



Seasonal Watering Proposal for the Wimmera Mallee Pipeline Wetlands Wimmera CMA Region 2018-19

Report prepared for: **Victorian Environmental Water Holder**
Report prepared by: Wimmera CMA

April 2018



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Publication details

*Seasonal Watering Proposal
for the Wimmera Mallee
Pipeline Wetlands – Wimmera
CMA Region 2018-19*

Date of publication: 20 April
2018

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Acknowledgements

The following individuals or
groups have assisted in the
preparation of this report.

Erin Round
Kym Wilson
Abdul Aziz
Kathryn Stanislawski
David Brennan
Tony Baker

However, it is acknowledged
that the contents and views
expressed within this report
are those of the
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1. Executive summary

The 2018-19 water year is likely to see continuing improvements for wetlands supplied by the Wimmera Mallee Pipeline following a wet year in 2016-17 and targeted deliveries in 2017-18. Good rainfall in winter/spring 2016 led to good allocations for use in pipeline wetlands although limiting water actions were required in 2017/18 given these wetlands are not naturally inundated every year and so carryover volumes remain high going into 2018/19.

Given a number of these wetlands were inundated in 2016 and they have an episodic hydrology, watering under most circumstances will again be targeted at filling/topping up the dams associated with the wetlands rather than inundating the broader wetland area. This means these wetlands retain their value as a watering point for local fauna, especially birds.

In several cases this is possible due to infrastructure works such as pipelines and small channels which can efficiently direct water to specific wetland areas and avoid third-party impacts. This has led to spectacular outcomes at Carapugna although the responses at Sawpit Swamp and Tarkedia have been more muted.

There is a solid foundation of ecological understanding of the wetlands values however knowledge of environmental water delivery to these wetlands is still in its early phases. Therefore monitoring will be undertaken to ensure environmental water is being used efficiently and effectively to maintain the value of these wetlands. WETMAP, the Victorian wetland environmental water monitoring and assessment program will continue to look at vegetation and bird responses at Carapugna and Crow Swamp. The episodic hydrology of these wetlands means a regime of wetting and drying over a number of years will achieve the maximum environmental outcomes. An Environmental Water Management Plan has been developed for these wetlands which assists long-term planning for environmental water use.

Estimation of volumes required to achieve these objectives are included in Table 1 which provides the watering scenarios based on varying climatic conditions – given the fact that numerous wetlands were inundated in 2016 there is no need to complete substantial watering actions but the high carryover volumes mean that regardless of climate, watering actions at wetlands that missed out on inundation in the last two years can take place in 2018/19.

Table 1: Priority watering actions under a range of planning scenarios for Wimmera Mallee Pipeline wetlands in the Wimmera CMA region.

Wimmera Mallee Pipeline Wetlands – Wimmera CMA	DROUGHT	DRY	AVERAGE	WET
Total maximum environmental water required (ML)	Fill/top up all dams plus provide wetland inundation for Crow Swamp, Pinedale, Carapugna and Challambra – total of 161 ML			

Information to ascertain changes due to environmental water actions will be gathered from a variety of sources (landholder observations, vegetation and bird surveys). A community wetland bird monitoring project is being trialled in 2018/19 thanks to support from the VEWB.

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Eastern Long-Necked Turtle – Mutton Swamp November 2017

2. Introduction

This seasonal watering proposal outlines the Wimmera CMA's proposed priorities for use of environmental water from the Wimmera and Glenelg Rivers Environmental Entitlement (the 'Water Holdings'), in the Wimmera CMA region for off-stream wetlands connected to the Wimmera Mallee Pipeline for the water year 2018-19. This seasonal watering proposal is submitted to the Victorian Environmental Water Holder (VEWH) in accordance with section 192A of the *Water Act 1989*. This seasonal watering proposal is endorsed by the Wimmera CMA Board for use by the VEWH as part of the development of the VEWH *Seasonal Watering Plan 2018-19*.

This proposal flags intentions for monitoring and communication to demonstrate the outcomes the watering has achieved as well as analysing and mitigating the risks associated with environmental watering activities. It is also valuable in terms of communicating priorities to storage operators to manage infrastructure to undertake releases as well as the community to flag priorities and highlight the assumptions, transparency and rigor that goes into decisions around the use of environmental water.

3. Engagement

It is prescribed in the Environmental Entitlement for the Wimmera and Glenelg Rivers that the best available science is needed to determine environmental water use in order to achieve the best regional ecological outcomes. There is currently limited but growing ecological information on which to base decision making but not a long record (>10 years) of monitoring data. Community information and input assists greatly in this regard. There is also useful feedback from stakeholders (i.e. other CMAs, VEWH), private landholders and Crown land managers (i.e. Parks Victoria) with respect to implementation of environmental watering actions.

