occupy the waterways associated with this application.
2. Pete Ravenscroft (RSU Assessment, 13/06/2020) also states: *“This (fish) survey was conducted in 2018, by Otago Regional Council (ORC) and the findings of no fish support a previous survey that was completed by ORC in other waterways on the Crown Terrace. The surveys did reveal the presence of invertebrate’s species from the Trichoptera, Ephemeroptera and Plecoptera families”.*
3. A fish survey to support the resource consent application was completed on 28 January 2020 by Matt Hickey and Ryders Consulting (WRM Memo, 2020). This survey utilised electric fishing along multiple reaches of the Royal Burn and New Chums Creek (Figures 1 & 2).
4. The WRM (2020) survey of New Chums Creek reconfirmed the absence of freshwater fish values within the majority of this creek and also noted the presence of natural fish passage barriers near the confluence with the Arrow River. The WRM Memo (2020) states: *“(Rainbow trout) were common below the most downstream waterfall to the confluence with the Arrow”.*

5. The WRM (2020) survey of Royal Burn found no fish species in the upper North nor South branches but brown trout were found below the confluence of the two branches. WRM (2020) states: *“Significant reaches of stream with good cover and habitat were surveyed above and below the existing takes in the North Branch of the Royal Burn with no fish caught or observed. The invertebrate community was dominated by large body specimens such as stoneflies indicating fish (especially salmonids) are not present. The same was true for the upper reaches of the South Branch”*. The WRM Memo (2020) also goes on to state: *“Downstream of take 97029 and 3073B the North Branch of the Royal Burn went dry despite two thirds of the flow passing the intake, indicating that the lower section of the Royal Burn North Branch is naturally intermittent.”*
6. There is no fish passage from the Arrow River to the Crown Terrace therefore it would appear that the presence of brown trout into the Royal Burn has occurred via human transference. The apparent intermittent nature of the lower section of the Royal Burn North Branch is believed to be acting as a fish passage barrier to trout moving further upstream (WRM Memo, 2020).
7. No information was provided by the applicant regarding the benthic substrates and habitat found within either creek. The presence of *“large body specimens (invertebrates) such as stoneflies”* however indicate high aquatic values in the creeks. It is not known where these invertebrate communities were found or if they are representative of the entire creek sections surveyed.
8. In the Glenn and Kerry Russell submission (02/08/2020) it is stated: *“the Brodie Creek had had small fish species in it for years, my children on many occasions would catch yabbies (koura) in that creek”*. It goes on to state *“This creek (Royal Burn) always had flow even in the dryer seasons, now there is significantly less flow even on some occasions running dry”*. Brodie Creek feeds into the lower section of the Royal Burn on the Crown Terrace with no stated fish passage barriers, other than observed intermittency, between this and the Lower Royal Burn North Branch take. Therefore, there could be the potential for further unidentified aquatic values within the Royal Burn.
9. Schedule 1A of the RPW (ORC, 2018) does not identify aquatic values for New Chums Creek nor Royal Burn, however the Arrow River is identified as having the following values:
  - Large water body supporting high numbers of particular species, or habitat variety, which can provide for diverse life cycle requirements of a particular species, or a range of species.

- Access within the main stem of the catchment through to the sea or lake unimpeded by artificial means such as weirs and culverts.
- Plant/boulder/gravel/sand/silt/rock bed composition of importance to resident biota.
- Absence of aquatic pest plants identified in the Pest Plant Management Strategy for the Otago Region.
- Absence of crack willow.
- Presence of significant fish spawning areas for trout
- Presence of significant areas for development of juvenile trout
- Significant presence of trout
- Also note outstanding natural features/landscapes areas with a high degree of naturalness.

10. A wetland 'swamp' was mentioned as being present by the applicant, downstream of both water takes on the Royal Burn in the Further Amendments to Application RM19.151 from Ahika Consulting on behalf of the applicant, 03/032021. When questioned about the ecology of the stated 'swamp' in an email dated 14/05/2021, the response in an email from Ms Lennox on 18/05/2021 was that the term 'swamp' had not been appropriately classified and should be referred to as a 'damp patch in the paddock'. Further to this it is stated to be dominated by willow, exotic pasture, bull rushes and other weeds. This wetted area was not considered to be of ecological value by Ms Lennox and this was reiterated by Mr Hickey in an email (dated 21/05/2021) who described this as "an area of groundwater upwelling" and did not consider it to be a 'swamp' as ecologically defined.

