Memo

Date	11 September 2018
To	OTOP zone committee
cc	
From	Dan Clark

Subject: Hydrological evaluation of options to address the flow regime in the Temuka Catchment

Introduction

The purpose of this paper is to:

a) Inform the Zone Committee of the implications on residual flows in the Temuka River and the changes in water availability for abstractors under different modelled options.

b) Support the Zone Committees decisions on what flow and allocation regime they recommend for the Temuka Catchment

Background

The Zone Committee has previously received a paper outlining the issues with the Temuka flow regime (dated 29 June 2018), The main findings in this paper are as follows:

a) The Temuka catchment has a very high allocation compared to the size of the River and is considered over-allocated compared to the limit set in the ORRP.

b) The A and B allocation blocks do not have partial restriction set in a way which prevents abstraction drawing the flow below the minimum flow level.

c) The A and B block have been set at levels where they overlap with each other.

These issues have also been discussed with the Temuka Catchment Working Party at a workshop on the 13th of August.

In the Draft ZIPA released in December 2017 the Zone Committee recommended increasing the A block minimum flow in two steps (over 5 and 10 years) and setting partial restrictions to prevent the minimum flow from being breached due to abstraction. The draft recommendations did not make any changes to the B block minimum flow or partial restriction.

This paper consists of two parts:

Part one investigates options to resolve the overlapping allocation blocks without changing the minimum flow trigger levels

Part two investigates changing the minimum flow trigger levels to those recommended in the draft ZIPA and those recommended by the Temuka Catchment Working Party (TCWP).

Part one: resolving overlapping allocation blocks

Minimum flow levels

While the Draft ZIPA includes increases in minimum flow at 5 and 10-year steps, this section is focussed on the implications of resolving the issues with the overlapping allocation blocks and setting partial restrictions to protect the minimum flow. Any increase in minimum flow will be additive to the findings of this paper and will increase the residual flows and reduce the availability for abstractors. Increasing minimum flows without resolving the issues discussed in this paper is unlikely to result in improved residual flows.

Options assessed for flow regimes to protect the minimum flow

Assumptions

- All options have been assessed with the current A and B allocations.
- All options have included the current summer and winter minimum flows.
- Partial restrictions have been applied as pro-rata to prevent the minimum flow from being breached due to abstraction.
- Modelling has assumed that water is taken whenever it is available.

Current

The current ORRP minimum flows and 50% partial restriction level on A block take occur 300l/s above the minimum flow. Figure 1 shows how the availability plot for summer with the current ORRP minimum flows and stepped partial restriction.

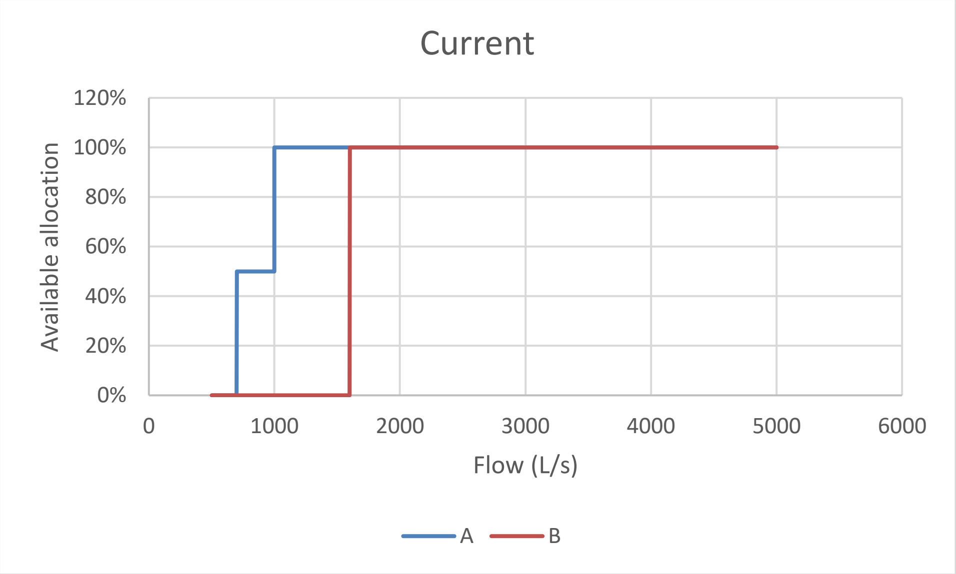

Figure 1 Availability with current minimum flows and current partial restrictions

The current regime does not prevent the minimum flow being breached due to abstraction. Under the current regime there are occasions where the allowable abstraction is greater than the amount of water physically in the river.

Current with pro-rata partial restrictions

Applying pro-rata partial restrictions to the current A and B block minimum flows results in the availability plot shown in Figure 2. This option results in occasions where the B block can abstract a greater percentage of their allocation that the A block due to the overlapping A and B allocations. This regime can still result in the minimum flow being breached by abstraction.

