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 NIGEL JOHN PARAGREEN ON BEHALF OF THE OTAGO FISH & GAME COUNCIL 7 SEPTEMBER 2021

STATEMENTOF EVIDENCE OF NIGEL JOHN PARAGREEN

1 My name is Nigel John Paragreen, I am the Environmental Officer with the Otago Fish and Game Council (**Fish & Game**) in Dunedin. I have worked with Fish & Game since January 2017, providing advice and services related to policy and planning.

2 I hold a Master of Environmental Management, specialising in sustainable development, and a Bachelor of Economics, specialising in natural resources and the environment, both from the University of Queensland, Australia. I have worked on planning, natural resource management and conservation projects in Australia and New Zealand since 2013.

3 In this hearing process, I will be appearing for Fish & Game and advocating on their behalf. I am submitting this lay evidence to clarify factual points in advance of Fish & Game's hearing appearance. As such, in providing this evidence as a lay person, I rely heavily on expert opinion and information provided during this process to date.

Naturalised 7-day mean annual low flow (MALF) at the flow recorder

4 Two competing naturalised MALF figures have been proposed for the Pig Burn, 79l/s by the Otago Regional Council (**ORC**)[1] and 53l/s by the applicants.[2]

5 An expert, independent review[3] of the hydrology information was commissioned by the ORC, which found:

> *"In the absence of a long term flow record for the Pig Burn both the short term estimate for the observed (or modified) 7D MALF as calculated by the applicant and the short term naturalised 7D MALF as calculated by ORC are considered reasonable"*
>
> *…*
>
> *"In summary, PDP agree with the short term observed flow statistics provided by the applicant but consider it prudent to recognise that the long*

[1] Xiaofeng, L., & Ravenscroft, P. (2016). *Management flows for aquatic ecosystems in the Pig Burn*. Dunedin: The Otago Regional Coucnil.
[2] Application Appendix C: Instream Ecology Assessment, Table 2 and Figure 4.
[3] Veendrick, B. (2020). *Technical memorandum: Pig Burn - collective replacement of water permits to take and use surface water*. Christchurch: Pattle Delamore Partners Limited.

term modified 7D MALF and naturalised 7D MALF is likely to be greater than 53 L/s."

I have appended the independent hydrology review to this evidence.

6 Based on this, it can be said the MALF of the Pig Burn is somewhat uncertain and likely to be within a range. I note that experts to date[4] have used figures within the 53l/s and 79l/s range at the flow recorder.

7 The exception to the above is Ms King, who has described the MALF range of roughly 30l/s – 80l/s, similar to what was identified during the pre-hearing meeting.[5] I understand the references to MALF being as low as 30l/s are linked to the lowest daily inflows identified by Mr Hickey.[6] With technical experts all referring to a MALF range of 53l/s – 79l/s, it appears the MALF range has been refined somewhat since the pre-hearing meeting.

8 I note that:

(a) all potential naturalised MALF flows within the 53l/s – 79l/s range would result in the lower losing reach being perennial on average, based on the observed ~40l/s loss to the lower losing reach as shown in Mr Hickey's Figure 4[7]; and

(b) Dr Holmes has adapted his analysis of the adverse effects of the activity on ecology to account for uncertainty in the naturalised MALF estimates.[8]

Gains and losses in the Pig Burn are uncertain

9 With respect to the longitudinal flow profile of the Pig Burn, which show the gains and losses of the creek as it moves downstream, the independent hydrological review commented that *"… it is considered that there is significant uncertainty regarding the (natural) flow regime in the Pig Burn."*[9] This is indicative of the hydrological information that has been presented so far.

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[4] Mr Hickey and Drs Allibone and Olsen refer to naturalised MALF as being higher than 53l/s, Dr Holmes considers a range of MALF figures between 53l/s and 79l/s.
[5] Section 42A report, page 21.
[6] Application Appendix C: Instream Ecology Assessment, Table 2.
[7] This shows losses at 53l/s, the lower end of the MALF range, but not the upper end.
[8] Evidence of Robin Holmes, paragraph 29.
[9] Veendrick, B. (2020). *Technical memorandum: Pig Burn - collective replacement of water permits to take and use surface water*. Christchurch: Pattle Delamore Partners Limited.