11. Regionally Significant Wetlands are listed in Schedule 9 of the RPW. There are no Regionally Significant Wetlands that will be affected, adversely or otherwise, by the proposed water takes and retakes. Based on the reclassification from Ms Lennox and Mr Hickey above, there are no National Environmental Standards (NES) consent requirements regarding the groundwater upwelling area.

#### **Hydrological Considerations for Ecological Values - General**

12. New Chums Creek is estimated to have a mean annual flow of 19.8 L/s and 7-day mean annual low flow (MALF) of 4.7 L/s (from the Ministry of the Environment River Flow database). The applicants' proposed rate of take is to not exceed 24.5 L/s.

13. The Royal Burn North Branch (upstream of upper take) is estimated to have a mean annual flow of 33.7 L/s and a MALF of 10.7 L/s (from the Ministry of the Environment River Flow database). The applicants' proposed rate of take at the Upper Royal Burn North Branch is to not exceed 15 L/s and the rate of take at the Lower Royal Burn North Branch is to not exceed 50 L/s.
14. In the Consent Amendment (dated 03/03/2021) the applicant proposes to reduce the annual volume sought from 1,822,608 m<sup>3</sup>/year to 1,214,683 m<sup>3</sup>/year. However, the abstraction rates are proposed to remain the same as within the original consent application.
15. The proposed abstraction rate for takes in the Royal Burn and New Chums Creek exceed the mean annual flow for both streams. Based on this, PDP's technical memorandum (PDP, 2020) notes the following: *"the applicant recognises that the proposed abstraction rate for both branches exceeds the mean annual flow and states that this will allow the applicant to store flood flows and ensure irrigation activities can continue during periods of low flow whilst reducing pressure on the creeks where possible. Given that the applicant is only proposing a visual residual flow condition for 50 m below the point of take, it appears unlikely that pressure on the creeks will be reduced at low flow"*. The proposed year-round abstraction, lack of daily maximum take, and the proposed exceedance of both the mean annual flow and the MALF relies solely on the applicant's management where they will attempt to manage abstractions and reduce pressure on creeks during periods of low flow *"where possible"*. Although *"reducing pressure on the creeks"* may be in the interests of the current owners this does not provide for the future sustainable management of these abstractions.
16. In the Bloomsbury Stud (NZ) Ltd submission (03/08/2020) it is stated: *"There has been a significant change in the use of land since the original allocations and the applicants' arrival. During construction of the extensive race system and ponds at the head of the Royal Burn catchment the Royal Burn creek was run dry depriving families and farms downstream of any water for long periods of time"*. This statement questions the sustainable management of the current water abstraction by the applicants and the likelihood that they will attempt to *"reduce pressure"* voluntarily on the creeks during periods of low flow.
17. It is stated by the applicant that New Chums Creek and Upper Royal Burn North Branch intakes have a small, constructed weir structure around them to allow water to pond around the intake pipe. The artificial impoundment of water at these locations means that even during periods of

low flow ( $\leq 5$  L/s), which was observed at New Chums Creek during a site visit on 31<sup>st</sup> December 2018, the intake pipe can still maintain its' abstraction rate based on pipe diameter. It is also noted that predominantly seepage with little or no flow was observed downstream of the two weirs (pages 16 & 17 of the resource consent application), indicating that the majority of flow during low flow conditions at least, is being dammed. No intake pipe diameters were provided in the application.