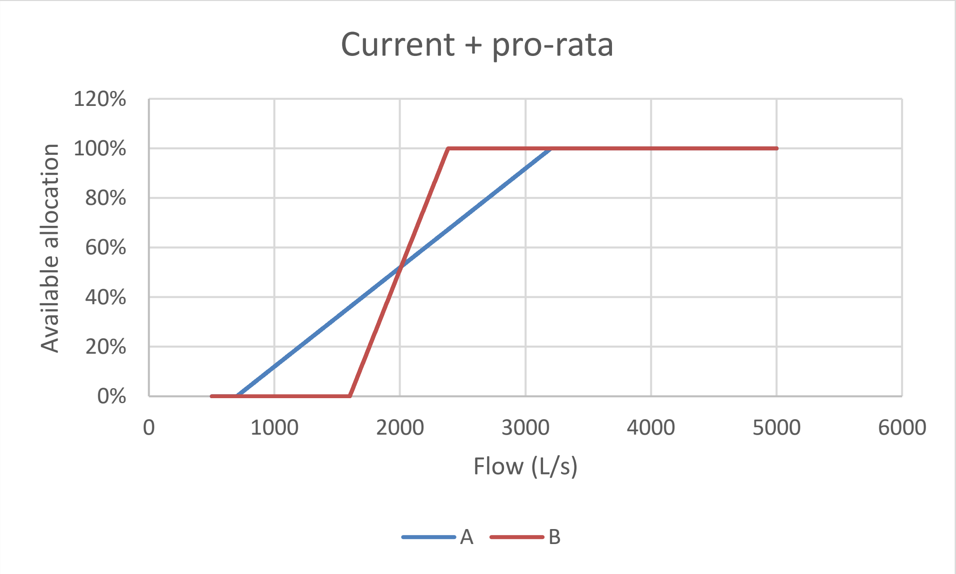

Figure 2 Availability with current minimum flows and pro-rata partial restrictions

Current A minimum flow with B block stacked on top

Stacking the B allocation block on top of the A allocation removed the issues of overlapping allocation blocks. Applying pro-rata partial restrictions to both blocks protects the minimum flow from being breached due to abstraction and protects the A block reliability from being impacted by the B block abstractions. Figure 3 shows the availability plot for a stacked flow regime with the B block being unavailable until all the A block can be taken. This approach maintains the priority set out in the ORRP with older A block allocation having priority over more recent B block allocation.

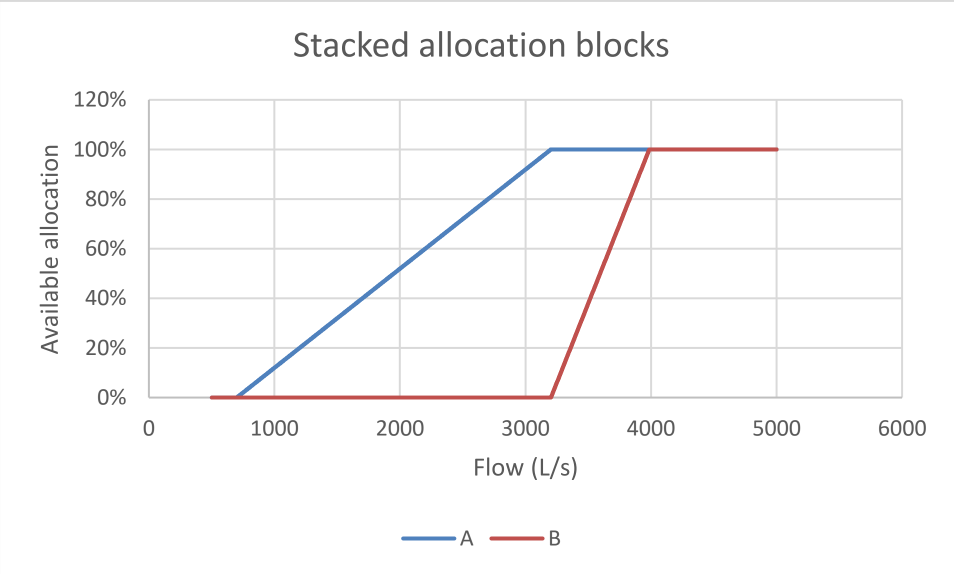

Figure 3 Availability with current A block minimum flow and pro-rata partial restrictions with B block allocation stacked on top

Often when flow regimes are designed, a gap is placed between the A and B allocation blocks to protect some flow variability. If a gap was placed between the A and B allocation, there may be some benefit to mid-range flows and would result in further loss in availability for B block takes.

Current minimum flow with one merged allocation block

Treating all the allocation as a single allocation block results in the availability plot in Figure 4. This option removes the priority within the ORRP. Pro-rata restrictions are applied from the sum of all allocation and prevents the minimum flow from being breached by abstraction. As this option only has one allocation block, both the current A and B block receive the same availability.

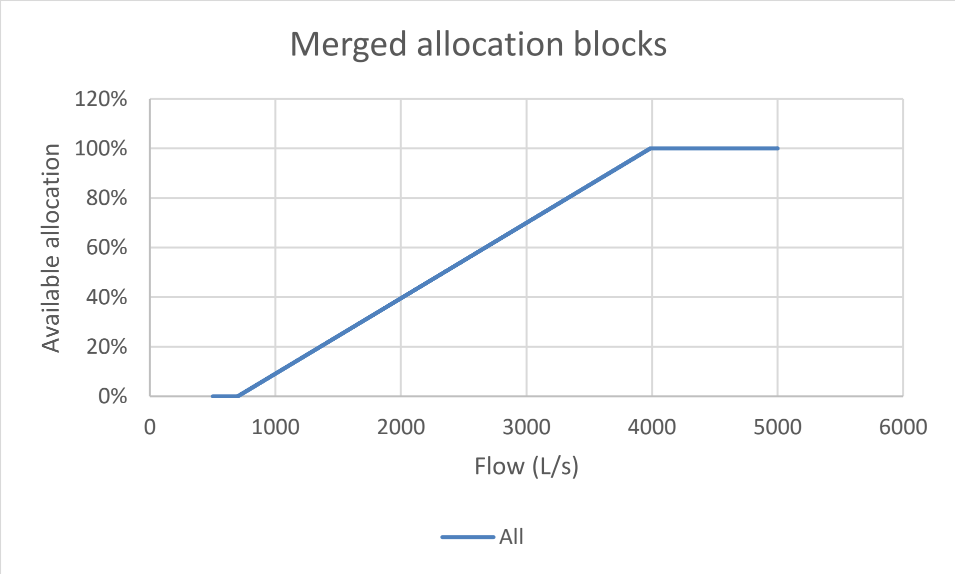

Figure 4 Availability with current minimum flow and a single allocation block with pro-rata partial restrictions

