Watering Proposal for Painkalac Creek

December 2016

Contents

1. Introduction

Barwon Water have recently upgraded the water supply for Fairhaven and Aireys Inlet and as a result, the Painkalac Reservoir is no longer being used to supply water to these townships. This then provides other opportunities for the potable water allocation stored in Painkalac Reservoir to be used for alternate purposes, such as for recreation or environmental benefit. This proposal is focused on the latter and is intended to provide a summary of a Flows Study conducted in 2008 (Doeg *et al*. 2008) as well as provide guidance on the potential use of the water from the reservoir for environmental benefit to the creek.

The scope of this report was to determine the most appropriate watering actions for Barwon Water to implement, that make best use of the additional water now available in the reservoir. These watering actions specifically detail potential flow releases from the reservoir that benefit key ecological parameters of the creek and consider the specifics of the system as well as its limitations.

2. System overview

Painkalac Creek begins in the Otway Ranges at an elevation of 430 m in the deeply dissected rolling hills at the north-eastern end of the Otway Ranges. It flows mostly in an easterly direction for 20.3 km before it enters Bass Strait, on the south-west side of Aireys Inlet, via the creeks estuary (Figure 1). The Painkalac Creek has a total catchment area of 6,133 ha, including the creeks main stem and the Distillery Creek sub-catchment, which meets Painkalac Creek about 4 km upstream of the estuary mouth and 200 m south-west of the Old Coach Road crossing. The estuary is approximately 3.6 km long, has an area of 16.2 ha and is classified as a wave dominated strand plain. It opens intermittently but the majority of the time it is closed to the sea.

The creek's upper catchment in the Otway Ranges is relatively untouched and in very good condition. A portion of the flow from this section of the catchment is harvested in Painkalac Reservoir, which was built in 1978 to provide potable water for the townships of Fairhaven and Aireys Inlet. The remainder of flow is allowed to pass downstream of the reservoir and through the lower section of the catchment. This lower section of the catchment is much more modified than the upper section, with water harvesting, farming and urban development impacting the lower Painkalac Creek and its catchment.

Painkalac Creek is listed as a priority waterway in the Corangamite Waterway Strategy 2014-22 as it is a water supply catchment and has significant environmental values (CCMA, 2014).

3. Engagement

Barwon Water, in partnership with the Corangamite CMA, established and worked with a community and agency representative group to inform the watering actions in this report. Members of the group included individuals from the community with a keen interest in the creek, as well as agency representatives from the Department of Environment, Land, Water and Planning (DELWP), Parks Victoria and Surf Coast Shire. The community and agency representative group was formed through an expression of interest process advertised in local papers.

4 Flows Study

In 2004, the Surf Coast Shire developed the Painkalac Estuary Management Plan (SCS, undated) to help improve the health and management of the Painkalac Creek estuary. The plan included actions to maintain and improve the health of Painkalac Creek downstream of the reservoir. During the production of the plan, the Aireys Inlet community raised concerns about the effects of the reservoir on river health.

A key action identified in the plan was to:

> *Undertake an investigation into environmental flow requirements for fresh water and estuarine systems to the Painkalac Creek from the Aireys Inlet Reservoir, with a view to reviewing the Bulk Entitlement held by Barwon Water. The investigation should also consider the potential role of the Aireys Inlet Reservoir in flood management downstream. (p. 25)*

