From:	Georgina Hamilton
To:	Plan Hearings
Cc:	Judy Blakemore; mwebb; "Andrew Mockford"; Julia Crossman; Greg Ryder; Richard Measures; Tim Kerr; Tim Ensor
Subject:	Plan Change 7: Adaptive Management Working Group (PC7-385) - Evidence in Chief
Date:	Friday, 17 July 2020 5:11:43 pm
Attachments:	Evidence in Chief of Judy Blakemore (AMWG) 17.7.20.pdf Evidence in Chief of Mark Webb (AMWG) 17.7.20.pdf Evidence in Chief of Andrew Mockford (AMWG) 17.7.20.pdf Evidence in Chief of Julia Crossman (AMWG) 17.7.20.pdf Evidence in Chief of Dr Gregory Ryder (AMWG & OWL) 17.7.20.pdf Evidence in Chief of Richard Measures (AMWG) 17.7.20.pdf Evidence in Chief of Tim Kerr (AMWG) 17.7.20.pdf Evidence in Chief of Tim Ensor (AMWG) 17.7.20.pdf

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Dear Tavisha

We act for the Adaptive Management Working Group (**AMWG**), submitter no. PC7-385.

We **attach** for filing, in relation to the above matter, statements of evidence in chief of the following witnesses on behalf of the AMWG:

1. Judy Blakemore (AMWG representative – Timaru District Council)
2. Mark Webb (AMWG representative – Fish and Game)
3. Andrew Mockford (AMWG representative - Opuha Water Limited)
4. Julia Crossman (AMWG representative - Opuha Water Limited)
5. Greg Ryder (ecology/freshwater quality) – please note that this statement of evidence also addresses matters pertaining to Opuha Water Limited's (OWL's) submission on PC7 and has been filed with the evidence of other OWL witnesses today).
6. Richard Measures (artificial freshes)
7. Tim Kerr (modelling)
8. Tim Ensor (planning)

Kind regards,

Georgina Hamilton
Partner

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BEFORE INDEPENDANT HEARING COMMISSIONERS
APPOINTED BY THE CANTERBURY REGIONAL COUNCIL

UNDER:	the Resource Management Act 1991
IN THE MATTER OF:	Proposed Plan Change 7 to the Canterbury Land and Water Regional Plan – Section 14: Orari-Temuka-Opihi-Pareora

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STATEMENT OF EVIDENCE OF MARK WHITBY WEBB ON BEHALF OF THE ADAPTIVE MANAGEMENT WORKING GROUP (SUBMITTER NO. PC7-385)

Dated: 17 July 2020

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1. INTRODUCTION

1.1 My full name is Mark Whitby Webb. I am employed as a Fish and Game Officer by Fish and Game New Zealand within the Central South Island Region ("**Fish and Game**") based at Temuka. I have held this position for 35 years.

1.2 Fish and Game is a member of the Adaptive Management Working Group ("**AMWG**"). My evidence is provided in my capacity as Fish and Game's representative on the AMWG, but is endorsed by Fish and Game.

1.3 I have also prepared a statement of evidence in support of the PC7 submissions by Fish and Game (Submitter ID 351) and the Opihi Flow and Allocation Working Party (Submitter ID 382). Where I address matters in this statement of evidence that are common with my Fish and Game evidence, I have cross-referenced that evidence to minimise duplication.

Qualifications and experience

1.4 I graduated from the University of Canterbury with a BSc in 1979 and have since worked for the Ministry of Agriculture and Fisheries, the former South Canterbury Acclimatisation Society and from 1990 its successor, the Central South Island Fish and Game Council. With that experience I have acquired a sound understanding of habitat requirements of sports fish and game birds, the recreation supported by these species and conflicts associated with water allocation and use.

1.5 I have been a community appointee on the Orari Temuka Opihi Pareora ("**OTOP**") Zone Committee since its inception in 2010 and have participated on community steering groups that developed the Pareora Catchment Environmental Flow and Allocation Regional Plan and Policies relating to the Orari River Catchment contained in sub-regional section 14.4 of the (then) proposed Canterbury Land and Water Regional Plan.

1.6 During the Opuha Dam development in the mid 1990's, I modelled unmodified Opihi River flows and potential minimum flow scenarios from the 20-year flow record to recommend best use of the environmental component of Opuha Dam storage as minimum flows in the Opuha and Opihi rivers.

1.7 Fish and Game has been represented on the Opuha Environmental Flow Release Advisory Group ("**OEFRAG**"), which was established by the Opihi River Regional Plan became operative in September 2000 as an advisory to ECan on flow releases from the Opuha Dam. While I am not the designated Fish and Game representative on OEFRAG, I have commonly attended meetings in that person's absence since 2015 to provide advice on flow needs for river health and recreation.

Background

1.8 As a member of the OTOP Zone Committee I have contributed to the development of the OTOP Zone Implementation Programme. This has involved many public meetings throughout the Zone and I have been the Zone Committee's representative on five Catchment Groups including Upper Opihi, Opuha, Lower Opihi and Waihi – Temuka.

1.9 The Zone Committee's work culminated in publication of the OTOP Zone Implementation Programme Addendum ("**ZIPA**") in December 2018 that contained the Zone Committee's recommendations to Canterbury Regional Council ("**CRC**") for water quality and quantity limits for inclusion in the Canterbury Land and Water Regional Plan ("**LWRP**") through the planning process known as Plan Change 7 ("**PC7**").

1.10 I am familiar with the provisions of PC7 to which these proceedings relate. In preparing my evidence, I have reviewed the relevant parts of the section 32 Report and the section 42A Report. In preparing my evidence, I have also reviewed:

(a) Jellyman P. 2019. Lower Opihi River ecological flow assessment. NIWA client report 2019231CHC prepared for Environment Canterbury.

(b) Evidence of other AMWG witnesses, including Judy Blakemore, Greg Ryder, Tim Kerr, Richard Measures, Andrew Mockford and Julia Crossman.