10 Mr Hickey has provided much of the information on gains and losses in the Pig Burn. In his report appended to the application, Mr Hickey identifies at least a 30l/s loss in the lower losing reach.[10] He qualifies this by acknowledging:

> *"… that there appears to be significant variation in losses based on the flow and take data coupled with the observation data, especially in the lower losing reach (between the Patearoa Waipiata Rd and O'Neil Rd), meaning that drying may or may not be an annual event naturally."*[11]

11 In evidence, Mr Hickey expands on this by discussing the results of concurrent guagings provided by the ORC and observations of the creek. He concludes that losses in the lower losing reach must be at least 40l/s. His reasoning is as follows:

> *"Based on ORC flow gaugings showing a **27 l/s** loss between Mulholland Take and the PatearoaWaipiata Bridge (Table 4 above). Observed dry 600m below the PatearoaWaipiata Rd Bridge on the 04/01/2017 and the 18/01/2017. Based on inflows at the Gorge Flow Site and recorded takes there was **23 - 29 l/s** expected to be passing the Mulholland Take on these days respectively. Flow required to maintain surface connection was therefore greater than 30 l/s."*[12] (**bold** emphasis mine)

To the best of my knowledge, the observations on hand shows that surface water lost in the lower losing reach is up to 30l/s. Loses above that have been speculated by Mr Hickey, such as the 40l/s loss listed in Table 5. In Figure 4, Mr Hickey depicts the lower losing reach with a 40l/s loss and an additional hypothetical 60l/s loss. There is no explanation for how the latter number was chosen.

12 Dr Allibone succinctly sums up his view of the lower losing reach characteristics.

> *"The lower loosing reach that has a flow loss of approximately 30 L/s is unlikely to dry naturally aside from during dry summers although this reach is likely to be a natural low flow reach in most summers"*[13]

13 Mr Hickey's Figure 4 suggests that at flows above 40l/s, the lower losing reach will be perennial. With a MALF range of 53l/s – 79l/s, this would place the balance of probabilities towards the reach being perennial more years than not without the influence of abstraction, as alluded to by Dr Allibone.

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[10] Application Appendix C: Instream Ecology Assessment, page 11.
[11] Application Appendix C: Instream Ecology Assessment, page 12.
[12] Evidence of Matt hickey, Table 5
[13] Evidence of Richard Allibone, paragraph 23.

In contrast, the 10l/s residual flow the applicant seeks leave immediately upstream of the lower losing reach seems likely to guarantee the reach will be dry whenever flows are restricted to that level, which I understand will occur in most years.

14 Providing the above logic is true, and acknowledging that there is a degree of uncertainty, the nature of the lower losing reach is reversed. Where it would be perennial most years without abstraction, under the proposed abstraction regime it becomes a reach that dries most years.

The scale of abstraction in the Pig Burn

15 Dr Holmes states that the allocation sought by the applicants is so large that it will cause more than minor adverse effects even if a reasonable residual flow is provided.[14] In his Figures 6, 7 and 8, Mr Hickey has provided examples of abstraction scenarios within the application's definition of low flows (see below for a discussion on that definition).

16 Over the page, I have graphed these scenarios to give a visual indication of the amount of water abstracted compared to key statistics discussed by Dr Holmes in evidence. Some key notes in interpreting the graphs:

(a) I have provided two graphs, representing both the 53l/s and 79l/s naturalised MALF estimates;

(b) I have inserted the recommendations for allocation and residual flows based on the Hayes *et al.* citation in Table 1 of the evidence of Dr Holmes – these will change with naturalised MALF estimates;

(c) I have summed the abstraction indicated in each of Mr Hickey's Figures 6, 7 and 8 to calculate the abstraction totals; and

(d) I have provided the residual flow proposed by the applicants at the confluence, as an indication of the water being retained in the Pig Burn after all abstraction takes place.

17 These graphs show that:

(a) the allocations abstraction and residual retained in river are divergent from those recommended by Hayes *et al.;*

[14] Evidence of Robin Holmes, paragraph 38.

(b) in the scenario depicted by each Figure, the proposed abstraction regime dominates the hydrology of the catchment, with inflows much higher than naturalised MALF reducing the creek to very low flow conditions.