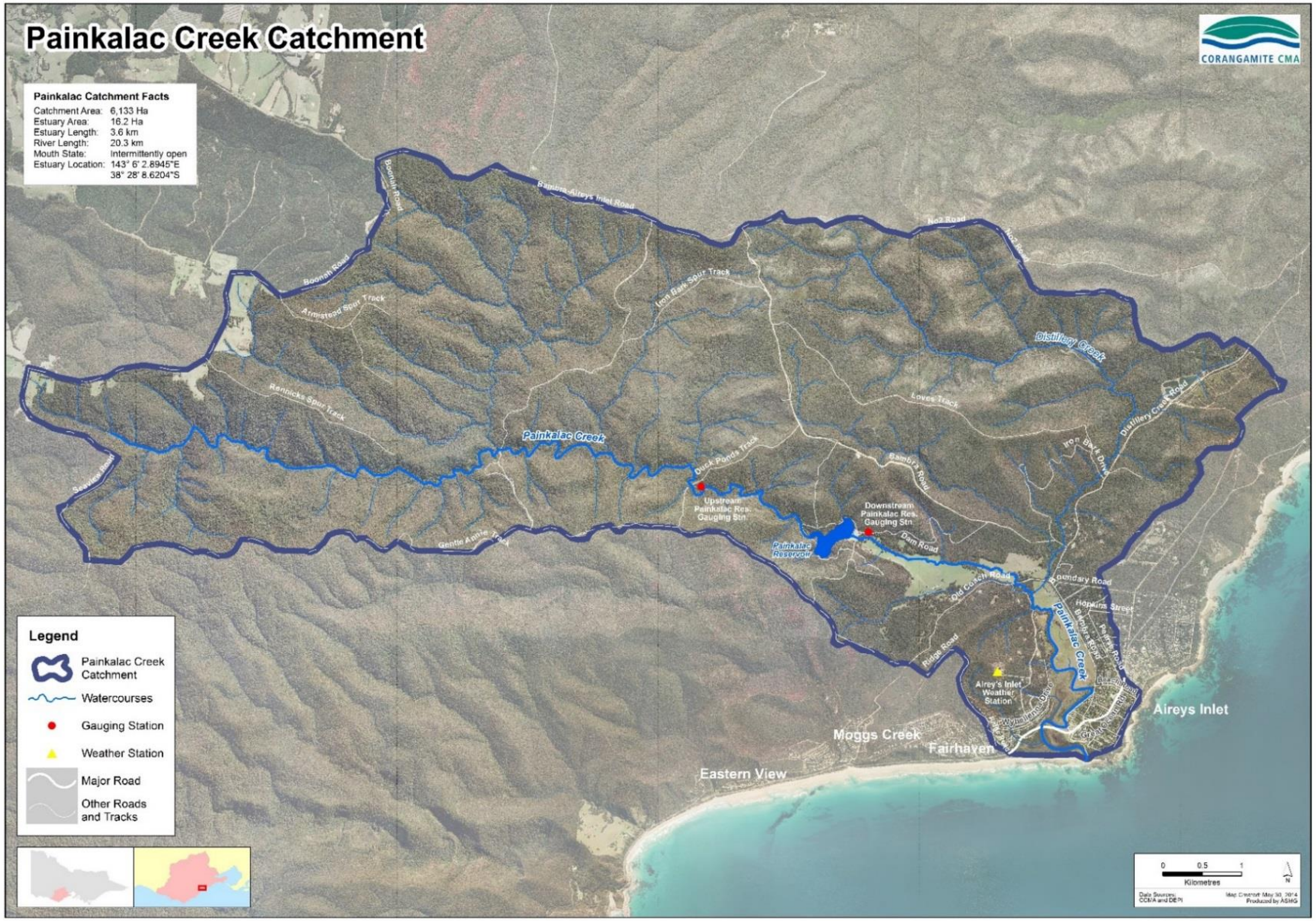

Figure 1. Painkalac Creek catchment

Subsequently, Tim Doeg, Paul Boon and Geoff Vietz were contracted by the Corangamite CMA to conduct an environmental flow study of the freshwater section of Painkalac Creek downstream of the reservoir using the FLOWS method – the standardised Statewide Method for Determining Environmental Water Requirements in Victoria (NRE, 2002a). This report was completed in 2008, the recommendations of which are presented in Section 3.3 below

4.1 Impact

When regulation is placed on a waterway it can drastically alter the natural flow regime of the downstream section of the waterway by:

- reducing flows;
- altering the seasonality of flows;
- changing the frequency, duration, magnitude, timing, predictability and variability of flow events;
- altering surface and subsurface water levels; and,
- changing the rate of rise or fall of water levels.

Altering the natural flow regime of waterways can have a number of adverse impacts to the ecological processes occurring in and on the waterway, which include, but are not limited to, the following:

- Impaired spawning, growth, recruitment, feeding and other life cycle processes of native fish.
- Creation of physical barriers to native fish movement and migration, which can also result in a loss in available habitat and refuge areas.
- Altering instream physical, chemical and biological conditions can change the biota, resulting in less food being available for fish.
- Drowning of riparian vegetation and wetlands which are adapted to temporary inundation.
- Reducing bank stability, causing slumping, loss of riparian vegetation, erosion and sedimentation.

4.2 Flow objectives

The purpose of releasing flow (in addition to passing flows) is to reduce the adverse impacts of flow regulation created by the reservoir and in doing so, improve the environmental health of Painkalac Creek downstream of the reservoir.

The Flows Study (Doeg *et al*. 2008) lists the following environmental flow objectives:

- Maintain or improve channel form and processes for ecological benefit.
- Restore self-sustaining populations of migratory fish species (short-finned eels, common galaxias, spotted galaxias, broad-finned galaxias, pouched lamprey and tupong) in Painkalac Creek.
- Restore self-sustaining populations of non-migratory fish species (flat-headed gudgeon and Australian smelt) in Painkalac Creek.
- Restore macroinvertebrate communities to meet SEPP (Waters of Victoria) environmental quality objectives for Forest-B segments.
- Maintain and enhance healthy and diverse communities of native aquatic vegetation in the instream and fringing zones.
- Maintain and enhance biofilms on submerged surfaces, particularly coarse woody debris.
- Maintain and enhance healthy and diverse communities of native vegetation in the riparian zone.
- Entrain terrestrial organic matter from the benches into the stream.

For each objective, a series of flow functions were determined – flow-dependent processes that must occur in the creek in order to achieve the objectives. Table 4.1 provides a summary of the flow components that target these flow functions, and thus the environmental flow objectives for Painkalac Creek.

Table 4.1 Summary of the flow components and their associated flow functions for Painkalac Creek.