18. Altering a creek's flow regime from permanent to intermittent or increasing a creeks intermittency reduces its' life-supporting capacity, including macroinvertebrate populations and increases the risk of periphyton proliferation.
19. Overallocation of Arrow River tributaries can also lead to potential flow reductions in the Arrow River and risks reducing or adversely affecting regionally significant trout habitat.
20. Based on the Ministry of the Environment (MfE) Proposed National Environmental Standards (NES) on Ecological Flows and Water Level (MfE, 2008) and the Draft Guidelines for the Selection of Methods to Determine Ecological Flows and Water Levels (Beca, 2008) to determine ecosystem flow, the assessment of risk of deleterious effects on instream habitat according to fish present and natural mean stream flow is considered 'High' for the Royal Burn and New Chums Creek based on trout being present in both streams (below fish passage barriers). A 'High' risk deleterious effect coupled with low baseflow (mean annual flow of  $<0.25$  m<sup>3</sup>/s or  $<250$  L/s) provides a 'High' degree of hydrological alteration (Tables A4.1-2; MfE, 2008). It should also be noted that the abstraction of more than 40% of MALF, or any flow alteration using impoundments (i.e. man-made weirs) is considered a 'High' degree of hydrological alteration, irrespective of region or source of flow.
21. It is noted that neither the proposed NES on Ecological Flows and Water Level (MfE, 2008) nor the Draft Guidelines prepared by Beca (2008) have been incorporated into central or regional legislation to-date. However, in the absence of certainty regarding the alteration of a creeks' hydrology from permanent to intermittent and therefore the potential for adverse effects on the ecology of the affected stream, it is considered an appropriate proxy to provide some level of guidance for ecological stability.



## Hydrological Considerations for Ecological Values – Royal Burn North Branch

22. The applicant states: *“it is questionable whether the Royal Burn North Branch would maintain a meaningful, connected flow through the length of the creek to the lower RBNB at all times, even if the abstraction activity was not occurring”*. Matt Hickey (WRM, 2020) states that: *“Downstream of take 97029 and 3073B the North Branch of the Royal Burn went dry despite two thirds of the flow passing the intake, indication that the lower section of the Royal Burn North Branch is naturally intermittent”*. However, as PDP notes in their technical memorandum that although these statements may be true, meaningful connected flow would be maintained during some flows if not for the abstraction.
23. Flow monitoring data provided by the applicant and completed by NIWA (Royal Burn – Gauging results for work completed 22 February 2021 by NIWA, 26 February 2021) shows that at the time of survey the Royal Burn North Branch gained approximately 5.4 L/s flow between the upper and lower takes. It appeared that approximately 8.6 L/s was being abstracted at the lower take during this time and the creek then lost an additional 7.8 L/s in the following section of creek, which is termed by the applicant as the ‘losing reach’. From Glencoe Rd the Royal Burn gained 3.4 L/s and in the section below the confluence with the Royal Burn South Branch and swamp had gained a further 31.9 L/s. No information was provided on the volume of take from the upper water abstraction point at the time of survey.
24. The applicant states they have undertaken monitoring of the Royal Burn North Branch since November 2020 to form a greater understanding of the potential creek intermittency and MALF. In the Further Amendments to Application RM19.151 (03/03/2021) it is stated *“Recent monitoring (undertaken by the applicant) has shown losses to ground along the Royal Burn North Branch of at least 7.8 L/s (and possibly as great as 13.2 L/s) between lower point of take down(stream?) and the swamp. Assuming a MALF of 10.7 L/s for the Royal Burn North Branch in the vicinity of the abstraction activities, the section of creek between the lower point of take and the confluence with the south branch is naturally drying, with a MALF that is closer to 0 L/s.”* It is agreed that based on this one-off flow gauging assessment completed at mean flow the Royal Burn North Branch exhibits losses and gains. However, this data does not clearly demonstrate whether the creek is naturally intermittent or not and it is unclear how losses of 13.2 L/s is derived.