Figure 1: Key statistics for Hickey Figures 6, 7 and 8, assuming a naturalised MALF of 53l/s and including recommendations from Hayes *et al.* referenced by Dr Holmes

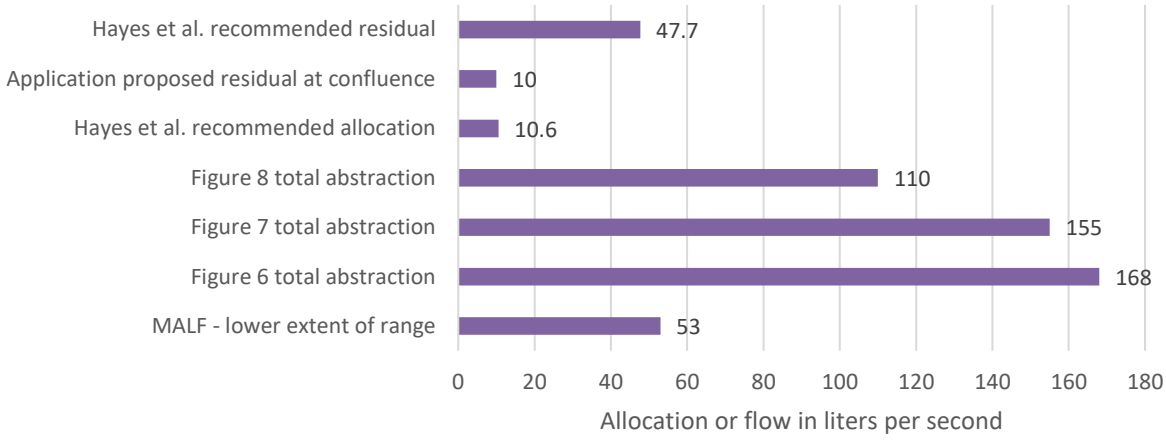
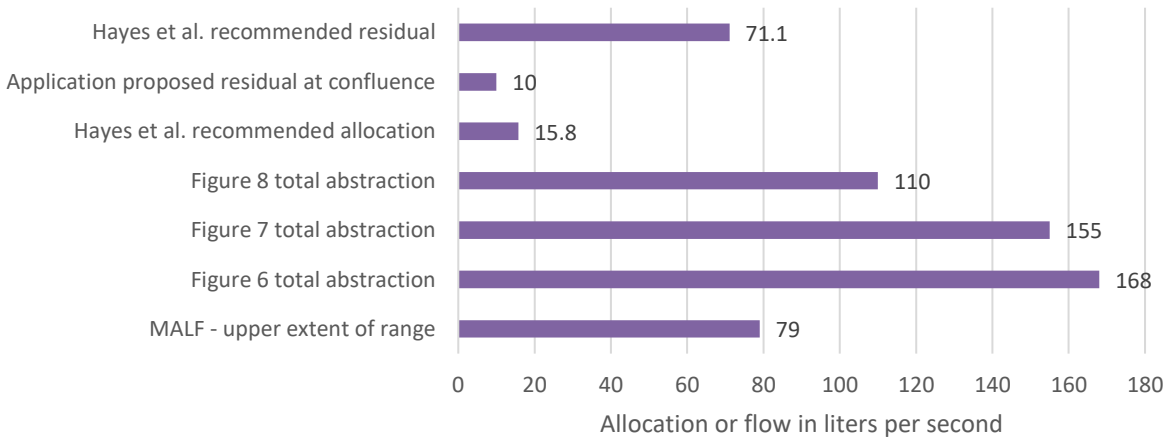


Figure 2: Key statistics for Hickey Figures 6, 7 and 8, assuming a naturalised MALF of 79/s and including recommendations from Hayes *et al.* referenced by Dr Holmes



Low flow definitions

18 The term ‘low flows’ have been used often by experts to date. However, there is some uncertainty about what this flow means in relation to the flow recorder. In his report appended to the application, Mr Hickey states that low flows occur when flows past the Herlihy Ford Take are less than 70l/s.[15] However, Dr Holmes[16] notes that this definition means low flows, as defined in the application, may include flows around naturalised median, when measured at the flow recorder.

19 It may be useful for low flows to be further refined and defined as a specific range of flows measured at the flow recorder.

Nigel Paragreen

Environmental Officer, Otago Fish and Game Council

7 September 2021

[15] Application Appendix C: Instream Ecology Assessment, page 20.
[16] Evidence of Robin Holmes, paragraph 20.