Landholders and land managers with wetlands on their land were consulted during the development of the Seasonal Watering Proposal as well as GWMWater in their role as storage manager, responsible for supplying the water to these wetlands (Table 2). An exciting initiative for 2018 is a workshop relating to bird monitoring at pipeline wetlands which is scheduled to take place in Watchem in April. This follows the successful wetland field trip held in March 2017 with North Central CMA that involved a number of landholders with wetland on/adjacent to their properties (Figure 1).



Figure 1. Community members on Wetland Field Trip at Fielding's Dam – March 2017

Table 2. Consultation undertaken in the development of the Seasonal Watering Proposal

Organisation/ individual consulted	Consultation mechanism	Purpose of consultation	Issues raised (and how it was addressed)
Landholders with wetlands on their property	Phone calls	Discuss outcomes of current year's watering and plans for next year	Indicated ongoing support for watering actions
Natimuk and District Field and Game (Stuart McFarlane, Dale Russell, Tom Hardman)	E-mail	Seek feedback re. outcomes for game reserves	Nil – appreciated being consulted
Parks Victoria (Evan McDowell, Kathryn Stanislawski)	E-mail and phone calls	Illustrate outcomes of current year's watering and plans for next year as well as determining process for Parks Victoria endorsement	Provided comments on draft which were addressed for final proposal
GWMWater (Kym Wilson, Abdul Aziz)	E-mail	Illustrate plans for next year in terms of determining feasibility of delivery and determining process for GWMWater endorsement	Provided comments on draft which were addressed for final proposal

4. Shared Benefits

Community Values

These wetlands are highly valued by the local community given there are few open water bodies in the northern Wimmera and are prized spots for birdwatching and a raft of other activities. The watering of wetlands that are State Game Reserves (Sawpit Swamp, Mutton Swamp, Wal Wal Swamp and Crow Swamp) will provide social benefits in terms of increased duck hunting opportunities. There will be other social benefits around bird watching and the aesthetics of surface water in a typically dry, semi-arid environment. Local community members, including landholders with wetlands on their property have been able to benefit from yabbing in dams that would otherwise be dry. The wetlands have their community values listed in Table 3.

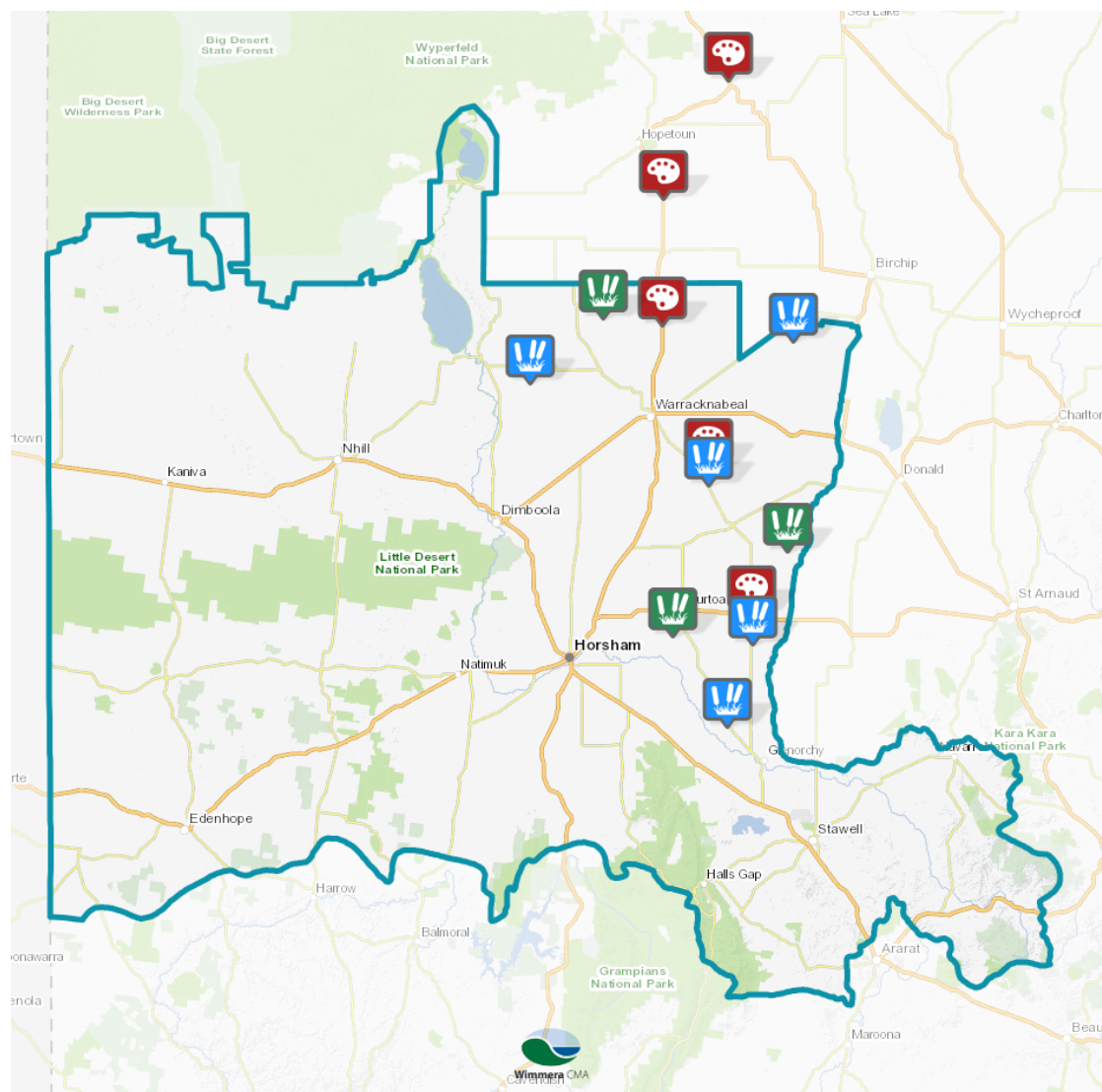
Table 3. Community values provided by supplying water to Wimmera Mallee Pipeline wetlands