25. It is stated in the application that there is a small, constructed weir at the upper take (RM14.364.01 & 96285) with potentially only seepage or low flow being permitted to pass (pg. 16 of the application) therefore it does not appear to be possible to assess whether the creek would have exhibited intermittency prior to the installation of the weir.
26. In the Clarke, P and Mason, N submission (24/01/2021) it is stated: *“On the 30<sup>th</sup> December last (2020) the culvert carrying the North branch (of the Royal Burn) was dry while the South branch was running”*. Barry Hodges submission (27/07/2020) also states that *“the whole creek has dried up at times when they (the applicant) draw water. First time in the 22 years I have lived beside the Royal Burn”*. Although both statements in these submissions are identified as general observations rather than data-based, to-date the applicant also has only provided general observations to say otherwise and the NIWA gauging to show the creek experiences overall losses and gains.
27. Given the disparity between the applicant and submitters and the potential for adverse effects on the ecology of the Royal Burn it would be reasonable to complete a robust groundwater assessment of this site and identify to what extent the intermittency currently noted within the North Branch is caused/exacerbated by the abstractions. The additional information provided in the Further Amendments to Application RM19.151 (dated 03/03/2021) states that it is believed the Royal Burn North Branch is intermittent and has a MALF of 0 L/s. However, the supporting data does not clearly demonstrate this.
28. The Further Amendments to Application RM19.151 (03/03/2021) states: *“Recent monitoring has shown losses to ground along the Royal Burn North Branch of at least 7.8 L/s (and possibly as great as 13.2 L/s) between lower point of take down(stream?) and the swamp<sup>1</sup>”*. It is important to note that based on the MALF of 10.7 L/s and the applicants estimated losses of ~7.8 L/s to ground, this section of creek appears to predominantly retain flow and provides for surface water input into downstream habitats.
29. Further Amendments to Application RM19.151 (03/03/2021) states *“Further discussion on the hydrology of the creek and potential effects on ecological values and downstream users will be provided by Matt Hickey in due course”*. This would be beneficial to the application as it is still unclear as to what the potential effects on the ecology will be with regard to the exacerbation of the Royal Burn North Branch intermittency.

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<sup>1</sup> The ‘swamp’ is now reconsidered by Ms Lennox and Mr Hickey to be predominantly an area of groundwater upwelling surrounded by willows, bull rush, exotic pastures and weeds.

### **Hydrological Considerations for Ecological Values – New Chums Creek**

30. The WRM Memo (2020) states: *“On the day of the (fish) survey there was only a seepage flow passing the take, while in the middle survey reach flows had gained to be more than 10 L/s. At the confluence with the Arrow, flows were estimated to be in excess of 30 L/s”*. No further information is provided as to the length of creek in which only seepage was occurring or the location of the *“middle survey reaches”* where the creek had gained approximately 10 L/s.
31. Given the applicants’ proposed take is 4.7 L/s higher than the mean annual flow and the current take is seemingly higher than this again, it would seem plausible that the New Chums Creek water take is currently having an adverse effect on the downstream ecology of the creek and is likely to continue to adversely affect the life-supporting capacity with the proposed water take rate, despite gaining flows in *“the middle survey reach”*.
32. The applicant states: *“The New Chums point of take is in dense bush and there is no public access to this part of the creek, so it could be argued that there is little to be achieved from maintaining a residual flow”*. It is important to note residual flow helps to ensure adverse effects on the ecology of a waterbody from the abstraction of water are avoided/minimised, it is not required as a benefit to the public.

### **Residual flow considerations – Royal Burn and New Chums Creek**

33. Instream values downstream of the Royal Burn and New Chums Creek abstraction locations are stated by Mr Hickey to include sensitive EPT macroinvertebrate taxa such as stoneflies and trout. A wetted ‘damp patch in a paddock’ is also identified below the lower take on the Royal Burn. Despite these habitats not including any known and currently threatened species the values identified by Mr Hickey require some level of protection through a residual flow to maintain life-supporting capacity. Trout were found in both creeks downstream of the takes and fish passage barriers. No further characterisation of specific sections of the creeks were provided, such as within the ‘losing reach’.
34. Based on the Proposed NES for Ecological Flows and Water Level (MfE, 2008) the proposed water abstraction for both New Chums Creek and Royal Burn North Branch is considered to be a ‘High’

degree of hydrological alteration. Potential issues surrounding this include periphyton biomass increases, connectivity/ fish passage restrictions and habitat degradation.