Code of Conduct

1.11 I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court's Practice Note as updated in 2014. My evidence has been prepared in compliance with that Code. In particular, unless I state otherwise, this evidence is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

2. SCOPE OF EVIDENCE

2.1 My evidence provides an assessment of PC7's proposed augmentation regime, particularly the minimum flows proposed in Table 14(v) and (w), and the amendments sought by the AMWG from a sports fish habitat and recreational perspective.

2.2 My evidence is structured as follows:

(c) OEFRAG experience with adaptive management of the Opuha Dam;

(d) An assessment of the PC7 minimum flow regimes and the AMWG's proposed changes from a sports fish habitat and recreational perspective;

(e) Commentary on the Opihi River mouth and lagoon;

(f) Comments on issues raised in the Section 42A Report; and

(g) Conclusions.

2.3 I note that my Fish and Game evidence provides a summary of my experiences in the Opihi catchment prior to and post the commissioning of the Opuha Dam and historical background to the current minimum flow and augmentation regime for the Opihi River at Saleyards Bridge under the ORRP. That evidence provides background and context to the matters I address in this statement of evidence.

3. EXECUTIVE SUMMARY

3.1 The AMWG makes its submissions to the Hearing Panel based on the experience of its members with the Opihi River prior to 1998 and environmental responses to management and operation of the Opuha Dam under the ORRP.

3.2 Over the period of the 2014/15 drought Lake Opuha reached its lowest ever storage level and was within 50mm of being empty at which point outflows from the Dam would have equalled inflows to the lake. Between December 2014 and July 2015 Opihi River flows at Saleyards Bridge and abstraction for OWL affiliated irrigators was controlled by Water Storage Directions recommended by OEFRAG and implemented by CRC under section 329 of the Resource Management Act 1991 ("**RMA**").

3.3 At approximately weekly intervals between December 2014 and April 2015, OEFRAG met to discuss water management in the Opihi Catchment and apply the knowledge of members to immediate needs of the community and environment. I believe OEFRAG was an excellent forum for community members with experience in the catchment to be involved in finding an agreed path through the drought.

3.4 From the 2014/15 experience the most important lessons learnt were –

(a) A lake level of 385m is too late to introduce storage saving;

(b) Three tiers of responses are required to manage river flows that cover full availability, minimum availability, and a mid-level that prepares for a worsening situation;

(c) When snow pack, inflows and the lake are at low levels the OEFRAG members used their experience, defined as discretionary indicators, to make the best use of Opihi flows for the river and irrigation;

(d) The experience of OEFRAG members has been reflected in a set of secondary factors, which in addition to the discretionary indicators referred to above, should inform discussions as to whether or not minimum flow reductions and irrigation restrictions should be applied; and

(e) The bottom line is to retain connectivity in the river – a dry riverbed has no ecological or recreational values.

3.6 These lessons are the foundation of the AMWG submissions. None of these lessons have been reflected in the planning framework proposed by PC7 or the Section 42A Officer report recommendations, and indeed there appears to be no desire for a continuing role for OEFRAG.

3.7 Proposed PC7 Full Availability and Level 1 and 2 minimum flows and Officers Report Level 1 and 2 minimum flows provide higher flows in the river at Saleyards Bridge in the short term, at lower lake levels than the AMWG flow regime, but the cost of this is a greater likelihood of a dry riverbed when low inflows persist. A dry riverbed is the worst outcome for the ecology of the Opihi River.

3.9 There is undisputed evidence that the Opuha Dam has reduced the frequency and duration of Opihi River mouth closures. Opuha Dam environmental flow release has sustained greater than 2-fold improvement in minimum flows compared to those provided in the 1984 Opihi River Catchment and Regional Plan. This has increased availability of preferred salmon fishing conditions at the river mouth and increased the distribution of salmon spawning in the Catchment by providing flows that enable fish passage.

3.11 Increased minimum flows in January and February proposed by AMWG in response to public concerns, provide better conditions than PC7 and the Officer Report in the Full Availability regime for trout fishing in the lower river when modelled as drift feeding adult brown trout habitat

3.12 October, March and April cover peaks trout fishing months at the start and end of the fishing season. Compared to PC7 and Officer Report Full Availability regimes the AMWG regime provides more adult drift feeding brown trout habitat, more juvenile trout habitat and more food producing habitat.

3.13 The AMWG proposed full availability flow regime for May to September provides more habitat for brown trout and salmon spawning than proposed PC7 and the Officer report.

3.14 The November and December full availability regimes for PC7 and Officer Report are modelled to provide minor positive benefit to adult brown trout habitat over that predicted for AMWG. The extra storage used at that time of the year has to be balanced against the cost of not having that storage later in the summer and in to the spawning season.

3.15 The experience of the 2014/15 drought made it clear to OEFRAG that relying on implementing a single restricted minimum flow regime when the Lake Opuha level reaches 385masl was too little too late. At 385m 50% of storage has already gone and the restrictions proposed by OEFRAG in its 2008 Draft Plan Change did not conserve storage to the level necessary to maintain connectivity in conditions like those of the 2014/15 season. The AMWG proposed Alternative Management Regimes Level 1 and 2 regimes provide a balance between early intervention to conserve storage while providing river flows that maintain natural spring and autumn flow variability. Proposed Level 2 flow of 3,500 L/sec at Saleyards has historically been identified as the minimum flow to maintain ecosystem health and will maintain connectivity throughout the river.

4. ADAPTIVE MANAGEMENT

4.1 In her evidence for the AMWG, Ms Judy Blakemore has explained the various roles of OEFRAG and the relationship between OEFRAG and the AMWG. Together the members of the AMWG have considerable experience and understanding of the Opihi River system and most are long standing OEFRAG participants.

4.2 As Ms Blakemore has noted, AMWG members have spent a considerable amount of time and effort over the last three years carrying out extensive modelling and analysis to inform the development of key elements of a potential adaptive management regime for inclusion in PC7. The AMWG's primary aim of incorporating an adaptive management regime into PC7 has been to make best use of the storage capability of Lake Opuha to –

(a) Retain connectivity in the Opihi River and reliability of supply to the river, affiliated community water supply and affiliated irrigators; and

(b) Improve river health in the downstream catchment.