Wetland	Community Values	Beneficiaries	Actions
Carapugna	Swimming, yabbing, aesthetics, potential firefighting water supply	Local community members, CFA	Top up dam, inundate wetland areas
Challambra	Swimming, yabbing, aesthetics, potential firefighting water supply	Local community members, CFA	Top up dam
Mutton Swamp	Duck hunting, aesthetics, potential firefighting water supply, yabbing	Local community members, CFA, Field and Game	Top up dam, inundate wetland areas
Pinedale	Yabbing, aesthetics, potential firefighting water supply	Landholders, CFA	Top up dam
Wal Wal Swamp	Duck hunting, aesthetics, fishing	Local community members, Field and Game, anglers	Top up dam
Crow Swamp	Duck hunting, aesthetics, potential firefighting water supply	Local community members, CFA, Field and Game	Top up dam, inundate wetland areas
Tarkedia	Aesthetics, potential firefighting water supply	Local community members, CFA	Top up dam
Harcoan's	Aesthetics	Local community members	Fill up dam
Sawpit Swamp	Aesthetics, duck hunting	Local community members, Field and Game	Fill up dam
Krong Swamp	Aesthetics	Local community members	Fill up dam
Opie's Dam	Aesthetics, potential firefighting water supply	Landholders, CFA	Fill up dam
Schultz/Koschitzke			Fill up dam
Fielding's Dam			Top up dam

The Wimmera CMA has sought to promote their community values through linking the wetlands with the Yarriambiack Silo art trail on the organisation's spatial information site (Pozi) (Figure 2) and advertised this through social media. There has not been any feedback to date around the effectiveness of this given it has been fairly limited exposure to the trail to date but there are opportunities to link in with the Silo Art Trail on social media in 2018/19.

[https://wcma.pozi.com/#/x\[142.16000\]/y\[-36.50961\]/z\[9\]/layers\[siloarttrail\]/layers\[swampsilarttrail\]/tab\[layers\]/](https://wcma.pozi.com/#/x[142.16000]/y[-36.50961]/z[9]/layers[siloarttrail]/layers[swampsilarttrail]/tab[layers]/)

Figure 2: Pozi map showing pipeline supplied wetlands on public and silo art locations



Aboriginal Cultural Values

Whilst no mapping of water-dependent cultural values has taken place that the Wimmera CMA is aware of at these sites, there are indications that there are sites of cultural significance at several of these wetlands. Perhaps most notably is the large scarred Black Box at Fielding's Dam. The watering activities at Fielding's Dam are important for maintaining the health of this significant tree (Figure 3).