Appendix 1: Technical memorandum

Pattle Delamore Partners Limited

TECHNICAL MEMORANDUM

INVESTIGATION	Pig Burn – Collective replacement of Permits to Take and Use Surface Water	**PROJECT**	ORC Consent Reviews
CLIENT	**Otago Regional Council**	**PROJECT NO**	C032635157
CLIENT CONTACT	Alexandra King	**PREPARED BY**	Bas Veendrick
CLIENT WORK ORDER NO/ PURCHASE ORDER	RM20.039/PO013336	**SIGNATURE**	
		DATE	21 July 2020

EXECUTIVE SUMMARY

Pattle Delamore Partners Limited (PDP) has been engaged by Otago Regional Council (ORC) to conduct a technical review of the hydrological assessments for the resource consent application by the Pig Burn water users (the applicants) to replace their nine permits relating to water takes from the Pig Burn.

Flow statistics

The applicant (Hickey, 2020) has provided flow statistics for the Pig Burn. These flow statistics are based on the flows measured in the Pig Burn at the Gorge flow recorder during the irrigation season. There are two takes upstream of the flow recorder and as such the flow statistics (including the 7D MALF estimate) provided by the applicant are representative of the observed (or modified) flows rather than the natural flows at this site. The flow statistics are based on a limited amount of flow data at the recorder site. Therefore, the 7D MALF estimate is only representative of the short term observed 7D MALF.

A report from ORC labelled *'Management Flows for Aquatic Ecosystems in the Pig Burn*' (Xiaofeng and Ravenscroft, 2016) includes hydrological analyses undertaken for the Pig Burn. This report has not been considered by the applicant. The ORC report estimated the naturalised 7D MALF for the Pig Burn using the combined ratio method. This method uses the short-term natural flow record of a recorder site in a neighbouring catchment (Sow Burn at Carr's intake) to estimate the natural 7D MALF for the Pig Burn at the Gorge. Based on this method ORC estimated a naturalised 7D MALF for the Pig Burn at the Gorge of 79 L/s. This 7D MALF estimate is also based on a relatively short flow record for the Sow Burn (2007-2012) and as such there are uncertainties associated with this estimate for the natural 7D MALF for the Pig Burn at Gorge.

In summary, limited hydrological data is available and there are uncertainties associated with any 7D MALF estimate for the Pig Burn. In the absence of a long term flow record for the Pig Burn both the short term estimate for the observed (or modified) 7D MALF as calculated by the applicant and the short term naturalised 7D MALF as calculated by ORC are considered reasonable. The long-term naturalised 7D MALF for the Pig Burn at the gorge is likely to be greater than the short term observed 7D MALF as calculated by the applicant. Continued long - term flow monitoring at the gorge recorder site, along with flow monitoring of the upstream abstractions will provide improved estimates and more certainty about the natural flow statistics in the Pig Burn at the gorge over time.

Longitudinal flow profiles

Downstream of the gorge, the Pig Burn flows through the Maniototo Plain (total length of approximately 10 km). In this reach of the Pig Burn the applicant has identified two (natural) losing reaches and two (natural) gaining reaches. The applicant has used the available flow data and observations from the Pig Burn water users to provide an indication of the general pattern of gaining and losing reaches in the Pig Burn below the Gorge by providing longitudinal flow profiles. There appear to be discrepancies in some of the longitudinal profiles provided by the applicant and a recent gauging run undertaken by ORC on 21 January 2020 should be analysed to gain a better understanding of the gains and losses in the lower reaches of the Pig Burn.

As recognised by the applicant, losses (especially in the lower losing reach) can vary greatly depending on groundwater levels. Therefore, if required to support/complete the assessment of effects on ecology it may be beneficial to undertake further concurrent gaugings between the Gorge flow recorder and the confluence with the Taieri River.

More specific comments from the technical review are provided in section 3 and 4 of this memorandum.

TECHNICAL MEMORANDUM

1. INTRODUCTION

Pattle Delamore Partners Limited (PDP) has been engaged by Otago Regional Council (ORC) to conduct a technical review of the hydrological assessments for the resource consent application by the Pig Burn water users (the applicants) to replace their nine permits relating to water takes from the Pig Burn. This includes a discharge (into Harpers Creek) and re-take of water (from Harpers Creek) with water taken from the Pig Burn. Therefore, eight permits authorise abstractions from the Pig Burn. The consents sought to be replaced by the applicants allow for a total combined maximum rate of take of 454.8 L/s.

As requested by ORC this memorandum only reviews the hydrological assessments undertaken by the applicants and other available hydrological information provided by ORC.