4.3 Underlying the AMWG various workstreams has been an intention to award priority to the environment, followed by community supplies then irrigation.

4.4 I believe that the experience gained by OEFRAG through the operation of the Opuha Dam since 1998 and in particular over the 2014-16 low flow situation demonstrated that adaptive management of the Opuha Dam would provide better environmental outcomes for the Opihi River than the ORRP's prescriptive SYB minimum flow regime.

4.5 Through the winter and spring of 2014, there were very low inflows and snowfall in the catchment above the Opuha Dam. Despite this, Dam storage was about 10% above average at 91% full heading into October, the month with the highest environmental flow requirement. The lack of snow melt and continuing low flows, combined with the early start to the irrigation season, saw a very heavy demand on storage and an unprecedented October drawdown in the lake to 67% full. Typically, lake storage increases through October driven mainly by melting snow.

4.6 OEFRAG first met in early November 2014 and agreed to recommend to ECan restrictions on the minimum flow and consented abstraction using a Water Shortage Direction if the lake continued to decline to 50% of full. In December, OEFRAG recommended WSD's at fortnightly intervals that first reduced irrigation by 25% and the minimum flow by 17% and then further reductions to 50% and 42% respectively. On 16 February when lake storage reached 14%, OEFRAG recommended a minimum river flow of 2,500 L/sec at Saleyards, a minimum not seen since before the Dam was commissioned. This flow was the equivalent of a 30% reduction on the 3,500 L/sec Saleyards Bridge minimum flow for February in the ORRP.

4.7 There was agreement by OEFRAG members in early March 2015 that reduction in the minimum flow below 2,000 L/sec would compromise connectivity of the Opihi River. The irrigation schemes supplied by Opuha Water Limited agreed to a complete shutdown of takes from 6 March 2015 and on that day there remained 5% of storage in the lake dedicated to maintaining river connectivity for as long as possible. On 11 March, at 3% storage (372m) the minimum flow was reduced to 2,000 L/sec at Saleyards Bridge, equivalent to a 70% reduction from the March minimum flow in the ORRP.

4.8 On 25 March 2015 with the lake within 90mm of “zero” there was rain in the catchment sufficient to maintain the minimum flow and lake storage above zero. Lake level reached 375m on 25 April and the minimum flow was raised to 4,000 L/sec. If the minimum flows had been set any higher than 2,000 L/sec between 11 March and 25 April and had irrigation not been restricted from 1 December 2014, it is almost certain that the lake would have emptied and the Opihi River would have run dry. From experience with previous salvage operations in the Opihi, I estimate that 45 days of flows less than 2,000 L/sec at Saleyards Bridge would have resulted in dewatering of about an 8km reach of the river down to the Temuka junction with estimated sports fish losses or salvage of 10,000 trout and salmon.

4.9 As I have outlined in my evidence for Fish and Game, based on my own observations of flows in the Opihi River during the summer of 2014/15 and previous hydrological analysis, I consider that a flow of at least 2,000 L/sec at Saleyards Bridge is required to maintain connectivity in the Opihi River downstream to the Temuka River junction. At a level of 370 m RL Lake Opuha retains a volume of approximately 5.1 M m^3 and a wetted area of approximately 89ha. The residual lake has a maximum depth of about 20m deep and would have an average depth of 5.8m. In a short-term reduction of the lake to this residual condition, I would not expect noticeable fish mortality. However, after 15 days I believe adult trout would be stressed and losing further condition, with mortalities starting to occur after 30 days. A total collapse of the lake trout population would result in up to approximately 5,000 adult trout and 25,000 juvenile trout deaths and six to 10 years for the fishery to naturally recover. Fish would be impossible to rescue from the residual lake.

4.10 While the potential losses to the trout fishery of Lake Opuha are high if the lake is held for long period at low levels, it is my opinion that maintaining flows for the trout and salmon fisheries of the Opuha and Opihi rivers are the higher priority for use of Lake Opuha storage.

5. ENVIRONMENTAL FLOW REGIMES AND RECREATION

5.1 Dr Greg Ryder has conducted an ecological assessment of the minimum flows proposed by PC7 for SYB and the changes sought by the AMWG in his evidence based on the lower Opihi River ecological flow assessment by NIWA

(Jellyman, 2019). In the following paragraphs, I consider these alternative minimum flow proposals from a recreational angling perspective, based on my own experience and knowledge of the Opihi River, Dr Ryder's evidence for AMWG and the NIWA assessment.

"Full availability" minimum flows

2025 and 2030 "Full availability" minimum flows

January and February Saleyards Bridge Minimum Flows

5.2 PC7 simply rolls over the ORRP's minimum flow regime at SYB for January and February that applies when the water level in Lake Opuha is above 375m (i.e. 3,500 L/sec), which appear as part of the "full availability" management regime in Table 14(v). It then proposes an increase in these "full availability" flows to 3,800 L/sec in 2030 (Table 14(w)).

5.3 The AMWG has sought amendments to the Table 14(v) full availability flow regime (set out in its submission in a new Table 14(v(ii)) to addresses public concern about adverse effects on recreation of low minimum flows in January and February. The AMWG's amendments raise the minimum flows in these months to 4,500 L/sec by an increase of 1,000 L/sec in each month from current (ORRP) levels, and are supported by Fish and Game.

5.4 Comparing the AMWG's proposed minimum flows to PC7 2030 minimum flows it is predicted that the AMWG proposed regime results in more habitat for all modelled invertebrate species (+1.5% to +4.8%) and adult brown trout (+18%).

5.5 The habitat suitability criteria for adult brown trout used in the lower Opihi River ecological flow assessment by NIWA that informed PC7, were for drift feeding adult brown trout (Jellyman, 2019). This habitat has a close association with trout angling as it is feeding adult brown trout that the angler seeks. A predicted 18% increase in drift feeding habitat for brown trout in the AMWG minimum flow regime in January and February is a significant improvement over that predicted to be present under the PC7 2030 regime.