There have also been reported sightings of clay balls for earth ovens at Carapugna (Kate Bennetts, Fire, Flood and Fauna, *pers. comm.*) and Tarkedia (Rae Talbot, Wimmera CMA, *pers. comm.*). Cultural values mapping at many of these would be a worthwhile project given their potential significance and create opportunities to achieve cultural outcomes with environmental watering and other activities.

Figure 3: Scarred Black Box Tree – Fielding’s Dam



5. Environmental Objectives and Flow Recommendations

The Wimmera Mallee Pipeline Project (WMPP) was implemented to modernise water delivery infrastructure throughout the Wimmera Mallee Region. Upon its completion in 2010, the project has converted approximately 17,500 km of highly inefficient earthen water channels to 8,800 km of reticulated pipeline. The project has resulted in a number of significant water savings which have been re-directed to deliver a range of environmental, economic and social benefits.

The *Wimmera and Glenelg Rivers Environmental Entitlement 2010* provided the legal means by which the majority of the water savings could be returned to the region's flow stressed rivers as well as isolated wetlands within the Wimmera Mallee Pipeline footprint. The 1000 ML entitlement supports priority wetlands that were historically associated with water storages under the former open channel water supply system. These wetlands, typically containing dams, are no longer part of the water delivery system, being replaced with tanks and pipes. The entitlement recognises the significance water within these wetlands provides within a region characterised by a semi-arid climate and limited surface water. Wetlands eligible to receive water from this entitlement are scattered across the Wimmera, North Central and Mallee CMA regions.

The following 13 wetlands were identified for supply within the Wimmera CMA region:

Wetland	Land Manager	Reserve name (if applicable)
Carapugna	Parks Vic	Watchem I120 Bushland Reserve
Challambra Swamp	Private/Parks Vic	Bangerang I101 Bushland Reserve
Harcoan's Swamp	Parks Vic	Burrero Bushland Reserve
Mutton Swamp	Parks Vic	Mutton Swamp Wildlife Reserve
Pinedale	Private	
Sawpit Swamp	Parks Vic	Saw Pit Swamp Wildlife Reserve
Wal Wal Swamp	Parks Vic	Wal Wal Swamp Wildlife Reserve
Crow Swamp	Parks Vic	Crow Swamp (Phillips Dam) Wildlife Reserve
Tarkedia	Parks Vic	Nullan I106 Bushland Reserve
Opie's Dam	Private	
Schultz/Koschitzke	Private	
Fielding's Dam	Private	
Krong Swamp	Parks Vic	Willenabrina I86 Bushland Reserve

They are all located in the north-east of the Wimmera CMA region (Figure 4).

The long-term objective for these wetlands are for them to act as a refuge for native fauna, especially wetland species during summer/autumn particularly during droughts as well as enhanced wetland vegetation abundance and diversity.

The absence of definitive information on the values and watering requirements of these wetlands led to the undertaking of studies by Australian Ecosystems in 2012 and Rakali Consulting in 2013, on behalf of Wimmera CMA. The studies benchmarked their condition through Index of Wetland Condition and flora surveys, mapping Ecological Vegetation Classes (EVCs) and recording observed fauna at each wetland. Following this the approximate areas and the recommended watering regime as classified in the *Water the Salinity Regime and Depth Preferences for Victorian Wetland EVCs* (DSE, 2012) were used as a guide to provide approximate volumes for each EVC area in each wetland (Table 4).

Ideally, dams should contain water perennially for local fauna but filling them in winter/spring and then having them dry out (but not empty) over summer/autumn will lead to fluctuation of water levels and encourage the growth of a diverse range of wetland vegetation. This in turn leads to benefits for fauna such as provision of habitat for tadpoles. For more details on the watering regimes recommended for these wetlands see the *Environmental Water Management Plan – Wimmera Mallee Pipeline Wetlands – Wimmera CMA Region* (Wimmera CMA, 2016). Experience shows that several dams do not hold water well and so temporary filling during winter/spring to promote wetland flora and fauna outcomes is the best outcome that can be achieved.