2. GENERAL CATCHMENT DESCRIPTION

The Pig Burn is a small tributary of the Taieri River draining the north-western facing slopes of the Rock and Pillar Range near Patearoa. The Pig Burn drains a catchment area of approximately 51 km^2 and elevations in the catchment range from around 1,325 metres above mean sea level (mamsl) in the upper ranges to around 350 mamsl at the confluence with the Taieri River. The Pig Burn flows through a gorge before it emerges onto the Maniototo Plain. As the river flows through the Maniototo Plain (total length of approximately 10 km) it loses to and gains from groundwater. Based on observations made by the Pig Burn Water Users Group, Hickey (2020) identified two (natural) losing reaches and two (natural) gaining reaches in the Pig Burn. He identified that the Pig Burn loses flow between the ORC gorge flow recorder site and Hamilton Runs Ford. From this location the stream gains flow through to the Waipiata Patearoa Road Bridge. The second losing reach is between Waipiata Patearoa Road Bridge and approximately 1 km upstream of O'Neill Rd Bridge from which point the river is gaining flow again through to its confluence with the Taieri River. As acknowledged in the application there appears to be significant variation in losses especially in the lower losing reach.

Figure 1 below (copy from Hickey, 2020) shows the location of the takes from the Pig Burn. As shown in this figure the majority of the takes are downstream of the ORC Gorge flow recorder.