5.6 The AMWG's proposed January and February Full Availability minimum flows are predicted to provide better conditions for trout fishing than the PC7 2030

regime. Higher minimum flows in the Opihi River mainstem will also increase the time the river mouth is open to the benefit of salmon angling.

March, April, October Saleyards Bridge Minimum Flows

5.7 Acknowledging the original constraint on the variable flow regime first proposed to Fish and Game by the Opuha Dam Company, that on an annual basis it should not exceed the volume of water that would have been released to maintain an annual average minimum flow of 6,000 L/sec, the AMWG have proposed reduced minimum flows in March, April and October to compensate for increased minimum flows proposed in January and February. Again these are supported by Fish and Game.

5.8 The AMWG's Full Availability regime proposes minimum flows of 7,000 L/sec for March and April and 8,000 L/sec for October. From a recreation perspective these flows are at or above the flow required to maintain the mouth open 90% of the time, and will maintain fish passage throughout the river.

5.9 Compared to the PC7 2025 and PC7 2030 Full Availability regimes the AMWG regime provides more adult brown trout (drift feeding) habitat, more juvenile brown trout rearing habitat, and more food producing habitat in all three months than both the PC7 regimes and provides more salmon spawning habitat in April than both the PC7 regimes.

5.10 April Full Availability minimum flow for the AMWG regime is lower than both PC7 regimes. Some of the justification for a lower April AMWG flow is to recoup lake storage used to maintain higher January and February minimum flows and April was considered an opportunity for this as high recreational flows for salmon fishing are no longer required in April with the season closed for salmon fishing since 2006.

5.11 October is the first month of the trout fishing season and is the most fished month of the season while April as the last month of the trout fishing season also sustains above average activity. PC7 2025 and PC7 2030 flow regimes both provide less predicted adult trout habitat in October and April than the AMWG flows and potentially impact negatively on trout fishing.

May, June, July, August, September Saleyards Bridge Minimum Flows

5.12 May, June, July cover the winter months and the flow of the Opihi River is naturally low. All fish and invertebrate species will be subject to low metabolic rates commensurate with low water temperature. Provided minimum flows are sufficient to enable fish migrations where these are necessary, then the need for minimum flows that are higher than current levels is not justified. The proposed AMWG and PC7 2025 regimes retain current winter flows, and the PC7 2030 regime adds 0.8m^3/s onto May, June and July flows. I do not believe the PC7 2030 increased flows are justified on any recreational or sports fishery grounds.

5.13 The AMWG's proposed Full Availability minimum flows for May to September provide more habitat for brown trout and salmon spawning than proposed PC7 2030 flows and better ensure sustainability of those recreational fisheries.

5.14 Waterfowl hunting is a significant recreational activity on the river during winter. An estimated 500 hunters will hunt in the Opihi Catchment each waterfowl hunting season. The proposed AMWG April and May Full Availability flows are more stable for waterfowlers ensuring that hunting sites selected on Tagging Day in the first week of April are more likely to remain huntable at the opening of the waterfowl season in the first week of May. PC7 2030 provides the greatest opportunity for interference with waterfowl hunting by having the biggest difference in the minimum flows for these months compared to the AMWG and PC7 20205 regimes. The AMWG's proposed April and May flows provide more security to waterfowlers than either of the PC7 (2025 or 2030) proposed flows and is also better than current ORRP minimum flows.

November and December Saleyards Bridge Minimum Flows

5.15 The proposed AMWG and PC7 2025 Full Availability regimes seek to retain existing minimum flows of 7,000 L/sec and 6,000 L/sec in November and December respectively. The proposed PC7 2030 regime proposes a 300 L/sec increase for both months.

5.16 As I have outlined in my Fish and Game evidence, the small increases in the proposed PC7 2030 minimum flows have minor positive benefits for adult trout and invertebrate habitat availability in November and minor negative benefits to the same habitat in December compared to current ORRP, and proposed AMWG and PC7 2025 regimes.

5.17 In my opinion, the minor positive and negative impacts to trout fishing and invertebrate habitat under the proposed PC7 2030 regime, from provision of 300 L/sec above the current ORRP, and proposed AMWG and PC7 2025 minimum flows in November and December, do not justify the loss of storage. At that time of year retaining storage can be critical to maintaining Full Availability minimum river flows with higher sports fish habitat and fishing values later in summer and autumn.

Justification for 2030 “Full availability” minimum flows

5.18 I understand that part of the justification for the proposed increases to Saleyards Bridge minimum flows at 2030 in Table 14(w) of PC7 is that the ZIPA at recommendation 5.3.1(i)(e) states that:

> …*all flow gains achieved by minimum flow increases on the Upper Opihi and Te Ana Wai rivers remaining in the mainstem of the Opihi River, and not being available for abstraction, and should be reflected in the minimum flows measured at Saleyards Bridge.*

5.19 In my view, there are three significant issues with this recommendation-

(a) The increases in 2030 minimum flows in the two named tributaries combined add up to monthly increases that range from 260 L/sec in December to March to 820 L/sec in May to July. These increases in the tributary minimum flows are much less than the increases in monthly flows that have been proposed for Saleyards Bridge from 2030 of from 300 L/sec to 1,000 L/sec (Table 14(w)). This point is demonstrated in the following table, which compares the total increase in minimum flows under PC7 from the Upper Opihi and the Te Ana Wai against the increases in Saleyards Bridge minimum flows from Table 14(w):