<table>
<tr><th>Dec</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th></tr>
<tr><th colspan="4">Low Flow Season (December to March)</th><th colspan="2">Transition (L-H)</th><th colspan="5">High Flow Season (June to October)</th><th>Transition (H-L)</th></tr>
<tr><td colspan="5">Low Summer Flow:
• maintain fish, macroinvertebrate and plant habitat</td><td colspan="7">Low Winter Flow:
• maintain fish, macroinvertebrate and plant habitat.
• inundate low bars and low benches to deter terrestrial plant encroachment.
• allow upstream migration of juvenile fish and lamprey (November).</td></tr>
<tr><td colspan="4">Low Flow Freshes:
• maintain quantity and quality of key habitats.
• maintain summer/autumn water quality.
• allow localised fish recolonisation.
• inundate bars and low level benches/bars for semiaquatic vegetation.
• wet exposed coarse woody debris to maintain biofilm communities.
• entrain organic terrestrial material to stream.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="4">Low Flow or Transitional Freshes:
• localised migratory species movement prior to freshwater breeding (spotted and broad-finned galaxias).
• prepare fish breeding habitat (spotted galaxias).</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="4">Transitional Freshes:
• localised migratory species movement prior to freshwater breeding (spotted and broad-finned galaxias).
• prepare fish breeding habitat (spotted galaxias).</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="5">High flows (Transitional Freshes and Low Winter Flow):
• wash larvae to sea (spotted and broad-finned galaxias).
• allow migration to estuary (common galaxias, tupong).</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="7">High Flow Freshes:
• maintain bed diversity for water depth variation.
• inundate high level benches to prevent colonisation by terrestrial plants and promote restoration of natural bench vegetation zonation.
• remove accumulated filamentous algal growth from surfaces.</td><td></td></tr>
</table>

Watering proposal for Painkalac Creek

<table>
<tr><th>Dec</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th></tr>
<tr><th colspan="4">Low Flow Season (December to March)</th><th colspan="2">Transition (L-H)</th><th colspan="5">High Flow Season (June to October)</th><th>Transition (H-L)</th></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="7">• flush sediment from habitat surfaces.
• wet exposed coarse woody debris to maintain biofilm communities.
• move organic terrestrial material to stream</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="6">Bankfull flows:
• inundate high level benches to prevent colonisation by terrestrial plants and promote restoration of natural bench vegetation zonation.
• connect side channels and old course</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="6">High Flow Freshes:
• non-migratory species movement prior to breeding (Australian smelt, flat-headed gudgeon).
• non-migratory fish breeding (Australian smelt, flat-headed gudgeon).</td></tr>
<tr><td colspan="12">Anytime – Bankfull flow:
• channel maintenance.
• wetting top of bank for vegetation.
• connectivity of main channel with important floodplain and anabranch zones.</td></tr>
</table>

4.3 Flow recommendations

Table 4.2 shows a summary of the environmental flow recommendations for Painkalac Creek. This table takes the information presented in Table 4.1 one step further and assigns specific timing, flow magnitude, frequency, duration and independence to flow events which are required to meet the environmental flow objectives for the creek.

Table 4.2 Summary of environmental flow recommendations for Painkalac Creek

<table>
<tr><th>Dec</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th></tr>
<tr><th colspan="4">Low Flow Season</th><th colspan="2">T(L-H)[#]</th><th colspan="5">High Flow Season</th><th>T(H-L)[#]</th></tr>
<tr><td colspan="12">Cease to Flow: No more than 2 spells per year, maximum spell length of 7 days</td></tr>
<tr><td colspan="5">Low Summer Flow: 0.5 ML/day (or natural)</td><td colspan="7">Low Winter Flow: 2 ML/day (or natural)</td></tr>
<tr><td colspan="4">Low Flow Freshes:
2 ML/day, 4 per year (or natural), 3 day duration (or natural)
8 day independence</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="4">Transitional Freshes:
20 ML/day, 2 per year (or natural) 1 day duration
7 day independence</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">High Flow Freshes:
200 ML/day, 2 per year (or natural), 1 day duration
19 day independence</td><td colspan="2">High Flow Fresh:
200 ML/day, 1 per year (or natural), 1 day duration</td><td></td></tr>
<tr><td colspan="12">Bankfull Flows: 700 ML/day, 1 in 2 years, 1 day duration</td></tr>
</table>

Note [#]: T(L-H): Transitional flow between low and high flow season; T(H-L): Transitional flow between high and low flow season.

Figure 2 is a conceptualisation of the above flow recommendations for Painkalac Creek as a series of flow components throughout the year.

These flow components are the 'ideal' flow scenario where all flow recommendations are delivered to specific quantities at regular time intervals for specified durations, ultimately to achieve a specific set of ecological objectives. In reality, flows within Painkalac Creek will vary considerably depending on the prevailing weather conditions for that year as well as the amount of water available in the system. These recommendations should not been seen as steadfast rules for water releases, but rather a guide to the flow requirements of the ecology of the system.

Additionally, the flow recommendations were developed based on meeting the ecological objectives alone, and do not take into consideration any limitations of the reservoir, its storage capacity, outlet size and capacity to deliver water downstream. The next sections discuss the limitations of the system as well as a comparison of current vs natural flow and uses this information to develop a series of watering recommendations for Barwon Water to implement that takes into consideration the flow recommendations detailed above.