35. The applicant has amended their application (Amendments to application RM19.151 27 November 2020) to include the following residual flow provisions based on Pete Ravenscroft RSU Assessment, with support from Department of Conservation:

- *That all three points of take have to adhere to any future minimum flow on the Arrow River.*
- *Consent No.95696 has to maintain a connected visible flow immediately downstream of the point of take for a distance of no less than 50 metres.*
- *Consent No's RM14.364.01 & 96285 has to maintain a connected visible flow immediately downstream of the point of take for a distance of no less than 50 metres.*
- *Consent No's 3073B & 97029.V1 has to maintain a connected visible flow immediately downstream of the point of take for a distance of no less than 50 metres.*

36. It is noted that the applicant adopted these residual flow provisions within their proposed conditions of consent in alignment with the ORC's RSU report prepared by Pete Ravenscroft on 13 June 2020. However, the proposal of these residual flow conditions, in my opinion, are not sufficient to ensure the life-supporting capacity of these creeks or the ecological flow (Ministry for the Environment, 2008), nor avoid/minimise the exacerbation of adverse effects during low or intermittent flows on the ecology of downstream sections of the creeks. Further to this, it is unclear how they are to be measured or enforced. This view is based on further information provided within the submissions, the proposed abstraction volumes and the lack of ecological and hydrological clarity and supporting data regarding the proposed creek intermittency and potential effects on ecological values.

37. A further consent condition has been volunteered by the applicant in the Further Amendments to Application RM19.151 (dated 03/03/2021).

- *Water must not be abstracted from the North Branch of the Royal Burn for irrigation purposes when flows in the Royal Burn drop below 5 L/s at NZTM2000 1274996E 5011547N.*

It should be noted that this further consent condition does not include water abstraction for the purpose of stock drinking, i.e., *“the applicant will still be able to take water for stock drinking water purposes as a permitted activity even if the low flow cut-off has been reached.”* Page 3, para 4 of Further Amendments to Application RM19.151 (03/03/2021).

38. Based on the flow gauging completed by NWA (February 2021) the principle of the volunteered consent condition in Point 36 is considered to be appropriate, however the level at which the flow cut off occurs is considered too low. If flows as little as 5 L/s occur at this point below the confluence with the Royal Burn South branch and groundwater upwelling area where gauging in February found a gain of 31.9 L/s and a total flow of 44.3 L/s, then there will be adverse ecological effects occurring upstream of this location. These will include the potential for stagnancy in the wetted area and reductions in water quality required to support ecological values such as dissolved oxygen and changes to water temperature, as well as increased stretches of creek intermittency. Based on this, a proposed residual flow of 10 L/s at this location is considered an appropriate limit to ensure maintenance of water quality for ecological values downstream. Further to this, concerns remain regarding the enforcement/monitoring of the removal of water below this low flow cut-off for stock drinking purposes only.
  
39. In their submission, Aukaha Ltd. stated a preference for a minimum flow of 90% of MALF and allocation of 30% of MALF as calculated by the Regional Council, in accordance with Proposed National Environmental Standard on Ecological Flows and Water Levels (MfE, 2008). For New Chums Creek, Otago Regional Council refer to NIWA Shiny MALF value of 4.7 L/s, and a MALF of 10.7 L/s for Royal Burn North Branch. This would provide for a residual flow of 4.23 L/s for New Chums Creek and 9.63 L/s for Royal Burn North Branch. However, it is recognised that creek intermittency suggested by the applicant may make this difficult to achieve at the Lower Royal Burn North Branch take.
  
40. Glencoe Station Ltd submission states that consent 96285 was issued with the following conditions:
  - That the abstraction does not exceed 50,000 litres per hour
  - This permit should not be exercised at the same time as 96284
  - That not more than one half of the flow in the Royal Burn North Branch shall be taken under this permit.

- The priority date for this permit is 8 June 1923. All permits on the Royal Burn have an equal priority.

41. Fourteen of the fifteen submissions oppose the application and of these a number of submissions specifically cite the lack of appropriate minimum flow for the retention and/or health of instream values as a reason for their view.

#### **Royal Burn North Branch Site Visit**

42. A site visit carried out on 13/05/2021 briefly assessed the two take locations on the Royal Burn North Branch.

43. The upper take was observed to not be a fully formed weir as was implied in the consent application and had a natural outflow which looks to be able to maintain flow under most flow conditions.