Current A and B minimum flow with partially merged allocation block

At the meeting with the Temuka Catchment Working Party on the 13th of August, it was discussed that a regime could be possibly developed which kept the existing minimum flows and overlapping allocation blocks, but partially merged them in a way that prevented the minimum flow from being breached. The availability plot in Figure 5 shows how this partially merged allocation could be implemented.

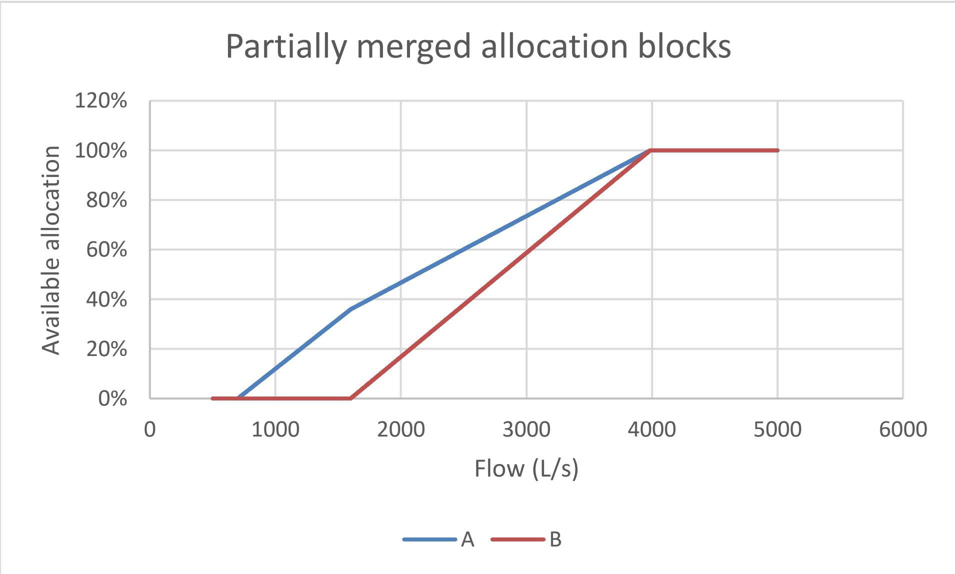

Figure 5 Availability with current A and B minimum flows and a merged allocation with varying pro-rata partial restrictions

The partially merged allocation blocks could be achieved by keeping both the A and B minimum flow triggers the same but different partial restrictions apply to both blocks. When the flow is above the A block minimum flow but below the B block minimum all the available allocation goes to the A allocation, when the flow is above the B block minimum flow the available allocation is shared between the A and B blocks based on the size of each block. This option would result in a complicated regime where restrictions are not a 1:1 pro-rata line, this complexity poses a risk for implementation by both consent holders and Environment Canterbury.

Residual flows

Under the current regime with overlapping blocks and a stepped partial restriction regime it is modelled that it would be possible for the Temuka River to be dry for around 15% of the time. This is due to the ability for abstraction on a given day to be greater than the available water in the river as the modelled flow drops to zero due to abstraction, the next day the abstractors must cease and therefore the flow recovers, this means that the duration of dry days is usually very short

Stacking and merging the allocation blocks both have the same impact on flows as they both have partial restrictions which prevent the minimum flow from being breached by abstraction, in Figure 6 both have the same flow duration curve.

The residual flows which can result from partial restrictions being applied to the current A and B minimum flows results in a flow duration curve which drops rapidly through the mid- flow range. This is due to the overlapping A and B block being able to abstract more water than is available above the minimum flow. The current minimum flows with pro-rata allows abstraction to breach the minimum flow.