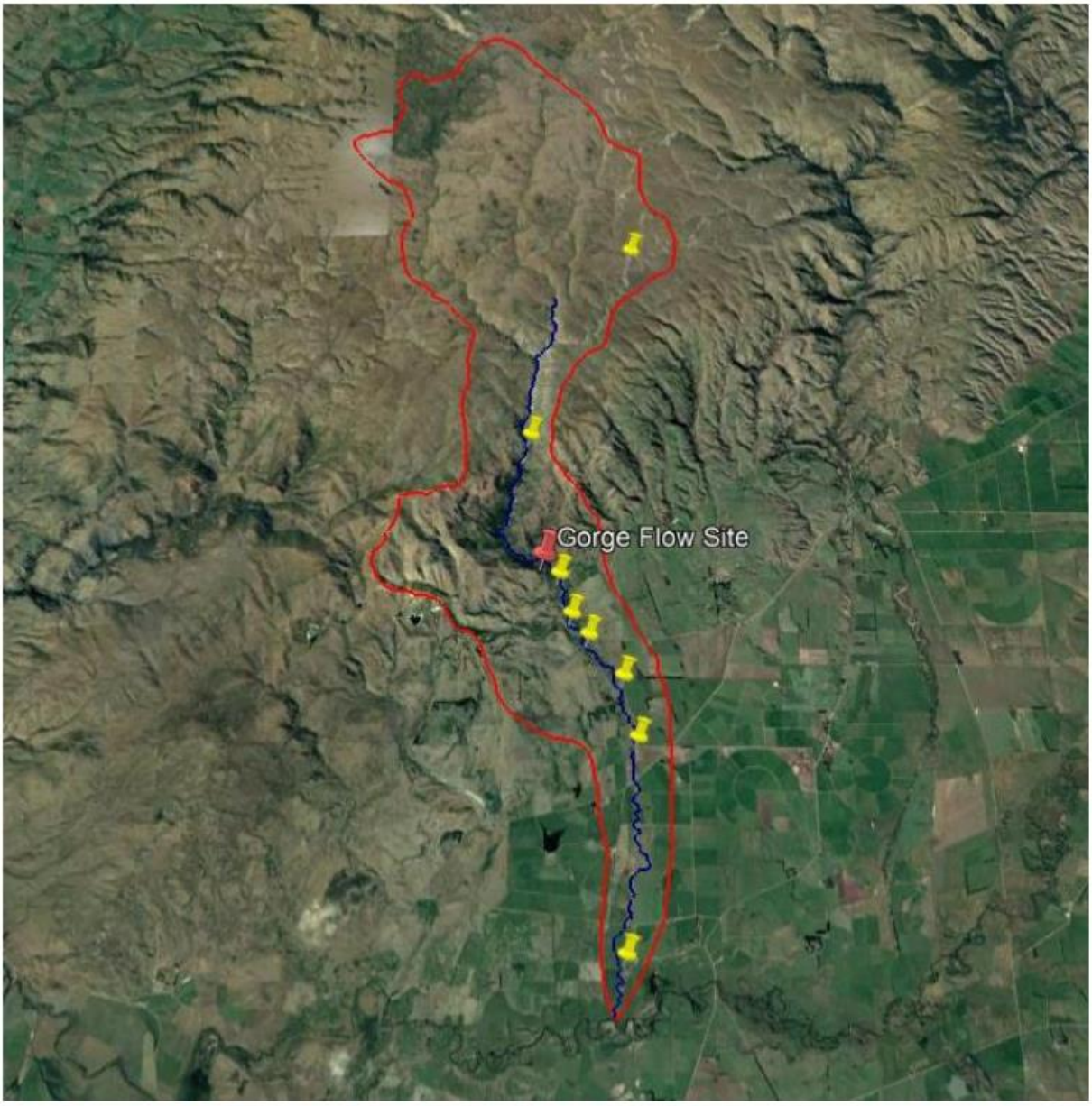


Figure 1: Map showing the Gorge flow recorder (red pin) and the existing take locations (yellow pins) from the Pig Burn Catchment (map from Hickey, 2020). View is to the south.

The application proposes a change to the existing abstractions by amalgamating three takes into one take during times of low flows. It also proposes residual flows for some takes and a reduction in the total rate of abstraction and annual volume.

3. REVIEW OF HYDROLOGY

Flow statistics

Hickey (2020) provides observed flow statistics for the Pig Burn at the Gorge flow recorder during the irrigation season (Oct – April) between 2010 and 2019. Some of these years have incomplete data at the recorder site and as such only five seasons were used to calculate flow statistics. It is noted that these flow statistics are based on observed flows rather than naturalised flows and it is common practise to naturalise flows for upstream abstractions to calculate naturalised flow statistics. Hickey comments that '*the two takes upstream of the Gorge flow site take very little water during summer low flows*'. A review of the available flow data at the Gorge and abstraction data (for these two upstream takes) indicates that very little water was taken during times of low flow in the 2016-2017 and 2017-2018 season. However, for the 2018-2019 season the recorded

abstraction was between 22 and 30 L/s during the 7 day annual low flow (7D ALF) recorded at the gorge. Table 1 below shows the difference between the observed and naturalised 7D ALF for the 2016-2017, 2017-2018 and 2018-2019 season. Only these three seasons could be assessed as abstraction for the two upstream takes is only available from 2016 onwards.

Table 1: Difference between observed 7 day annual low flow and naturalised 7 day annual low flow

Season	Observed 7D ALF	Naturalised 7D ALF
2016-2017	74	78
2017-2018	33	36
2018-2019	46	72

Based on this initial review it is likely that the naturalised 7 day mean annual low (7D MALF) will be slightly higher than the observed 7D MALF. The available flow data also indicates that at times a reasonable proportion of the flow is abstracted by the upstream takes. During times of low flow in the 2018-2019 season this was 35-40% of the flow recorded at the gorge. Therefore in order to provide a better indication of the impact of the upstream takes on the flow regime of the Pig Burn it is recommended that a comparison be undertaken between the observed and naturalised flows at the gorge for a range of flow statistics. This should include flow statistics for the observed and naturalised flow for the following flow statistics: minimum, 7D ALF, 90th percentile, lower quartile, median, mean and upper quartile.

It is noted that ideally a long-term flow record is used to estimate the 7D MALF and other flow statistics. In this case the available period of record is relatively short and it appears that there is no long term flow record available in a neighbouring catchment that could be used for regression analyses to provide an estimate of the likely long term 7D MALF at the site. However, an indication of whether the 7D MALF is likely to be similar, greater or smaller than the short term 7D MALF can be provided by using the long-term flow record of the Taieri River at Waipiata. A quick comparison between the 7D ALF's in the Taieri River at Waipiata and the Pig Burn indicates that the summer low flows, for the seasons with available flow data at the Pig Burn, were relatively low compared to the 7D ALF's over the full available record period for the Taieri at Waipiata (1992-2019). It is recognised that this recorder is at a location on the river that drains a much greater catchment area and is influenced by upstream takes. However, the comparison does indicate that the calculated long term 7D MALF is likely to be greater when a longer-term record is available at the Pig Burn.