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Upper Opihi	Current	790	790	790	1280	1280	1280	1280	1280	1280	1280	790	790
	2025 flows	850	850	900	1500	1500	1500	1500	1500	1500	1400	950	850
	2030 flows	1000	1000	1000	1500	1500	1500	1500	1500	1500	1400	1000	1000
	Upper Opihi increase (current-2030)	**210**	**210**	**210**	**220**	**220**	**220**	**220**	**220**	**220**	**120**	**210**	**210**
Te Ana Wai	Current	400	400	400	400	600	600	600	600	500	400	400	400
	2025 flows	450	450	450/550	700	1200	1200	1200	1100	900	700	550/500	450
	2030 flows	450	450	450/550	700	1200	1200	1200	1100	900	700	550/500	450
	Te Ana Wai increase (current-2030)	**50**	**50**	**50/100**	**300**	**600**	**600**	**600**	**500**	**400**	**300**	**150/100**	**50**
	TOTAL Upper Opihi and Te Ana Wai increases (current to 2030)	**260**	**260**	**260/310**	**520**	**820**	**820**	**820**	**720**	**620**	**420**	**360/310**	**260**
Mainstem	Current												
	2025 flows	3500	3500	7500	8000	4500	4000	4000	4500	6000	8500	7000	6000
	2030 flows	3800	3800	7800	9000	5300	4800	4800	5200	6600	9400	7300	6300
	TOTAL Mainstem increase	**300**	**300**	**300**	**1000**	**800**	**800**	**800**	**700**	**600**	**900**	**300**	**300**

(b) Minimum flow levels applied at Saleyards Bridge are maintained by release from Dam storage during times when natural river flows cannot meet the specified Saleyard Bridge minimums. Increased minimum flows in the Upper Opihi and Te Ana Wai are not sustained by release of water from storage. They are sustained by reduction in abstraction. If the tributaries are at or below their minimum flows and there is no abstraction then higher minimum flows are just a statement in a plan that cannot be naturally or artificially sustained. If these tributaries are at or below their minimum flows, there is no justification for higher minimum flows at Saleyards Bridge to be sustained by release from the Dam on the basis that there is more flow coming from the tributaries (as required by ZIPA recommendation 5.3.1(i)(e)).

(c) In times of low flow when abstraction has ceased in the tributaries and they are naturally below their minimum flow levels, the PC7 full availability scenario from 2030 (Table 14(w)) will require more storage to be released from the Dam to maintain higher Saleyards Bridge flows on the basis that tributary minimum flows will be higher when in reality they won't be. Dr Kerr has confirmed that this "lost" storage is in the order of 5.2 million cubic metres on average per year or 8% less stored water on average per year. The proposed increase in minimum flows at 2030 will only hasten reduction in storage and cannot be justified when tributary flows are naturally at or below their minimum flows.

(d) No assessment of the cost of this recommendation in terms of additional use of Dam storage to maintain the increased Saleyards Bridge minimum flows and the increased risk of higher level flow restrictions at Saleyards Bridge due to loss of storage was provided to the Zone Committee to support this recommendation (or in the Section 32 Report in relation to Table 14(w)).

(e) As noted in the AMWG's submission, the approach raises issues of equity as PC7 does not include a commensurate increase in minimum flows for AN permits at SH1 (Table 14(u)).

5.20 For these reasons, I believe there is justification for the AMWG's primary request that Table 14(w) be deleted.

"Alternative management" minimum flows

5.21 In January and February in response to public concern at loss of recreation in mid-summer under the current ORRP, the AMWG Level 1 and Level 2 Alternative Management regimes have higher minimum flows than current ORRP, and proposed PC7 2020 and PC7 2025 flows. In all other months the AMWG's proposed Level 1 and Level 2 regimes are lower.

5.22 In a drought situation of which the 2014/15 event is an example, I believe the priority for the Opihi River is to retain connectivity. Having great flows for recreation and ecological health right up to the point where the river ceases to flow, even for a day, does not outweigh the damage caused by a dry river and the long-term impacts of this on the ecology of the river. From my experience

with the dry Opihi River before the Opuha Dam I believe a more successful outcome for the health of the river is for it to retain connectivity where otherwise, without the Dam, the river would have been dry.

5.23 In 2008 OEFRAG submitted to ECan an "Application for changes to Opihi River Regional Plan – Consultation Draft". This recommended retaining the existing Full Availability regime for Saleyards Bridge flows and introducing a restriction regime that proposed lower Saleyards Bridge flows for when lake storage was between RL370m and RL 385m equivalent to 0% and 50 % full respectively.

5.24 The experience gained by OEFRAG since 2008 when it recommended a Draft ORRP flow regime change to ECan, and during the 2014/15 drought, identified that if events like the 2014/15 drought are to be survived successfully then management of Dam storage must start when lake levels are higher and restriction levels need to make a meaningful impact on retaining storage. It was also identified that relying on lake level alone as a trigger for reducing flows and imposing restrictions on abstraction would not ensure timely action and that other factors such as snow storage and inflows were just as important.

5.25 Based on experience, the AMWG's proposed Level 1 and Level 2 restriction regimes provide an acceptable balance between conservation and use of Opuha Catchment water availability above the Dam, and environmental health and agricultural production below the Dam. I believe that while the proposed PC7 2025 and PC7 2030 Level 1 and Level 2 restriction regimes provide higher minimum flows in March to December than the AMWG regime, they produce much greater risk of restriction being required beyond Level 2, to the point of a dry riverbed, and more frequently than the AMWG's proposed restrictions. This is supported by Dr Kerr's modelling.

5.26 The AMWG have given careful consideration to an appropriate "bottom line" minimum flow under PC7's proposed Level 2 "alternative management" regime. As Ms Blakemore has explained in her evidence, the AMWG believe that the Level 2 minimum flow should be consistent with the State Highway One minimum flow, which PC7 proposes should increase at 2022 to 2,600 L/sec from the current (ORRP) minimum flow of 2,500 L/sec.

5.27 Based on the work of de Joux that I refer to in my Fish and Game evidence (Section 11), a flow of 2,600 L/sec at State Highway 1 translates to 3,500 L/sec at Saleyards Bridge.

5.28 For completeness, I note that hydraulic modelling studies as early as 1988 have indicated a flow of 3,200 L/sec at Saleyards Bridge will maintain continuous flow in the lower river, will assist with maintaining an open river mouth and that below 3,000 L/sec the habitat available for fish and invertebrates declines rapidly (Sagar and Palmer, 1990). For this reason, I believe that the AMWG's proposed Level 2 minimum flow of 3,500 L/sec is appropriate during severe natural drought events.