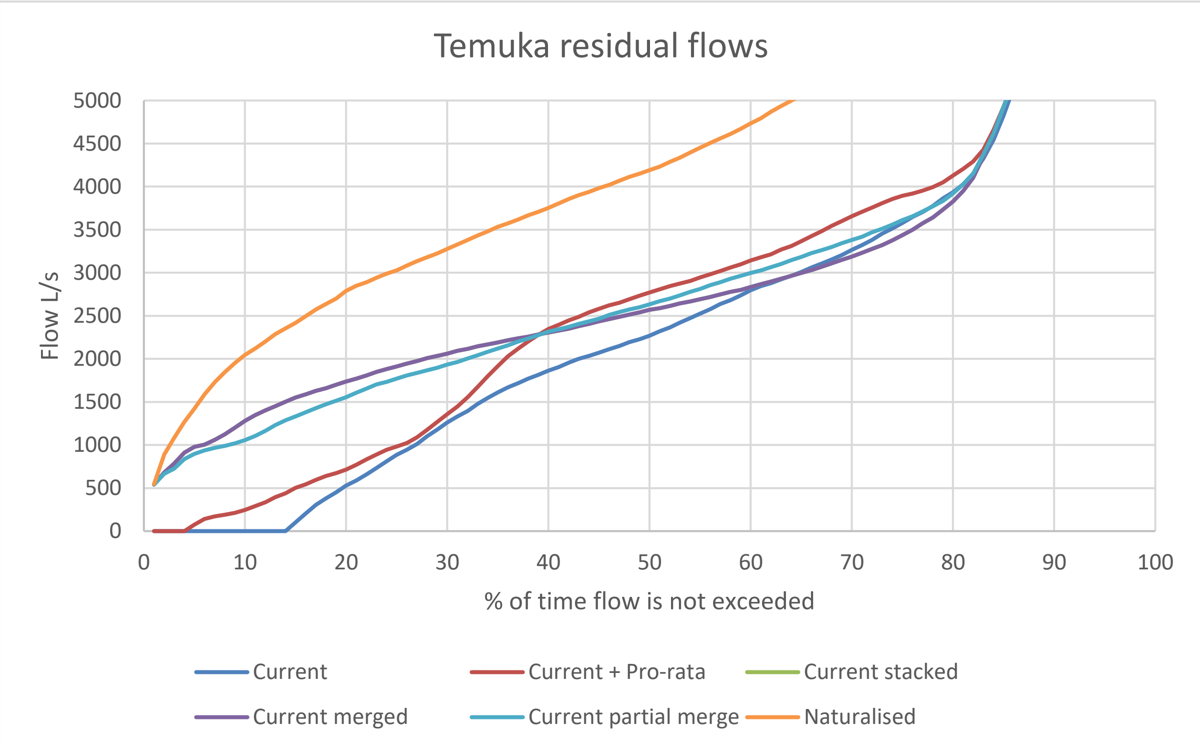

Figure 6 Flow duration curves for modelled options of addressing the allocation in the Temuka Catchment

The partially merged allocation block results in residual flow which are like those with a stacked or merged allocation block and as only the water above the minimum flow is available to be take the minimum flow is protected.

Allocation block size and water use

The impact of flow regimes on residual flows and availability for abstraction is determined by the natural flows in a river, minimum flow triggers, allocation block size and partial restrictions. As the natural flow in the river is unable to be altered, the combination of the other three factors can be controlled to achieve the outcome the Zone Committee wishes to see for the river.

As the point at which partial restrictions apply is the minimum flow plus the allocation block size, there has been an interest in reducing the size of the allocation block. It has been suggested that there may be some consent holders who hold consents which are never used. The Temuka Catchment Working Party requested information on consents which have water use data that indicates they do not use their consents.

The water use data for the Temuka catchment showed that only a small number of consents had sent ECan data showing a season or more of zero water use. Even less of these had sent multiple consecutive years showing zero water use and not all of these have been in the most recent years. Looking at the data shows that only 3 consents have sent ECan data indicating zero water use in the last three or more years. Of a total of 147 consents in the Temuka catchment, this is unlikely to be a significant avenue to reduce the allocation. Caution must also be taken when looking at observations of zero use as these can also reflect gaps in data or issues with infrastructure or monitoring equipment.

Availability results

In all cases where the overlap between the A and B allocation blocks is resolved there is a loss in availability. Table 1 shows how the different blocks availability changes under each of the modelled options. Figure 7 and Figure 8 plot the same information in a graphical way to highlight the difference in availability across the year. As the current A and B blocks to not have adequate partial restriction to protect the minimum flow from being breached, these have high availability across the year. Setting pro-rata restrictions without resolving the overlapping of the blocks results in a decrease in availability for the A block and an increase for the B block. Stacking the B block on top of the A block provides the smallest reduction in availability for the A block but the largest reduction for the B block. Merging the two blocks into a single allocation results in the greatest reduction in availability for the A block and smallest reduction for the B block. By partially merging the A and B block the priority between the blocks is maintained with both blocks sharing the reduction in availability. While a partially merged allocation regime may result in equal pain between the A and B blocks it comes with a significantly more complex restriction regime which would add much more operational complexity to both consent holders and Environment Canterbury.

Table 1 Mothly availability for modelled allocation block options

	Current regime A	Current regime B	Current + pro-rata A	Current + pro-rata B	Stacked allocation regime A	Stacked allocation regime B	Merged allocation regime	Partially merged regime A	Partially merged regime B
Jan	76%	67%	63%	67%	68%	19%	57%	59%	41%
Feb	72%	62%	55%	57%	60%	15%	50%	52%	34%
Mar	68%	51%	50%	51%	54%	15%	45%	47%	31%
Apr	59%	47%	43%	44%	47%	13%	39%	45%	28%
May	64%	52%	50%	52%	53%	22%	45%	52%	36%
Jun	63%	50%	50%	53%	53%	18%	45%	53%	33%
Jul	72%	60%	61%	63%	63%	24%	54%	61%	42%
Aug	80%	72%	68%	73%	73%	27%	62%	68%	53%
Sep	76%	66%	65%	67%	71%	24%	60%	65%	50%
Oct	85%	77%	74%	78%	81%	35%	70%	73%	54%
Nov	85%	74%	72%	74%	80%	26%	67%	71%	49%
Dec	81%	70%	68%	71%	75%	19%	62%	64%	46%