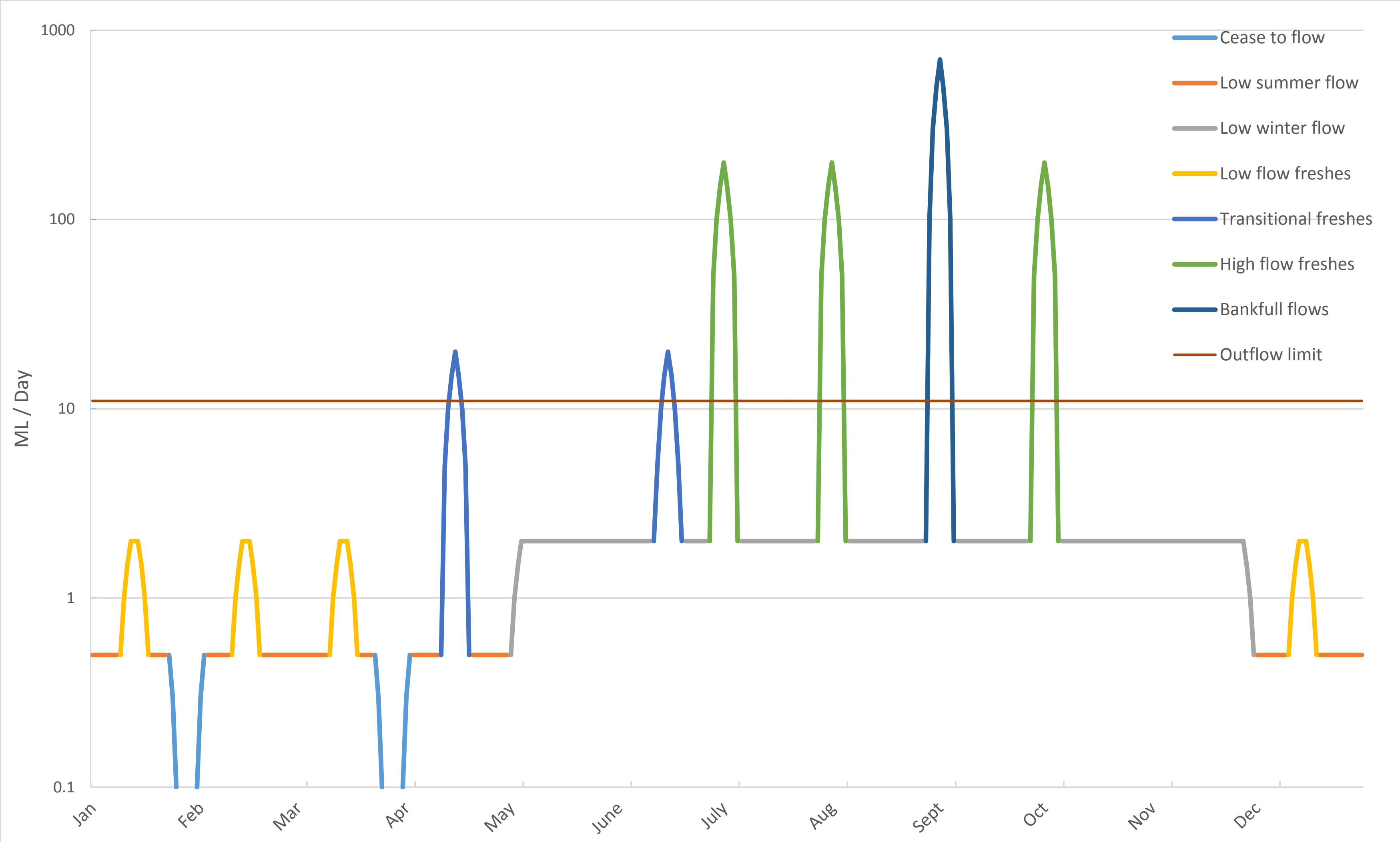

Figure 2. Conceptualisation of the recommended flows and timing[1]

[1] For the purpose of showing all flow components the chart is displayed in logarithmic scale.

4.4 Limitations

Much of the existing infrastructure will remain in place and Barwon Water will not be installing any new infrastructure as part of this project. As such, Barwon Water will maintain Painkalac Reservoir to ensure its ongoing safety and requirement to provide passing flows to Painkalac Creek. The major components that will remain in place include the dam wall and spillway, outflow pipes/valves for water discharge, access roads (private vehicles only), reservoir water aerator and the upstream and downstream monitoring stations. While this places some limitations on the system it also presents an opportunity for Barwon Water to take greater control of the flow being distributed to the downstream section of the creek for ecological benefit.

With the reservoir remaining in place there are some key operational parameters that will have an effect on flow distribution. These include the following:

- Painkalac Reservoir has a capacity of 532 ML and for safety reasons needs to remain above 50% capacity.
- The annual potable water consumption of approximately 160 ML has ceased (as of mid-2016) and is now available for environmental purposes.
- The bulk entitlement will remain in place with passing flows being specified as follows:
    - March to November, the lesser of 0.5 ML/day or inflow;
    - December to February, entire flow.
- Maximum outflow that can be manually released is 11 ML/day (shown in Figure 2 above). Greater flows can be achieved when the reservoir is full and overflowing.

4.5 Comparison of Recommendations with the Current Flow

The 2008 Flows Study (Doeg et al, 2008) compared the environmental flow recommendations for Painkalac Creek (presented in Table 4.2) with the flows provided in the modelled current flow regime. Comparisons for each flow scenario were made as follows:

- **Cease to Flow** comparison was based on the percentage of years in the current flow regime with more than the recommended frequency, and the percentage of spells that exceeded the recommended maximum duration.
- **Low flow** comparisons (summer and winter) were based on the number of days each year in the current flow regime where flows were below the recommended flow (compared with the natural flow regime).
- **Freshes and high flow recommendations** (Low Flow Freshes, High Flow Freshes and Bankfull flows) were compared with the frequency of freshes in the current and natural flow regime in two parts. Where the natural frequency was equal to or higher than the recommended frequency in any year, the flow was considered comparable with the recommendation if the current flow regime had at least the recommended frequency. Where the natural flow regime had less than the recommended frequency, the current flow was considered comparable with the recommendation if the current flow regime had the same number of freshes (a result of the “or natural” provision). The overall comparison simply used the percentage of years that the current flow matched the recommendation.