A report from ORC labelled '*Management Flows for Aquatic Ecosystems in the Pig Burn*' (Xiaofeng and Ravenscroft, 2016) includes hydrological analyses undertaken for the Pig Burn. The applicants have not reviewed or commented on this report in the application. This ORC report estimated the naturalised 7D MALF for the Pig Burn using the combined ratio method. This method uses the short-term natural flow record of a neighbouring catchment (Sow Burn at Carr's intake) to estimate the natural 7D MALF for the Pig Burn at the Gorge. The reason for using this method was that (at the time of writing that report) no abstraction data was available for the takes upstream of the Pig Burn at Gorge flow recorder. The flows recorded in the Sow Burn at Carr's intake were assumed to be very close to the natural flow regime and as such this record was used to estimate the natural 7D MALF for the Pig Burn. The combined ratio method uses the natural 7D MALF of the Sow Burn at Carr's intake along with the catchment area and median aerial rainfall to estimate the naturalised 7D MALF for the Pig Burn. Based on this method ORC estimated a naturalised 7D MALF for the Pig Burn at the Gorge of 79 L/s. It is noted that the 7D MALF estimate for Sow Burn at Carr's intake (which was used to estimate the naturalised 7D MALF for the Pig Burn at Gorge) is also based on a relatively short flow record (2007-2012) and as such there are uncertainties associated with this estimate for the natural 7D MALF for the Pig Burn at Gorge. Overall, it needs to be recognised that limited hydrological data is available and that there are uncertainties associated with any 7D MALF estimate for the Pig Burn.

In summary, PDP agree with the short term observed flow statistics provided by the applicant but consider it prudent to recognise that the long term modified 7D MALF and naturalised 7D MALF is likely to be greater than 53 L/s. Continuation of the flow monitoring in the Pig Burn at the Gorge and at the takes will improve the naturalised 7D MALF estimates over time. To provide a better indication of the impact of the takes upstream of the Gorge flow recorder on the flow regime of the Pig Burn it is recommended that a comparison be made between the observed and naturalised flow regime at the gorge using a range of flow statistics.

Longitudinal flow profiles

To provide an indication of losses and gains in the Pig Burn as it flows through the Maniototo Plain the applicant has provided longitudinal flow profiles between the Gorge flow recorder and the confluence with the Taieri River. Flow profiles have been provided at the observed 7D MALF (53 L/s at the Gorge flow recorder) and at a flow of 31 L/s (at the Gorge flow recorder) as recorded on 17 January 2018. Based on observations from the Pig Burn water users group and measured abstraction rates for the takes, the applicants have identified two losing and two gaining reaches. Overall, the flow profiles provide a very useful and reasonable indication of the general pattern of the losing and gaining reaches in the Pig Burn. However, as recognised by the applicants, losses (especially in the lower losing reach) can vary significantly depending on groundwater levels. Gauging information provided by ORC indicates that on 21 January 2020 a longitudinal gauging run was undertaken by ORC staff at a flow of 99 L/s at the Gorge recorder site. This gauging run was not analysed by the applicant. Considering the likely variability in the rate of the losses and gains it is recommended that this gauging run is analysed to provide further insight into the flow regime of the lower Pig Burn. This gauging run should be analysed for losses and gains under the natural, existing and proposed flow regime using the results from the gauging run along with the take rates from the abstractors on this day. It is noted that this information may not have been available to Water Resource Management Ltd (Matt Hickey) at the time of writing his report (which was dated January 2020). The analyses should clearly explain the assumptions made and flow rates used for modelling the existing, naturalised, and proposed flow regime.

Figure 6 and 10 in the Hickey (2020) report provide a long section of the observed flow regime on 17/1/2018 (at a gorge flow of 31 L/s). The observed flow regime in Figure 6 for this day differs from the observed flow regime in Figure 10. Flows in the gaining reaches (especially the upper gaining reach) in Figure 6 are significantly higher than in Figure 10. Water Resources Management Ltd should clarify this discrepancy and (if required) update the longitudinal flow profiles. It is noted that if the observed flows in the upper gaining reach are close to 20 L/s (as shown in Figure 6) on 17 January 2018 then there is little difference between the proposed and observed flow regime for the upper gaining reach (refer to Figure 10). Updated longitudinal profiles should be provided along with a clear description of the assumptions made and flow rates used for the modelling. Flow rates, calculations and abstraction rates for the observed, natural and proposed flow regime should be provided in table format such that calculations can be reviewed. This information should also be provided for Figure 9 which provides a longitudinal flow profile at the observed 7D MALF (53 L/s).