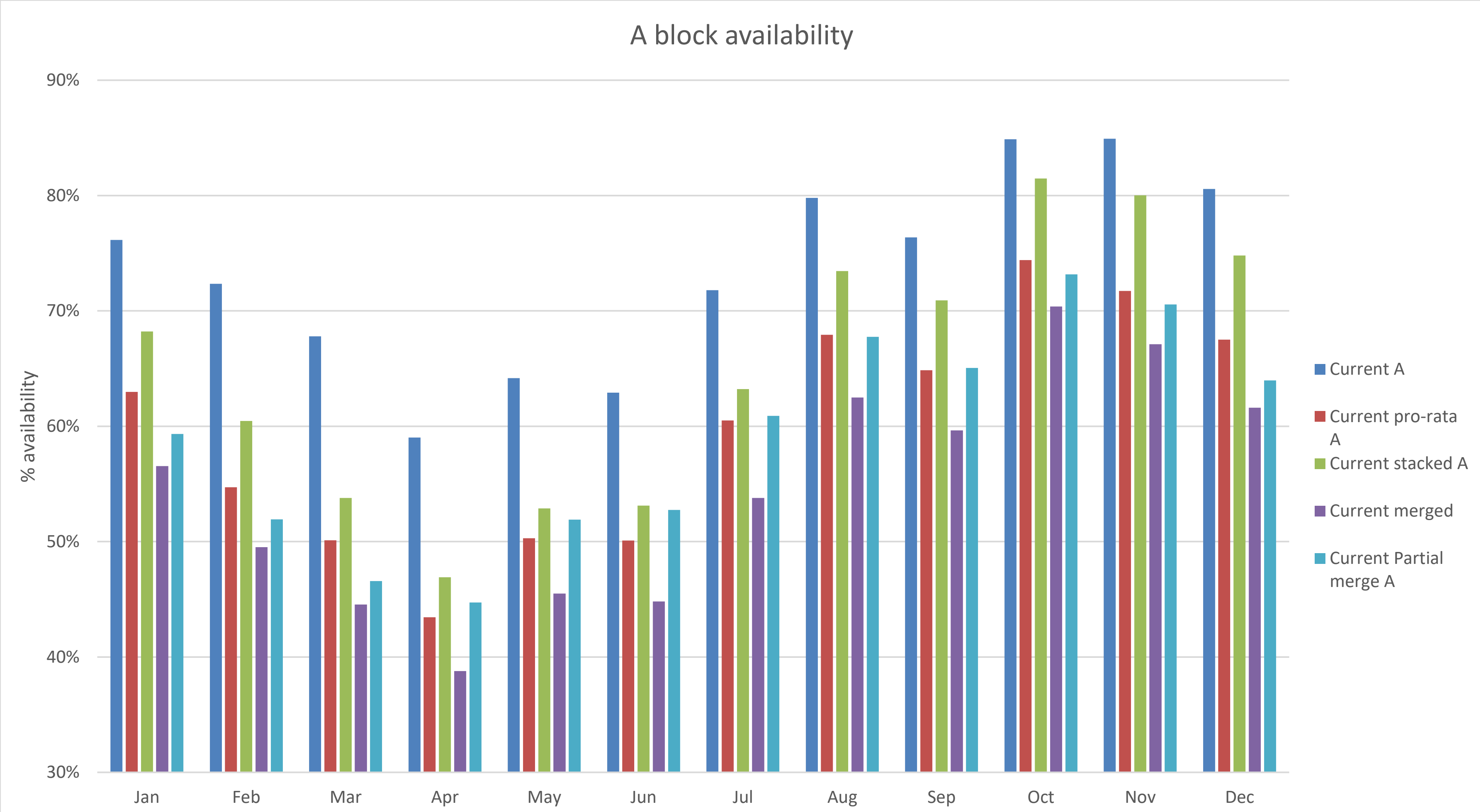

Figure 7 Monthly A block availability for the modelled allocation block options

Figure 8 Monthly B block availability for the modelled allocation block options

Table 2 Summary of allocation block options

	Flow regime				
	Current	Current + pro-rata	Stacked	Merged	Partially merged
Maintains existing priority	√	√	√	x	√
Avoids minimum flow being breached by abstraction	x	x	√	√	√
Improvement in residual flows	x	√	√	√	√
Management and implementation complexity	Simple	Simple	Simple	Simple	Complex
A block availability	73%	60%	65%	55%	59%
B block availability	62%	63%	21%	55%	41%

Key decision area

- **How should the A and B allocation blocks be set for the Temuka Catchment to prevent them overlapping?**
    - **Option 1 - Stacked B block on top of A Block**
    - **Option 2 - Merge into a single block**
    - **Option 3 - Partially merged Block**

Part two: Minimum flow options

In this section of the paper I have evaluated the proposed flow regime in the draft ZIPA recommendations and two draft regimes proposed by the TCWP. For consistency with the TCWP options, I have modelled the B block stacked on top of the A block for the two steps in the ZIPA.

Minimum flows

Draft ZIPA recommendations

The interim recommendations in the draft ZIPA include two stepped increases in minimum flow for the A block. The draft ZIPA does not set different summer and winter minimum flows as already exists in the ORRP. The draft ZIPA recommendations do not make any changes to the B block minimum flow. This caused the unintended consequence of the B block takes having an increase in availability while the A block takes had a decrease. The draft ZIPA recommendations have been modelled as a single minimum flow applying across the year with the B block stacked on top of the A block with no gap.