Recommendations that involve the duration of freshes were difficult to assess. Where freshes were reduced in frequency, it was often the shorter freshes that were eliminated, so the average or median length of remaining freshes in the current flow regime were often longer than in the natural regime. In this case, a simple assessment was made as to whether the median length of remaining freshes was the same or higher than the recommended duration. If so, it was assumed that the distribution of fresh duration in the current flow regime is the same as for the natural flow regime.

The comparisons for each flow component are presented in Table 4.3, along with a discussion and recommendation for releasing each flow component as it applies to the systems current flow regime.

Table 4.3 – Comparison and discussion of flow recommendations to current flow regime.

Flow recommendation	Natural vs current flow (1970-2006) (source: Doeg et al. 2008)	Discussion and recommendations
Cease to Flow: No more than 2 spells per year, maximum spell length of 7 days	The current flow regime has 2 years (5%) with more than 2 Cease to Flow spells per year. In the current flow regime, 35% of spells are longer than 7 days duration. **Conclusion**: While Cease to flows are rarely more frequent than recommended, many spells are longer than recommended.	Passing flow rules set under the Bulk Entitlement for the reservoir allow some, if not all inflows to pass through the reservoir for the entire year (see Section 3.4 for passing flow rules). This allows the number cease to flow events to remain low, however, these events are often longer than the recommended. ***Recommendation****: monitor the duration of cease to flow events and when greater than 7 days in length, release 1 ML/day for a 7 day period.*
Low Summer Flow: December to April, 0.5 ML/day (or natural)	**Natural:** • Median number of spells lower than 0.5 ML/day per year – 3 per year • Median duration of spells lower than 0.5 ML/day per year – 4 days • Median annual days lower than 0.5 ML/day – 20 days per year **Current:** • Median number of spells lower than 0.5 ML/day per year – 3 per year • Median duration of spells lower than 0.5 ML/day per year – 4 days • Median annual days lower than 0.5 ML/day – 20 days per year ***Conclusion:*** The current flow regime aligns with the recommendation as the current flow regime has been modelled with a passing flow provision of 0.5 ML/day (or natural)	The flow recommendation was being met through passing flow provisions when it was assessed in 2008. However, with current and predicted decreases in rainfall it is likely that this flow recommendation will fail to be met on a more regular basis. ***Recommendation:*** monitor low summer flow for median number of spells, duration of spells and annual days lower than 0.5 ML/day and provide intervening flows in years when they differ significantly from the current flow regime.
Low Winter Flow: May to November, 2 ML/day (or natural)	**Natural:** • Median number of spells lower than 2 ML/day per year – 12 per year • Median duration of spells lower than 2 ML/day per year – 3 days • Average annual days lower than 2 ML/day - 69 days per year **Current:** • Median number of spells lower than 2 ML/day per year – 12 per year • Median duration of spells lower than 2 ML/day per year – 3 days • Average annual days lower than 2 ML/day - 81 days per year In all years between 1970 and 2006, the current flow regime has more days lower than 2 ML/day between May and November than in the natural flow regime. Between 1970 and 1999, the difference is relatively small (an average increase of 9	As this was designed to be a winter harvest period for the reservoir, it is understandable the low winter flows are below natural. However, the difference is only felt between the average annual days lower than 2 ML/day, which is 15% greater in current vs natural flows. Additionally, the greater difference between natural and current flows for the years 1999-2006 occurred during the millennium drought, indicating a lack of inflows contributing significantly to the difference. ***Recommendation:*** Given the reservoir, and its only reducing the average annual days lower than 2 ML/day by 15%, no low winter flow provision is recommended to be delivered. However, monitoring of low winter flows is

Flow recommendation	Natural vs current flow (1970-2006) (source: Doeg et al. 2008)	Discussion and recommendations
	days per year), but recent years (1999-2006), the difference is much larger (25 days per year). ***Conclusion:*** Longer periods with lower flows than recommended.	recommended to ensure over the long-term the current regime does not change significantly from the natural regime.
Low Flow Fresh: December to March, 2 ML/day, 4 per year (or natural), 3 day duration (or natural), 8 day independence	**Natural:** • Median number of spells higher than 2 ML/day per year – 4 per year • Median duration of spells higher than 2 ML/day per year – 3 days • Median annual days higher than 2 ML/day - 35 days per year **Current:** • Median number of spells higher than 2 ML/day per year – 2 per year • Median duration of spells higher than 2 ML/day per year – 4 days • Median annual days higher than 2 ML/day - 15 days per year In the natural flow regime, there were 25 out of 37 years where 4 or more freshes occurred (all prior to 1999). In 20 of these years, less than 4 freshes were recorded in the current flow regime. Of the 12 years with less than 4 natural freshes, 4 years had less than the natural number in the current flow regime. Therefore, 24 of 37 years (65%) of years are not compliant with the frequency recommendation. ***Conclusion:*** Frequency too low in most years. Freshes remaining in current flow are of adequate duration.	Low flow freshes are often impacted when regulation is placed on a waterway. This is evidenced here with the median number spells and days higher than 2 ML/day reducing from natural to current flow regime from 4 to 2 per year, and 35 to 15 days per year respectively. The median duration of freshes in the current flow regime is higher than the natural median. This is because it is the shorter freshes that have been eliminated from the current flow regime, leaving more of the longer natural freshes to occur once the reservoir is at capacity and spilling. ***Recommendation:*** release flows that compliment natural flows to achieve the low flow fresh recommendation of 2 ML/day, 4 per year, 3 day duration, with 8 day independence.
Transitional Fresh: March to June, 20 ML/day, 2 per year (or natural), 1 day duration, 8 day independence	**Natural**: • Median number of spells higher than 20 ML/day per year – 2 per year • Median duration of spells higher than 20 ML/day per year – 1 day • Median annual days higher than 20 ML/day - 6 days per year **Current**: • Median number of spells higher than 20 ML/day per year – 2 per year • Median duration of spells higher than 20 ML/day per year – 1 day • Median annual days higher than 20 ML/day - 6 days per year In the natural flow regime, there were 21 out of 37 years where 2 or more freshes occurred between March and April. In 2 of these years, less than 2 freshes were recorded in the current flow regime.	Similar to the low flow freshes, transitional freshes are often impacted when regulation is placed on a waterway. This is evidenced here with the median number of spells, duration of spells and annual days higher than 20 ML/day being equal for the natural and current flow regimes. The reservoir outlet is limited to a maximum capacity of 11 ML/day, thus achieving a transitional fresh from outlet releases alone is not possible. In order to achieve the flow recommendation, releases of upwards of 11 ML/day would need to coincide with natural flows over the spillway, once the reservoir is at capacity. ***Recommendation:*** where possible release flows to coincide with natural flows to achieve the transitional fresh