44. The upper take intake pipe was measured to be 330 mm and at the time of site visit did not have additional piping with sediment screen attached (Figure 3). The pipe position in the ponded area, without the additional section of piping with sediment screen, shows that at most, only half of the intake pipe will be submerged in the water column and will naturally allow for residual flows of at least 10 L/s.

45. The additional piping with sediment screen at the upper take was sitting on the bed of the ponded area above the water take (Figure 4). It is unknown why this had been removed and is also unknown the depth at which the opening sits within the water column when it is attached to the intake pipe. However, it looks to be able to be fully submerged. Therefore, when this additional piping is attached water can be abstracted at low stream levels.

46. The flow gauging meter located on the race near the upper intake point looks to provide nearby infrastructure to support additional metering of the Royal Burn North Branch directly below the ponding outfall without significant cost nor effort.

47. The lower take was observed to have flow spilt by a large rock at approximately a 50:50 split (Figure 5). This means that roughly half the flow is abstracted at this point and half remains in the stream.

## Conclusions

48. Mr Hickeys assessment of the ecological values of the Royal Burn and New Chums Creek, namely EPT invertebrate taxa and introduced trout, are generally agreed with, despite no data pertaining to macroinvertebrate sampling in his memo. However, his assessment of the intermittent nature of the Royal Burn does not appear to provide sufficient evidence that the reach naturally goes dry. This uncertainty is due to the modification of the creek (i.e. the ponded area and partial weir) at the upper intake coupled with unquantified abstractions occurring during all flow observations from the applicant, Mr Hickey and the flow gaugings completed by NIWA.
49. A connected visible flow for 50 m immediately downstream of the point of take is not considered an appropriate residual flow based on the potential for adverse ecological effects to occur from exacerbated intermittency or hydrological alterations of Royal Burn North Branch and New Chums Creek. A measurable and consistent residual flow should be considered to maintain water quality parameters and flow that will allow for EPT taxa and trout to persist in these streams.
50. Based on the results of the fish survey completed by Mr Hickey, fish screens on the intakes are not considered required.
51. The applicants' proposed abstraction cut-off at *NZTM2000 1274996E 5011547N* below the gaining reach on the Royal Burn is generally agreed with. However, the 5 L/s at which the cut-off is proposed to occur is not agreed with. Based on the 31.9 L/s of surface water gain directly above this point from the NIWA gaugings at mean flow, if a low flow of 5 L/s is reached the upstream ecology of the stream will already have been adversely affected and the stream bed may largely be dry. A low-flow cut-off of 10 L/s is considered more appropriate and will allow for sufficient flow to provide survivable water quality conditions for EPT taxa and trout below this section of waterway.

## Recommendations

52. In order to protect the natural ecological values, in particular EPT invertebrates and trout, and the life-supporting capacity of the creeks via maintenance of water quality parameters, a residual flow comprising of 90% of MALF is recommended at the New Chums Creek take (95696) and the Upper Royal Burn North Branch take (RM14.364.01 & 96285). It is proposed that this can be achieved by using a specific diameter piped off-take through the New Chum weir and flow gauging at

approximately NZTM2000 1275670E 5013002N directly below the Upper Royal Burn North Branch take partial weir.

53. In recognition of the potential for surface water losses below the upper take and the lack of low flow gauging data, it is recommended that the Lower Royal Burn North Branch take (97029 & 3073B) utilises a “50:50 flow-sharing” regime for residual flow (MfE, 2008; Beca, 2008). This ensures that in conjunction with the increased residual flow at the upper take, ecological values are able to be maintained downstream of the takes, but also allows for intermittency if this is naturally occurring. The site visit on 13/05/2021 confirmed that approximately a 50:50 flow-sharing regime is already occurring at this point of take, therefore no changes to this intake are recommended.
54. The applicants’ volunteered condition of consent is considered appropriate with the following amendment (in bold): “*Water must not be abstracted from the North Branch of the Royal Burn for irrigation purposes when flows in the Royal Burn drop below **10 L/s** at NZTM2000 1274996E 5011547N*”. However, given the downstream location of this proposed low flow cut-off and to address concerns that further abstraction can still occur, it is recommended that the 13,000 m<sup>3</sup> of water from the storage pond is primarily utilised for stock drinking purposes, PRIOR to any further water abstraction.
55. Fish screens are not recommended due to fish passage restrictions downstream of all takes.