TCWP

The TCWP has worked to develop two flow regime options which may address the flow and allocation issues in the Temuka Catchment. This group has been sent the outputs of the modelling described in this paper to allow them to complete their own assessments prior to finalising their proposal to the Zone Committee. To provide the Committee with sufficient time to consider these evaluations, this paper has been prepared in parallel to the TCWP receiving my model outputs and potentially reviewing and updating their proposed regimes. Any changes to these regimes that may occur through the TCWP reviewing the model outputs have not been incorporated into this evaluation.

The two draft options for Temuka flow regimes proposed by the TCWP are described in Table 3. These regimes have minimum flows which vary in different months of the year and have a B block which is above the top of the A block. Both regimes also have pro-rata partial restriction regimes which apply from the top of the allocation block to avoid the minimum flow from being breached by abstraction. Option1 has a reduction in the size of both the A and B allocation block, no mechanism is suggested as to how this reduction could be achieved. Option 1 also includes a Gap between the A and B allocation blocks.

Table 3 Draft flow regimes as proposed by the TCWP

	Minimum Flow at Manse Bridge	**Allocation**
Option 1 (8yrs from Operative Plan)	Sep 1400l/s, Oct 1200l/s, Nov – Feb 1050l/s, Mar 1200l/s, Apr – Aug 1500l/s	A Allocation – Management Block of 2,000 l/s B Allocation – Management Block of 500 l/s

		B Block same minimum flow as Option 2, given this reduced A Block would mean lower minimum flow. This enables a gap for the river.
Option 2 (3yrs from Operative Plan)	Sept 1200l/s, Oct 1000l/s, Nov – Mar 850 l/s, April 1200 l/s, May – Aug 1500 l/s	Current – no change in block sizes B Block stacked on A Block

Residual flows

In the flow duration plot (Figure 9) there is a large difference between the naturalised and current flow regime curves, and this is due to the very large allocation in the Temuka catchment. By setting flow regimes which prevent the minimum flows from being breached and higher than current minimum flows, the modelled curves for the ZIPA and TCWP regimes sit closer to the natural flows at times of low flows and closer to the current curve at higher flows. This results in all ZIPA and TCWP regimes providing higher summer low flows than would be possible under the current regime in the ORRP. As the allocation remains high the modelled options have higher flows which would more closely resemble those under the current regime.

As TCWP Option 1 has a smaller allocation block, less water can be taken from the river at times of full availability. This, combined with higher summer minimum flows than Option two, would result in higher residual flows than those modelled in Option 2. All modelled flow regimes result in residual flows which are higher than those which could occur under the current regime, due to the application of a pro-rata partial restriction regime. As described in part 1 of this paper the current regime does not prevent the minimum flow from being breached and this results in periods of very low flow and occasions of modelled drying.