Flow recommendation	Natural vs current flow (1970-2006) (source: Doeg et al. 2008)	Discussion and recommendations
	Of the 16 years with less than 2 natural freshes, 2 years had less than the natural number in the current flow regime. ***Conclusion:*** Frequency too low in a few years. Freshes remaining in current flow are of adequate duration.	recommendation of 20 ML/day, 2 per year, 1 day duration, 8 day independence
High Flow Fresh: June to August, 200 ML/day, 2 per year (or natural), 1 day duration, 19 day independence	**Natural:** • Median number of spells higher than 200 ML/day per year – 1 per year • Median duration of spells higher than 200 ML/day per year – 1 day • Median annual days higher than 200 ML/day - 1 day per year **Current:** • Median number of spells higher than 200 ML/day per year – 1 per year • Median duration of spells higher than 200 ML/day per year – 1 day • Median annual days higher than 200 ML/day - 1 day per year ***Conclusion:*** All freshes in the natural flow regime are matched in the current flow regime.	High flow freshes are currently matching the natural flow regime. In addition, they cannot be delivered within the constraints of the system (i.e., outlet limitation of 11 ML/day) and are dependent on the reservoir spilling once at capacity. ***Recommendation:*** none
Bankfull Flow: Any time, 700 ML/day, 1 in 2 years, 1 day duration	A single bankfull flow in the natural flow regime (January 2005) appears to be missing from the current flow regime. However, the modelled current flow peaked at 627 ML/day, so is likely to have a similar ecological outcome. ***Conclusion:*** All bankfull flows in the natural flow regime are matched in the current flow regime.	Bankfull flows are currently matching the natural flow regime. In addition, they cannot be delivered within the constraints of the system (i.e., outlet limitation of 11 ML/day) and are dependent on the reservoir spilling once at capacity. ***Recommendation***: none

4.6 Priority watering actions

Based on the discussion and recommendations provided in Table 4.3 above, as well as considering the physical limitations and constraints of the system, the priority watering actions focus on re-instating flow variability back into the system, while reducing periods of cease to flow events particularly during dry periods.

It is important to note that these watering actions are intended to alleviate some of the stress placed on the waterway by regulation. However, with the reservoir remaining in place, there will still be impacts to flow and water volumes (e.g., through flow attenuation and/or water loss through evaporation).

Watering actions in order of priority, are listed below:

1. Provide **low flow freshes** of 2 ML/day, 4 per year, 3 day duration with 8 day independence, between December and March.
2. Maintain a **summer low flow** (December to April) of 0.5 ML/day. Because of the known losses to groundwater immediately below the reservoir. This objective aims to maintain flow all the way to the estuary and will require releases in excess of 0.5 ML/Day at the outlet. Depending on the flow required to achieve this objective, it may not be able to be met for the required period due to the requirement to keep the reservoir above 50% capacity. Existing passing flow rules will contribute to meeting this objective and flows will be varied (by small amounts) to ensure flow variability.
3. Implement 2 **cease to flow** events (maximum spell length of 7 days) between December and April. This will be timed to coincide with periods of no inflow to the reservoir.
4. Where possible, provide flows of 11 ML/day (maximum outlet capacity) to coincide with rainfall to contribute to the **transitional fresh** (March to June) recommendation of 20 ML/day, 2 per year, 1 day duration with 8 day independence.
5. Where possible, maintain **winter low flow** of 2 ML/day (May to November). This is likely to require releases in excess of this figure to maintain an increased flow to the estuary. Flows are to be varied (by small amounts) to ensure variability of flows over this period.

While some of the priority watering priorities were being met when the recommendations were established in 2008, with current and predicted decreases in rainfall it is unlikely that flow recommendation will continue to be met on such a regular basis in future. Releases from Painkalac Reservoir will likely be required to maintain these flow components.

It is also important to note that priority 4 and 5 may not be met in most years due to the requirement to keep the reservoir above 50% capacity.