Discretionary entry into Level 1 and Level 2

5.29 During the 2015/16 low flow period and since that time OEFRAG have identified criteria for Opuha Lake level, inflow rates and snow pack that are primary indicators of the state of the environment in terms of water storage in the upper Opuha Catchment. These primary indicators have been used to alert OEFRAG that abstraction and environmental flows may need to be altered to make the best use of available storage if catchment conditions are dry, or if storage potential is increasing the indicators have been used to identify that OEFRAG may consider reducing restrictions on abstraction and environmental flows. This is the benefit of a discretionary entry approach into Level 1 and Level 2 regimes as proposed by PC7 and sought to be retained by the AMWG (subject to modification).

5.30 The primary indicators signal that altered flows need to be considered by OEFRAG, not that they must be implemented. The local experience available within OEFRAG enables a number of other environmental factors to be considered before recommending or not recommending a change in outflow from Lake Opuha. While the primary indicators largely identify storage and signal the need for a review, the secondary indicators relate more to ecosystem health. In the deliberations of OEFRAG both primary and secondary factors are reviewed and contribute to the final recommendation. Secondary factors include river connectivity, river mouth status and lagoon health, cultural river health, and general river health.

River connectivity

5.31 One of the key objectives for the original development of the Opuha Dam was to address the problem of the Opihi River running dry during summer with the resultant devastating impact on the in-stream habitat, fisheries, and recreation. It was considered essential to maintain the 'connectivity' of the river to prevent fish from becoming stranded in isolated pools and to maintain a continuous, flow along the entire river bed. During the extreme low conditions experienced in early 2015, the critical low flow reach of the river between State Highway One and the Temuka confluence was closely monitored as river flows were reduced. It was agreed by OEFRAG that a minimum flow of 2,000 L/sec at Saleyards Bridge would maintain connectivity in the Lower Opihi above the Temuka confluence. Given that inflow, Lake level, and snow pack were all well within normal levels, it was the drive by OEFRAG to maintain connectivity that determined outflow from the Opuha Dam and abstraction able to be sustained.

5.32 Since 2015, further analysis of flow and storage has indicated that the Alternative Management Regime Level 2 minimum flow of 3,500 L/sec recommended by the AMWG can be maintained provided the Alternative Management Regime Level 1 restrictions are implemented early enough to maintain storage potential.

5.33 A consequence of the proposed PC7 Table 14(w) Alternative Management Regime Level 1 and Level 2 September to December minimum flows is that the flow required to sustain these will increase the likelihood of storage being depleted to the point of being empty, later in the summer. Proposed PC7 Table 14(w) does not provide a further level of restriction, and therefore would rely on Water Storage Directions being implemented.

River mouth status and lagoon health

5.34 There are many different interests associated with the lagoon and river mouth and ECan have overall responsibility for the management of the area including the maintenance of the river mouth. Assessing the overall condition of the lagoon (e.g. water quality including temperature and water level) and the incoming river flow can be instrumental in decisions around management of the lagoon. The status of the river mouth and lagoon health, as determined through consultation with parties such as Arowhenua, ECan and Fish & Game is an

important assessment factor in determining the flow release from the lake which will impact on inflows to the lagoon.

5.35 The lagoon and river mouth of the Opihi is a naturally dynamic environment where the location and form of the river mouth (connection to the sea) changes daily and can also close up completely if certain sea and river flow conditions prevail. River flow in excess of 6,000 L/sec assists with maintaining an open river mouth which is generally favoured by most people connected to the lagoon and its environs.

5.36 As a typically small coastal foothills fed Canterbury river the Opihi mouth historically closed naturally. With abstraction of surface and connected ground water, mouth closures became more frequent. To a significant degree this has been mitigated by management of storage by the Opuha Dam. I believe the environmental flows released by the Dam assure an open Opihi River mouth with greater frequency than at any time since the Levels Plain Irrigation Scheme was commissioned in 1938. The presence of the Dam assists with flows that maintain good river mouth conditions for seasonal migrations of many fish species – eel, lamprey, torrent fish, flounder, Galaxidae, salmon. In the past when timing has been critical, OEFRAG has considered the migratory needs of individual fish species when assessing environmental flow releases.

Cultural river health

5.37 Cultural river health relates to the views of local Rūnanga on the state of the river in areas of importance to them. Input from Rūnanga is an important assessment factor in any flow assessment process and Arowhenua's participation on OEFRAG has been a very valuable influence.

5.38 Arowhenua input into OEFRAG recommendations has been crucial in consideration of timing of artificial freshes and minimum flow levels and the effect of these on native fish migrations and the state of the river mouth.

General River Health

5.39 An assessment of general river health considers the views of those who are familiar with the Opihi River and includes recreators e.g. anglers, walkers, and professionals e.g.DOC, F&G, ECan. The perception of poor river health may

follow long periods of low or steady flows and indicates the value of artificial freshes and other short term variability.

Monthly flow transitioning and flow variance

5.40 The AMWG support provision for step changes in the minimum flows applying at Saleyards Bridge to be gradually introduced over 48 hours. This is particularly important where the step in flow is downwards – from a month of higher flow to a month of lower flow as proposed in all PC7, Section 42A Report and AMWG regimes for the transition from minimum flows between April and May, October and November, and December to January. Some of these transitions approach a halving of the flow, for example 41% reduction April to May and 40% reduction December to January in the proposed PC7 Table 14(w) Full Availability regime.

5.41 Instantaneous flow reductions of this magnitude are unnatural. To enable aquatic species to adapt to the reduced flow by retreating from drying stream margins and in the worst case, from drying braids that may be hundreds of meters long, a period of adjustment of 48 hours is proposed by the AMWG.

5.42 Transition between minimum flows where the step is up in flow is less important. Braided rivers naturally sustain rapid flow increases from high rainfall events. It is the rapid flow decreases that are not natural and need to be planned for.