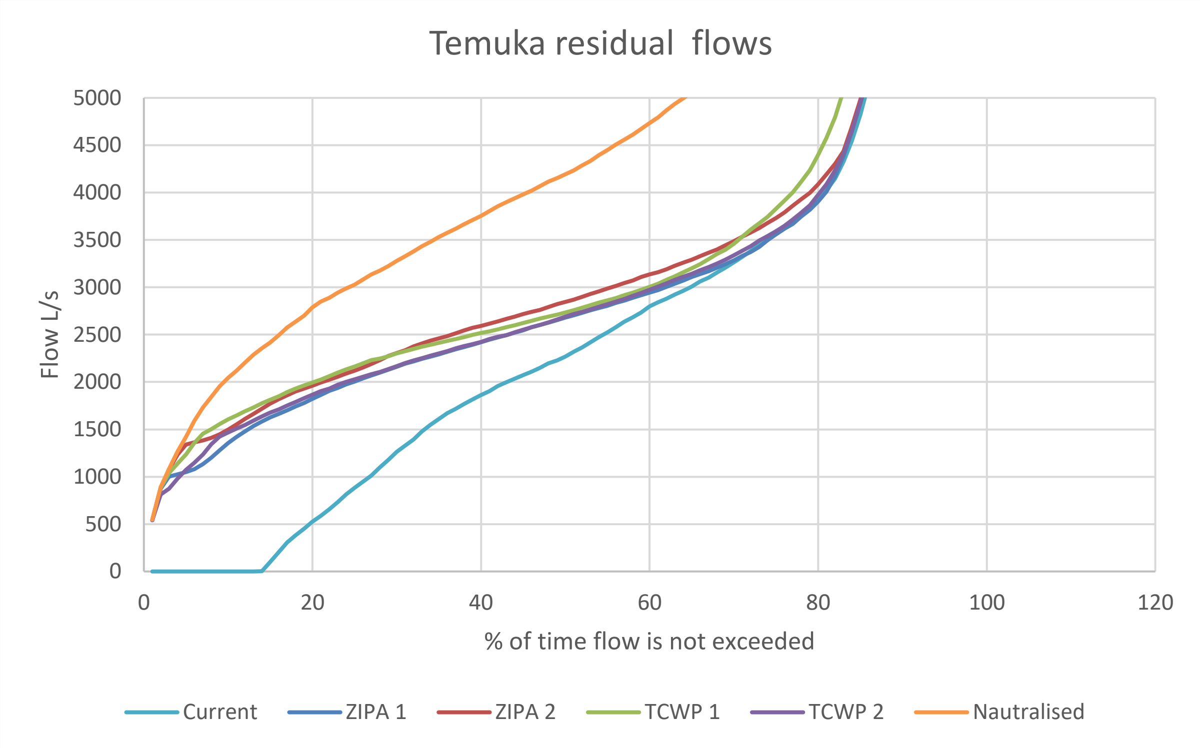

Figure 9 Flow duration curves for the modelled ZIPA and TCWP flow regimes

Availability

All modelled regimes have a reduction in availability for both the A and B block. The reduction in B block reliability is significant due to the B block being stacked on top of the A to maintain the existing priority system (shown in Table 4, Figure 10 and Figure 11). Of the modelled ZIPA and TCWP regimes, the TCWP option one has the highest availability. This is achieved due to the reduced allocation block proposed in this regime. By reducing the size of the allocation block the consent holders within the block receive a higher availability, while those who are removed from the block have no water available. The TCWP option one does not include any mechanisms for reducing this allocation block size. When compared to the draft ZIPA recommendations the TCWP options have higher availability over all the summer months with lower availability in the low demand winter months.

Table 4 Monthly availability for each of the modelled flow regimes

	Current A	Current B	ZIPA 1 A	ZIPA 1 B	ZIPA 2 A	ZIPA 2 B	TCWP 1 A	TCWP 1 B	TCWP 2 A	TCWP 2 B
Jan	76%	67%	63%	17%	58%	15%	72%	22%	66%	18%
Feb	72%	62%	55%	14%	49%	13%	64%	16%	58%	14%
Mar	68%	51%	48%	14%	43%	12%	53%	16%	51%	14%
Apr	59%	47%	46%	13%	41%	12%	46%	13%	44%	12%
May	64%	52%	52%	22%	48%	20%	52%	23%	47%	20%
Jun	63%	50%	52%	18%	48%	17%	53%	19%	47%	16%
Jul	72%	60%	63%	23%	58%	22%	64%	24%	56%	21%
Aug	80%	72%	73%	27%	68%	25%	75%	29%	67%	24%
Sep	76%	66%	70%	23%	65%	22%	75%	25%	68%	23%
Oct	85%	77%	77%	32%	73%	29%	84%	35%	78%	32%
Nov	85%	74%	75%	23%	70%	20%	86%	29%	78%	25%
Dec	81%	70%	70%	17%	64%	15%	80%	22%	73%	18%