What is clear from the comparisons table is those higher flow events in winter/spring (i.e., transition/high flow freshes and bankfull flows) are largely being achieved and greatly benefit from a reservoir at capacity and spilling. As such, the above watering actions prioritise summer flow components above those in winter in an attempt to: a) meet the flow requirements for the summer flow components; and b) keep the reservoir capacity as high as possible through the winter period to allow spills over the spillway to occur as frequently as possible and mimic ‘natural’ flow events.

Table 4.4 presents a summary of the above watering actions under different climatic scenarios.

Table 4.4. Summary of priority watering actions under different climate scenarios[2].

Parameters	Climatic scenarios		
	DRY	AVERAGE	WET
Reservoir capacity as at September 1[3]	<50% capacity	Between 50 to 80% capacity	>80% capacity
Volume required for release	0 to 30 ML	100 to 250 ML	120 to 900 ML (this is dependent on the Reservoir filling during the year)
Priority watering actions	**Low Flow Freshes** **Cease to Flow**	**Low Flow Freshes**. **Summer Low Flows** **Cease to Flow**	**Low Flow Freshes**. **Summer Low Flows** **Cease to Flow** **Winter Low Flows** **Transitional Fresh**
Rationale	Maintain integrity of dam wall by retaining as much volume as possible. No flow to be released when capacity is <50%. Continue to implement passing flows requirements.	Maintain integrity of dam wall by retaining sufficient water capacity. No flow to be released when capacity is <50%. Continue to implement passing flows requirements. Avoid critical loss of habitat and species. Maintain key refuges.	Provide all aspects of the flow regime (within the limitations of the system) to maintain or improve the ecological health of the system.

[2] This table only presents the priority watering actions for different scenarios, these are above and in addition to Barwon Water's passing flow requirements under the bulk entitlement.
[3] The date of September 1 is used as it provides a good indicator of the upcoming water years (July 1 to June 30) water availability given it is post the winter filling period.

Confidence in water availability

Figure 3 is a graph of the Painkalac Reservoir's volume over the past eight years from 2008 to 2015 (Barwon Water, 2016). It shows in all but one year (2015), the reservoir filled to 100% capacity. Given the relatively small size of the reservoir and the 'flashy' nature of flows in the system, the reservoir often fills to capacity in one or two significant rainfall events, as can be seen in six of the past eight years (i.e., 2008-10 and 2012-14 years). In addition, in most years once the reservoir had filled, it remained full for an extended period (often months).