5.43 The natural state of flow variability in braided rivers is that flow is constantly changing. Braided rivers are not naturally rigidly held at constant flow. The variable minimum flow regime developed in partnership with the Opuha Dam Company in the 1990's provided for monthly variability in minimum flows at Saleyards Bridge and has been considered a better outcome for river health than one minimum flow all year. Further variability at predefined levels and down to fortnightly or shorter periods appears difficult to define and justify and include as a rule in a plan.

5.44 The variability in the 24 hour average flow provided in proposed Rule 14.4.35(b) appears adequate to allow for a range of flows that may vary by 1,000 L/sec or more over a 24 hour period. The Rule identifies that flows are not permitted to be more than 500 L/sec less than the minimum and the 24 hour average must be the required minimum flow or greater. I believe this rule allows for minor

variability around the minimum flow without the flow receding too far below the minimum to the extent that it would negatively impact on ecological health.

Partial restrictions

5.45 Ms Crossman has explained in her evidence the approach that the AMWG has adopted in formulating its proposed partial restriction regime for affiliated permits tied to Saleyards Bridge minimum flows, which is supported by Fish and Game.

5.46 The following table outlines the environmental and recreational requirements across the year that informed that approach:

Month	Environmental and Recreational Requirements
September **October** **November** **December**	x Migrations for whitebait and the sport that depends on them, peak in October. x Whitebait season from August to November. x Lamprey migration through the river mouth x Juvenile eel migration across the spring months and peak in November. x Spawning for the non-migratory mudfish, Canterbury galaxias and upland bully occurs across the spring. x Increased spring flows mirror natural Opihi flow pattern, these provide for freshening of the river after winter. x Increased flow in October encourages trout angling and redistribution of fish after spawning. x Spring flows maintained for recreation through to holiday period. x Riverbed birds?????
January **February**	x Connectivity of flows to maintain native and introduced fish passage within the river. Within the river downstream migration of common bully larvae, adult longfin and shortfin eel, upstream migration of lamprey, and downstream migration of juvenile salmon, maintained by connectivity. x Mouth opening subject to increases in natural inflows or mechanical opening if thresholds breached. x Flow variability less critical as a behaviour cue for fish during these months.
March **April**	x Spawning and migration triggered by increased and variable flows. x Whitebait, principally inanga, spawning and larvae migration to sea must have open mouth. x Continued adult eel migrations to sea and juvenile lamprey upstream. x Higher flows for maintaining an open river mouth critical for adult salmon passage and ideal flows for salmon fishing. x Flows encourage trout and salmon upriver to preferred spawning grounds and reduce schooling in lower river and over-harvest.
May **June** **July** **August**	x Winter generally lowest flow and food requirements for fish. x Flows sufficient for connectivity and river mouth open from natural flow increases are adequate for fish. x Upstream migration of juvenile longfin and shortfin eel and adult lamprey. x Whitebait runs into the rivers commence. x Stable flows for trout and salmon egg incubation and juvenile rearing.

6. THE OPIHI RIVER MOUTH

6.1 In section 11 of my Fish and Game evidence I provide details of my personal experience of the direct impact of low Opihi River flows on fish survival in the river over the 1984/85 summer below Saleyards Bridge before construction of the Opuha Dam. My evidence also indicates a 75% reduction in the total days of mouth closure from comparison of diaried records from five years before and five years after the Dam was constructed.

6.2 I believe the augmentation of Opihi River flows by management of storage released from the Opuha Dam has caused a reduction in the number of times the Opihi River mouth is blocked and the duration of those events during the October to April fishing season.

6.3 Minimum flows in January and February proposed in the AMWG Full availability and Alternative Management Regimes are higher than those in the current ORRP and proposed PC7 2025 and PC7 2030 regimes. The January and February flows proposed by the AMWG (Table 14(v)(ii) of its submission) will be more beneficial to improving the reliability of the river mouth being open than the current ORRP or proposed PC7 regimes.

6.4 In other months the proposed PC7 2030 Full Availability and Alternative Management Regimes (Table 14(w)) are generally higher than the corresponding AMWG flows. The cost of higher PC7 2030 flows is greater use of Dam storage and if it is used to supplement higher flows in the Full Availability regime then it is no longer available to sustain flows in later months when stronger restriction regimes are applied. So, while the higher minimum flows under the PC7 2030 regimes appear better for retaining an open river mouth they are also likely to be less sustainable across a longer period of restriction than the AMWG proposed regime.

6.5 In a situation where the river mouth has been blocked for an extended period, the AMWG flow regimes provide for artificial freshes during Level 1 and Level 2 restrictions. These freshes will be large enough to target breaching the Opihi lagoon beach bar if the Opihi River mouth is blocked at the time and there is ecological justification to mechanically open it. The storage of water to provide for these freshes has been built into the AMWG flow regimes. If higher Full Availability flows under the proposed PC7 2030 were instead required to be released these will deplete Dam storage and it is less likely that sufficient storage would be available to enable an artificial fresh.

6.6 The evidence of Dr Kerr for AMWG indicates that the proposed PC7 2025 and PC7 2030 Full Availability and Alternative Management Regimes will reduce the amount of storage available leading to high risk of flows breaching the minimum flows and dropping below the “ecological minimum” of 3,000 L/s (referred to in para 5.28 above). In my opinion, this will increase the likelihood of the management of minimum flows being required by WSD below proposed Level

2 levels, than will the AMWG proposed flows in Table 14(v)(ii) in its submission. The AMWG regimes seek to implement management of storage at higher lake levels to reduce drawdown to extreme levels and likelihood of needing to implement WSD.

6.7 The experience of the 2014/15 drought and the WSD that operated through December 2014 to March 2015 was that river mouth dynamics reverted to the pre-dam form with the gut through the beach between the lagoon and sea lengthening and tracking down the beach rather than through it, until it blocked and remained blocked for 20 days in two events.

6.8 The evidence of Dr Kerr in Table 2 identifies that if the proposed AMWG flow regime had operated from June 2014 to April 2015, the flow in the Opihi River at Saleyards Bridge would not have been below 3,000 L/sec at any time compared to 8 days when flows were less than 3,000 L/sec if the proposed PC7 2030 Table 14(w) regime had operated.