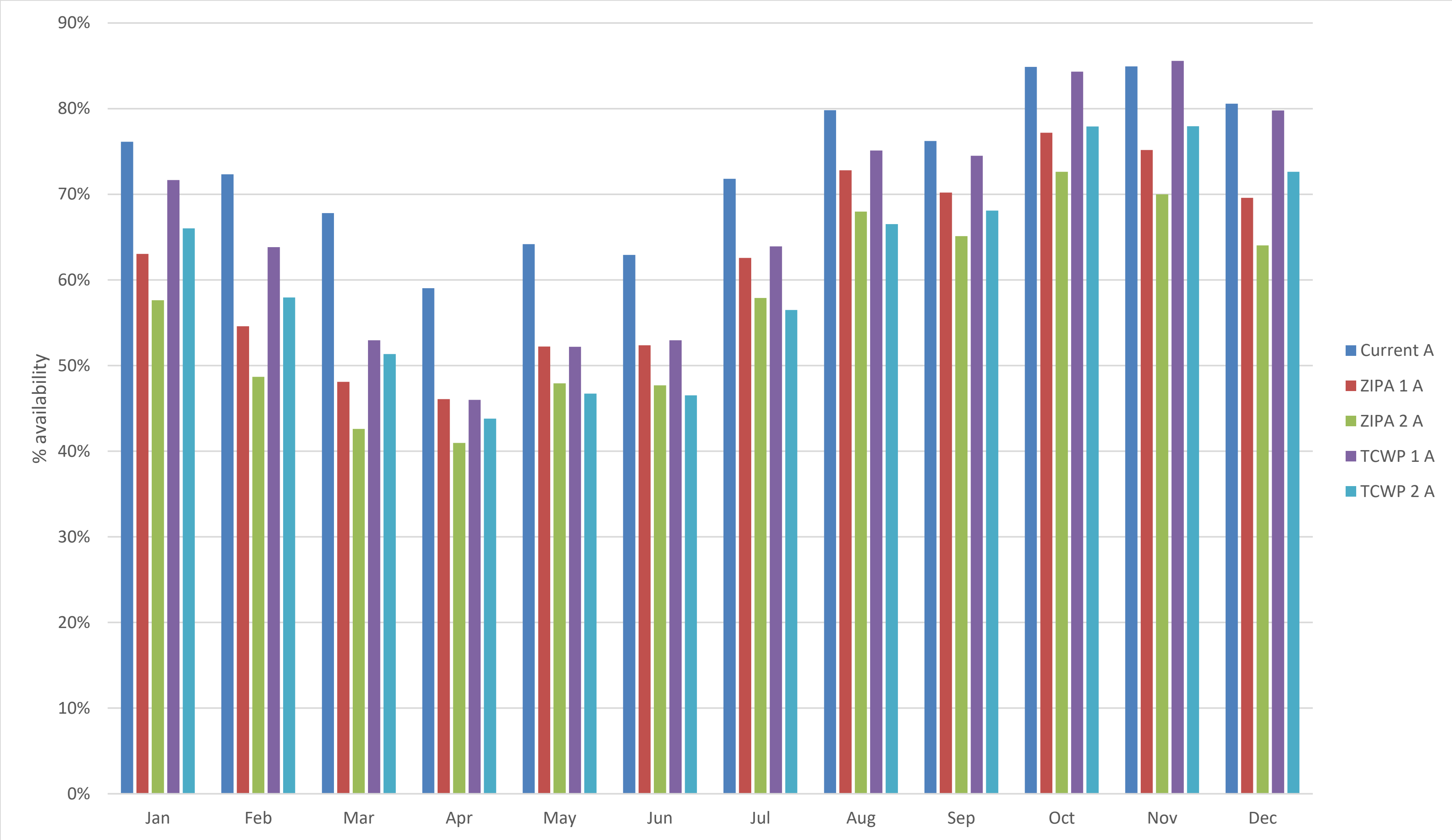

Figure 10 Plot of monthly A block availability

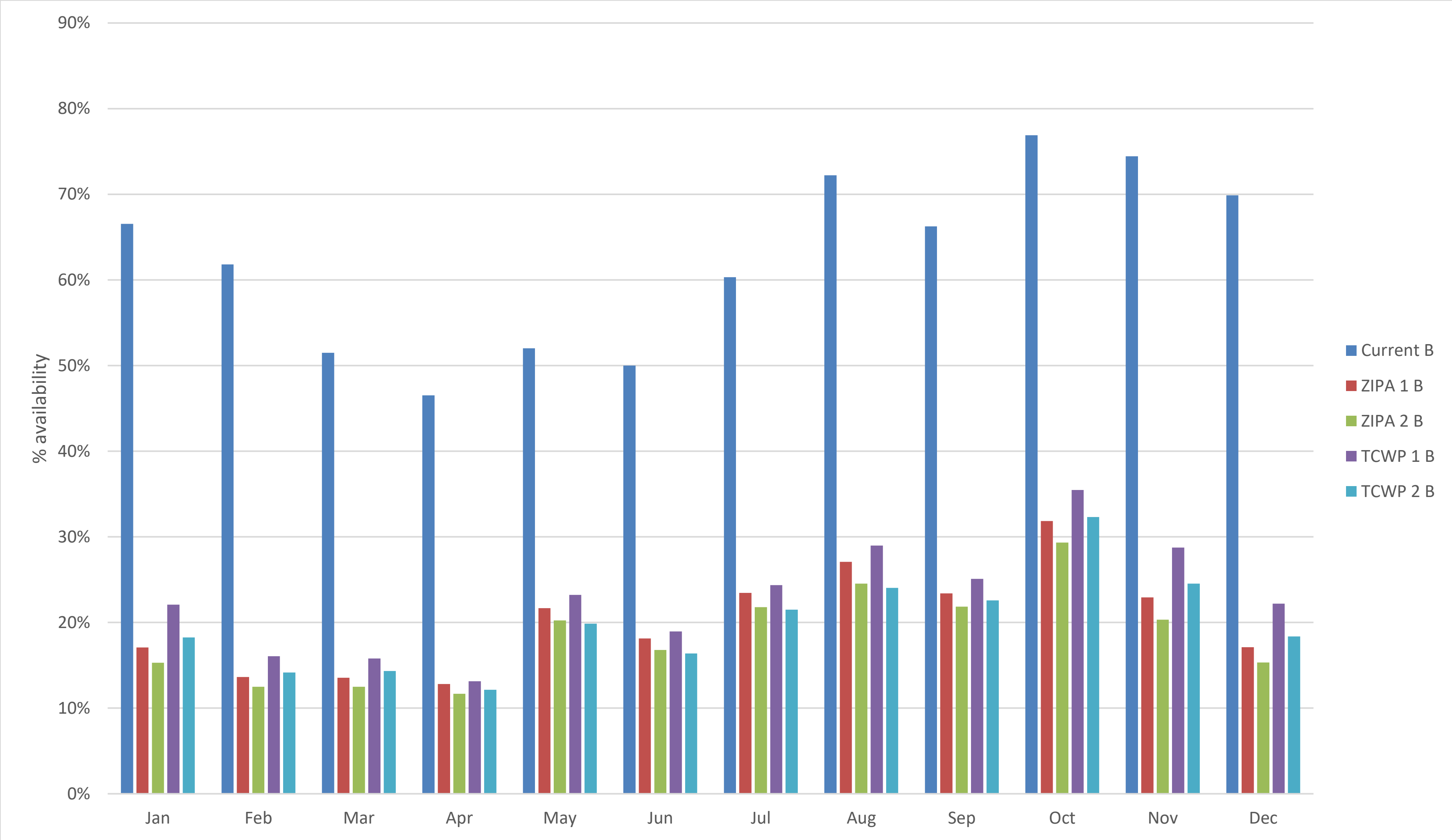

Figure 11 Plot of monthly B block availability

Table 5 Summary of ZIPA and TCWP flow regimes

	Existing ZIPA recommendations	TCWP Option one	TCWP Option two
Number of time steps	2	1	1
Timing of minimum flow increases (from operative plan)	5 and 10 years	8 years	3 years
Seasonally varying minimum flows	x	√	√
Avoids minimum flow being breached by abstraction	√	√	√
Average A block availability	Step 1 62% Step 2 57%	67%	61%
Average B block availability	Step 1 20% Step 2 19%	23%	20%
Requires a reduction in the allocation	x	√	x
Includes mechanism to reduce the size of the allocation block	Not required	No	Not required

Key Decision Areas

- **Do the minimum flow recommendations in the Draft ZIPA need to be amended?**
- **What minimum flow and allocation regime do the zone committee want to include in its ZIPA for further feedback?**