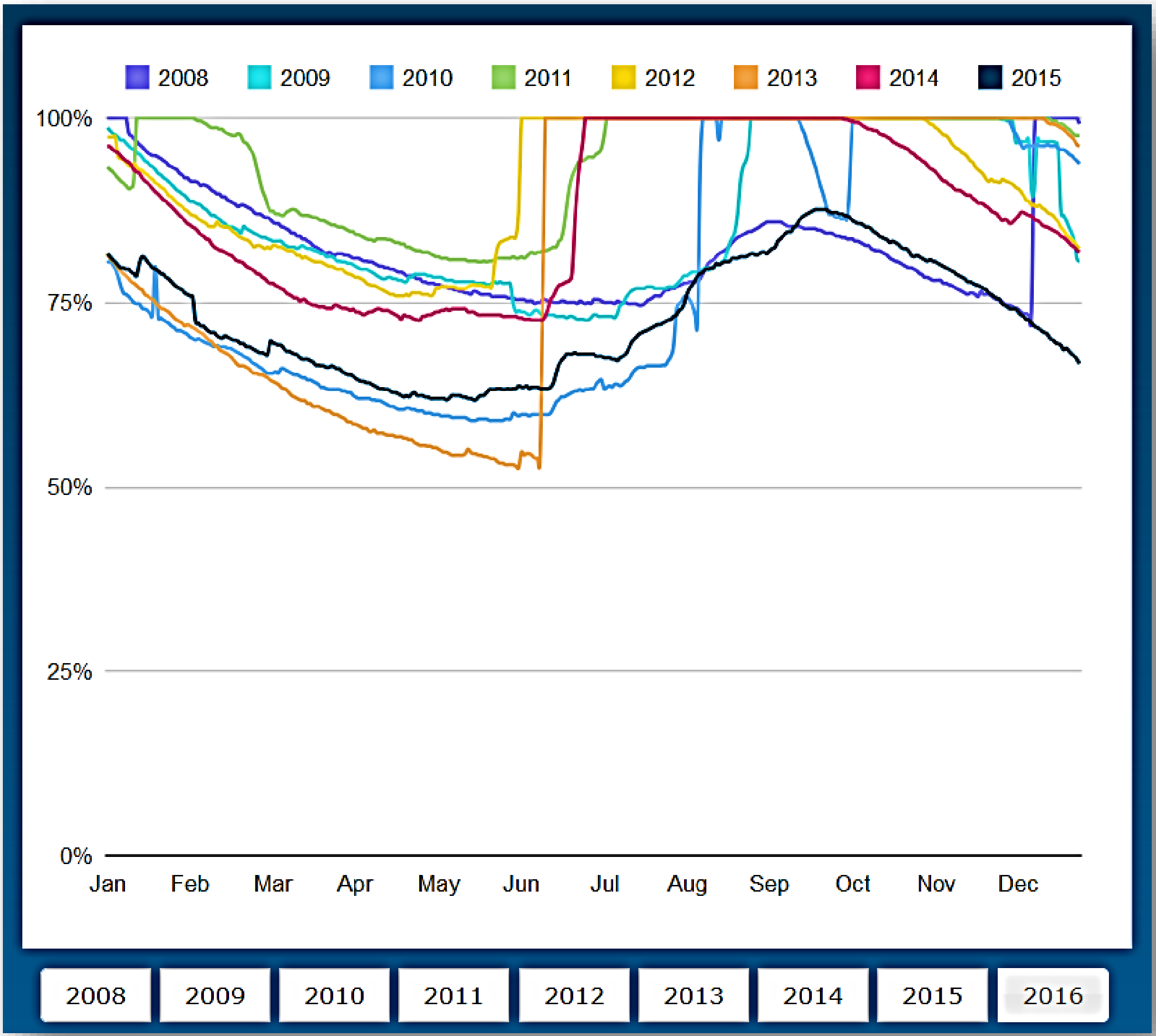

Figure 3. Painkalac Reservoir storage level from 2008 to 2015

Flood watch and flood warnings

In the event of a flood watch or flood warning issued by the Bureau of Meteorology all environmental releases will be stopped. Planned flows will resume once the warning has been withdrawn unless planned flow volumes and durations were met or exceeded by the naturally occurring event. A planned release will not commence if a flood watch or flood warning is current.

5 Knowledge gaps / further discussion

Managing flows is just one component of the greater management of Painkalac Creek. It is rare that all of the environmental issues and threats within a catchment can be resolved by only providing an appropriate flow regime. In most catchments, other management actions and works need to be implemented in combination with flow management to meet the stated environmental flow objectives.

This section provides some comment on the knowledge gaps of the system and the current flow regime, but also the other issues of the system and identifies additional work (i.e. in addition to this project) that could be undertaken in the future to improve knowledge of the system.

Released water volumes

Currently, our understanding of the hydrology of Painkalac Creek downstream of the reservoir is limited. In terms of flows, of the water being released from the reservoir it is unclear how far this water moves down the system, and at what volumes. While there is a monitoring station approximately 500 m downstream of the reservoir, often (particularly in summer) when passing flows are being released at smaller volumes (0.5 ML/day) from the reservoir, they are not observed at the monitoring station. Observations from Barwon Water staff have the water disappearing underground prior to reaching the monitoring station and it is unknown whether the water surfaces further downstream.

The system would benefit from further understanding the hydrology of the system, particularly in relation to flows being released from the reservoir and how these translate to flows observed at the monitoring station and further downstream in the creek.

Current flow regime

In 2013 the state government released new FLOWS study methods for determining the flow requirements of waterways. An updated FLOWS study for the system using the new methodology proposed by the state would lead to an improved understanding of the flow requirements of the system in the current climate conditions and now it is no longer being used as a potable water source.

Land use practice

Land use, particularly clearing and uncontrolled stock access is contributing to degradation of riparian vegetation. The riparian zone of the study reach (from Doeg et al, 2008) showed little evidence of regeneration of overstorey trees, and little understorey, with the surrounding pasture reaching all the way to the stream bank. Any regeneration would therefore likely to be grazed by stock and/or kangaroos. It was noted in the 2008 Flows Study by Doeg et al, that the local landholder had commendably introduced a number of actions to ameliorate the impacts of grazing including extensive weed control, a limit on the number of stock, the provision of reticulated water points in all paddocks which stock preferentially use, and the introduction of 8 species of dung beetle to minimise faecal contamination of the creek (Doeg *et al*, 2008).

The Corangamite Waterway Strategy identifies a number of management activities that are focused on protecting the stream-side zone along Painkalac Creek. These include the establishment of native indigenous vegetation and the establishment of stewardship/management agreements.

Fish Passage

There are number of known instream structures (bridges, grade control structures) that impede the movement of fish along Painkalac Creek. Currently it is unknown how much flow (ML/day) is required to allow fish passage over or through these structures. Therefore, the fish passage recommendations may not provide adequate flows for passage across or through these structures. Investigations to improve our understanding of the impact on fish movement from these instream structures would be of real benefit to the system.

Climate change

It is projected that temperatures will continue to increase in all seasons, including more hot days. There is also likely to be less rainfall, but with more intense rainfall events. Sea levels are expected to rise and there is expected to be an increase in extreme natural events such as bush fires and floods (CSIRO, 2014).

The flow recommendations provided in this report should be seen as independent of climate change – the requirements of the in-stream and riparian flora and fauna will not change with the climate. However, the amount of water available to satisfy both environmental and social uses will decline to some degree, which may present a challenge to the Painkalac Creek community in the future.

Painkalac Creek Estuary

The recommended flows in the freshwater section of Painkalac Creek are designed to provide for the requirements of environmental assets in that reach. The flow requirements of the estuary were not assessed as part of the 2008 Flows Study. Whether the flows recommended are suitable to provide for environmental water requirements of estuarine assets is unknown.

In 2012 the state government developed the Estuary Environmental Flows Assessment Methodology (DSE, 2012) for determining the flow requirements of estuaries. An estuary FLOWS study would improve knowledge of the system, particularly of the flow requirements of the estuary as it relates to the freshwater section of the creek.

Document Review

It is recommended that this document is reviewed annually in partnership with the community and agency representative group to consider learnings and new information that has become available.

Risk management

Risks associated with water releases will be managed in accordance with Barwon Water’s enterprise risk management framework.

References

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