Bryony Miller

20 May 2021





Figure 1: Electric fishing survey sites for the Royal Burn. Red dots = no fish, green dots = brown trout. The existing takes are also shown (sourced from WRM, 2020).



Figure 2: Electric fishing sites for New Chums Creek. Red dots = no fish, yellow dots = rainbow trout. Existing take is shown along with a 2 m+ waterfall (sourced from WRM, 2020).





Figure 3: Pipe intake at upper Royal Burn North Branch water take. Intake pipe diameter is 330 mm. Outflow of ponding area is shown by blue arrow. Photo taken by Bryony Miller during site visit 13/05/2021.

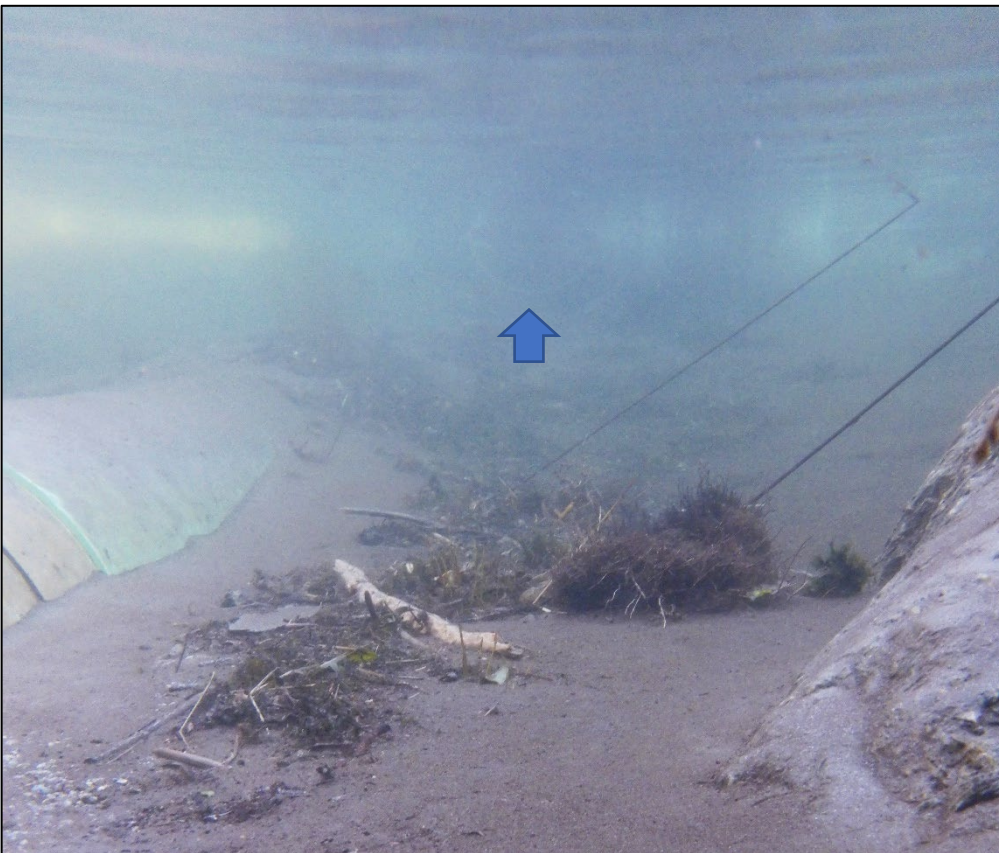


Figure 4: Additional piping with sediment mesh in left foreground. Intake pipe observed faintly in background with blue arrow to clarify. Photo taken by Bryony Miller during site visit 13/05/2021.





*Figure 5: Flow split at the lower take on the North Branch of the Royal Burn. Red arrow indicates the take and blue arrow is the residual flow. Photo taken by Bryony Miller during site visit 13/05/2021.*

## References

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