Although the recent gauging run will provide some additional information regarding the gains and losses in the Pig Burn it is considered that there is significant uncertainty regarding the (natural) flow regime in the Pig Burn. If required to support/complete the assessment of effects on the ecology it may be beneficial to undertake further concurrent gaugings between the Gorge flow recorder and the Pig Burn upstream of the confluence with the Taieri River. Ideally this would include one or two gauging runs during winter low flow conditions as well as another gauging run during summer low flows. The winter gauging runs will provide a better understanding of natural gains and losses when most of the takes are not operating (although losses are likely to be slightly smaller than in summer due to higher groundwater levels).

Residual Flows

The applicant has proposed residual flows for several takes from the Pig Burn. No information has been provided, nor are any consent conditions proposed regarding residual flow monitoring.

Some comments are provided by the applicants regarding the increased flows in the Pig Burn as a result of the 70 L/s proposed residual flow for the Herlihy Ford Take. The longitudinal profiles provided focus on flows at or below 53 L/s. It would useful if the applicants can provide further comments and/or hydrological analyses (for example longitudinal profiles at higher flows) to show the impact of this proposed residual flow on the lower Pig Burn.

4. SUMMARY

Considerations and recommendations for ORC from this technical review are summarised below:

- PDP agree with the short term observed flow statistics for the Pig Burn at Gorge during the irrigation season. However, the naturalised 7D MALF at the gorge flow recorder is likely to be slightly greater than the observed 7D MALF. A relatively short flow record is available at the Gorge and the long term

modified and naturalised 7D MALF is likely to be greater due to the flow record covering a period with relatively low summer flows.

- To provide an indication of the effect of the upstream takes on the flow regime of the Pig Burn it is recommended that a comparison be made between the observed and naturalised flows for the period of available flow data at the gorge and abstraction data at the takes upstream of the Gorge. This should include flow statistics such as minimum, 90th percentile, lower quartile, median, mean and upper quartile.
- The long sections provided by the applicant provide a useful and reasonable indication of the general pattern of gaining and losing reaches in the lower Pig Burn downstream of the Gorge. However, as recognised by the applicants, losses (especially in the lower losing reach) and gains can vary significantly depending on groundwater levels. ORC has recently undertaken a concurrent gauging run (i.e. gaugings on the same day) at several locations in the lower reaches of the Pig Burn. This information should be analysed (in combination with the abstraction data) to provide a better indication of the gains and losses in the lower Pig Burn under the natural, existing and proposed flow regime.
- The longitudinal profiles for the observed flow on 17 January 2018 in Figure 6 and Figure 10 in the Hickey (2020) report are inconsistent. If required, the longitudinal profiles in the report should be updated and a clear description should be provided outlining the model assumptions and flow rates used for the modelling. Flow rates, calculations and abstraction rates for the observed, natural and proposed flow regime should be provided in table format such that calculations can be reviewed. This information should also be provided for Figure 9 which provides a longitudinal flow profile at the observed 7D MALF (53 L/s).
- Although the recent gauging run will provide some additional information regarding the gains and losses in the Pig Burn it is considered that there is significant uncertainty regarding the (natural) flow regime in the Pig Burn. If required to support/complete the assessment of effects on the ecology it may be beneficial to undertake further concurrent gaugings between the Gorge flow recorder and the Pig Burn upstream of the confluence with the Taieri River. Ideally this would include one or two gauging runs during winter low flow conditions as well as another gauging run during summer low flows. The winter gauging runs will provide a better understanding of natural gains and losses when most of the takes are not operating (although losses are likely to be slightly smaller than in summer due to higher groundwater levels).
- The applicant has proposed residual flows for several takes from the Pig Burn. No information has been provided, nor are any consent conditions proposed regarding residual flow monitoring.
- Some comments are provided by the applicants regarding the increased flows in the Pig Burn as a result of the 70 L/s proposed residual flow for the Herlihy Ford Take. The longitudinal profiles provided focus on flows at or below 53 L/s. It would useful if the applicants can provide further comments and/or hydrological analyses (for example longitudinal profiles) to show the impact of the 70 L/s proposed residual flow on the lower Pig Burn.

References

Hickey, M. (2020). Assessment of Effects on Instream Ecology due to Water Takes from the Pig Burn. Assessment undertaken by Matt Hickey, Water Resource Management Ltd. January 2020. Prepared for the Pig Burn Water Users Group;

TECHNICAL MEMORANDUM

McKeague Consultancy Ltd (2020). Collective replacement of Permits to Take and Use Surface Water. Resource Consent Application and Supporting Information.

Xiaofeng, L., Ravenscroft, P. (2016). Management Flows for Aquatic Ecosystems in the Pig Burn.