6.9 The AMWG acknowledge that the primary aim of their proposed Level 2 Alternative Management Regime of 3,500 L/sec is to maintain ecological health and connectivity. In the situation where WSD are required it is unlikely that an open river mouth will be maintained. The proposed PC7 2030 regimes neither maintain the river mouth nor provide certainty that connectivity will be achieved seeking instead to introduce higher minimum flows at lower storage levels that increase the likelihood of a closed river mouth and a dry riverbed.

7. SECTION 42A REPORT

7.1 At paragraphs 9.17 to 9.23 the s.42A report considers the ecological flow needs of the Opihi River. It is important to note that all species identified in the NIWA ecological work have species specific preferred flow ranges. While it is clearly evident that flows lower than the preferred range result in less habitat and or poorer habitat quality, it is often not recognised that the same happen with flows that exceed the preferred range. There is a danger in the assumption that because water is abstracted therefore the more water that can be put back in the river the better it is for the ecology of the river.

7.2 In assessing the summary of ecological values presented in Figure 15, page 27 of the NIWA lower Opihi Report (Jellyman, 2019), the heat map identifies two

preferred flow ranges – 5,000 to 7,500 L/s for invertebrate species and 1,750 to 3,000 L/sec for fish species. The flow range that is likely to be acceptable to most species, 70% to 90% of maximum WUA, appears to be in a range of about 2,500 to 4,500 L/sec.

7.3 In paragraphs 9.30 to 9.32 the Officers Report refers to Te Mana o te Wai. I agree that the principle of Te Mana o te Wai is a relevant consideration for PC7. However, all parties concerned with water management need to know how this can be achieved – what are the specific objectives that need to be achieved particularly for river flow?

7.4 At the time the Opuha Dam was proposed, the major constraint on the ecological health of the Opihi River were summer low flows and the common frequency of river mouth closure. I believe the Opuha Dam design addressed these concerns and in this respect I do not agree with the suggestions in the Officers Report at paragraph 9.47 that *"..the existing flow regime is resulting in degraded water bodies..."*. Issues of water quality including increased nutrient levels and arrival of *Didymosphenia* are more recent events and were not identified for incorporation into how the Opuha Dam would function.

7.5 Paragraphs 9.48 to 9.50 of the Officers Report identify concerns that the proposed AMWG Level 1 regime may impact river mouth closure in periods of critical fish migration. The current minimum flow regime is based around an average annual minimum flow into the lagoon of approximately 6,000 L/sec. Given that monthly flow variation of the minimum flow, based on the natural flow regime of the Opihi, means that at times the minimum flow is below 6,000 L/sec, there remains a high probability that the river mouth will be closed. If the catchment is in a Level 1 restriction that implies water is already in short supply and it is likely the natural flow of the river would be insufficient to maintain the river mouth. However, the proposed PC7 and AMWG flow regimes provide for artificial freshes which could alleviate fish passage concerns at the mouth. With water availability at the equivalent of Level 1 restrictions, the Opihi without the Opuha Dam could not provide artificial freshes and would likely have greater incidence of natural river mouth closure.

7.6 The Officers Report at Paragraph 9.51 comments that at the Level 2 restriction regime proposed by AMWG the ability to retain an open river mouth may be significantly compromised. There is no dispute with this comment. If a Level 2

restriction is warranted then there is very little flowing water in the catchment and stored water in the Dam is contributing significantly to river flow. Without the Dam and the regime to maintain storage proposed by AMWG, the river mouth would certainly be blocked under natural flows and very likely the river would be dry with associated loss of all ecological health. The AMWG regime provides storage to maintain river connectivity to the last drop.

7.7 In regard to comments in the Officers Report at paragraph 9.57 regarding the need for artificial freshes to open the river mouth particularly during summer months, it should be noted that under the current minimum flow regime that has operated since 1998 the need for river mouth opening has been significantly reduced. My evidence for Fish and Game at 13.10 to 13.13 and Table 12 clearly identifies the benefits of the Opuha Dam supplemented minimum flow regime at maintaining an open river mouth without the additional need for regular artificial freshes. Given this improvement over the pre-Dam environment, the need for more artificial freshes to maintain the river mouth open, than those proposed by AMWG are difficult to justify particularly considering the cost in terms of storage for providing artificial freshes.

7.8 I have concerns with the Officer Report recommendation to Policy 14.5.35(e) that appears to require operation of the Dam to release flushing flows so that periphyton does not reach nuisance levels and without PC7's provision for compensatory flows following a fresh. I believe this will place a significant burden on Lake Opuha storage and does not limit the responsibility to a specified number of events. Dr Kerr has addressed this further in his evidence, explaining the results of his modelling of the Section 42A Report recommendations and how they would affect storage and SYB flows.

8. CONCLUSION

8.1 OEFRAG has the first hand experience and local knowledge to understand and balance the complexities of water management and environmental needs of the Opihi River under drought conditions. That knowledge and experience cannot be easily translated into prescriptive rules in a plan. However, the plan can and should continue to allow OEFRAG to make recommendations to CRC on management of the Opihi River flows and storage under dry catchment conditions.

8.2 There is no evidence that the proposed PC7 and Section 42A Officer Report flow regimes would have provided a better outcome for the Opihi River than did OEFRAG in 2014/15. In fact these proposed regimes would have had Lake Opuha empty and the Opihi River dry at State Highway One.

8.3 It can be argued that the higher minimum flow regimes of the proposed PC7 and Officers Report for Full Availability and Alternative Management/Level 2 regimes compared to the AMWG regimes, provide minor improvement towards achieving Te Mana o te Wai. However detailed examination of the habitat availability for key macroinvertebrate and fish species does not support the argument that the higher flow regimes provide more habitat. Instead the higher flow regimes drain Lake Opuha storage at a faster rate, and provide no incentive for further intervention before the lake is drained.

Mark Whitby Webb

17 July 2020