Ridged Water-Milfoil, a nationally threatened species at Carapugna – September 2017

Figure 4: Off-stream wetlands proposed to be supplied in the Wimmera CMA region

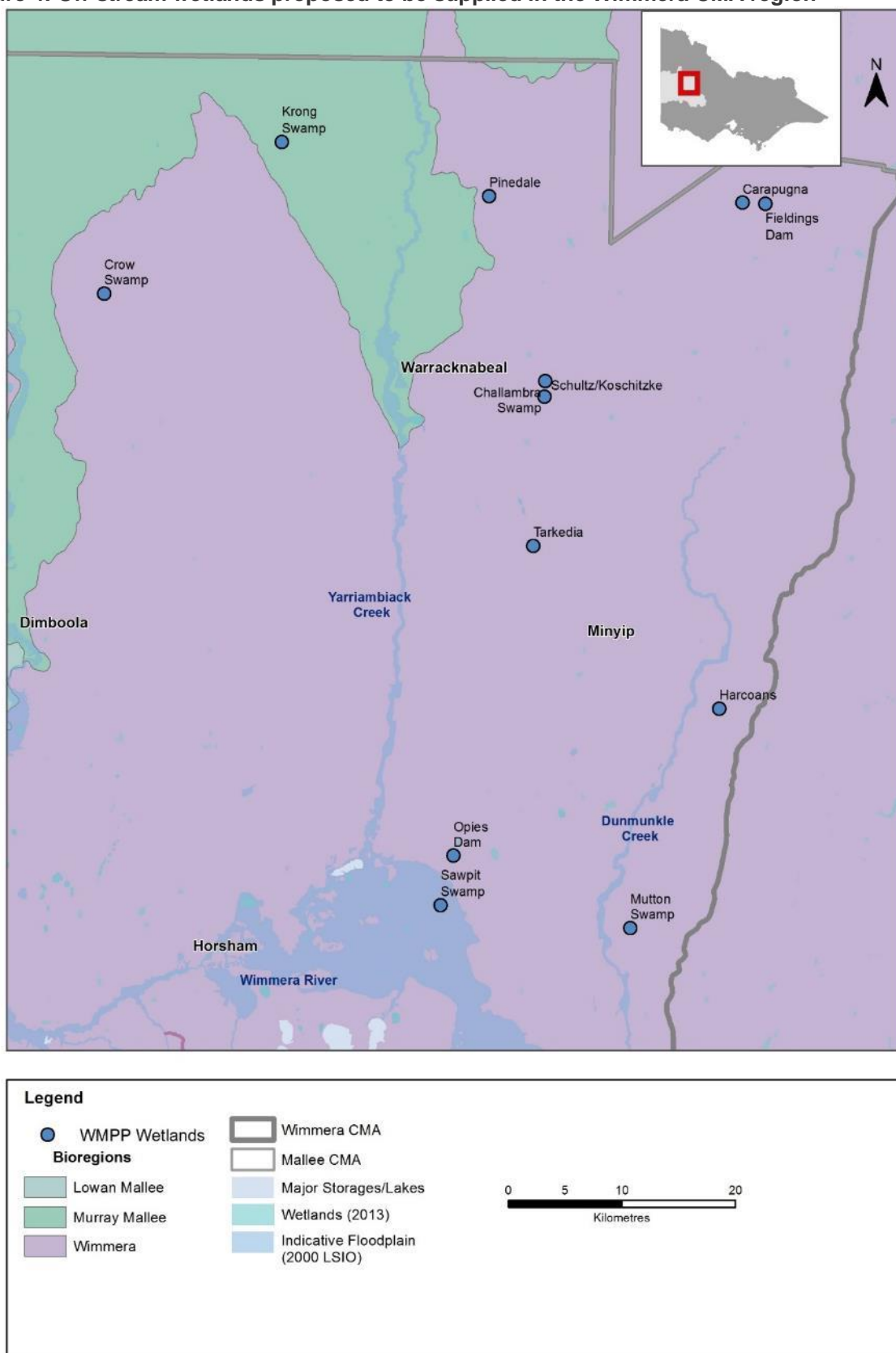


Table 4. Wetland categories of nominated wetlands and inundation preference information from Australian Ecosystems (2013) and Rakali Consulting (2014).

Wetland name	Wetland category	Wetland EVCs	Optimum inundation frequency	Inundation duration	Inundation depth	Approximate Volume Required per EVC (ML)
Carapugna	Freshwater Meadow	Black Box Wetland	3-7 years in 10	1 month to > 1 year	Up to 30 cm	50.4
		Northern Wimmera Riverine Chenopod Wetland	Sporadic and uncommon	Not recommended to be artificially inundated		
Challambra Swamp	Freshwater Meadow	Black Box Wetland	3-7 years in 10	1 month to > 1 year	Up to 30 cm	32
		Lake Bed Herbland	< 3 years in 10	1 month to > 1 year	30 cm to 2 m	46.4
Crow Swamp	Shallow	Intermittent Swampy Woodland	3-7 years in 10	1 month to > 1 year	30 cm to 1 m	14
	Freshwater	Lake Bed Herbland	< 3 years in 10	1 month to > 1 year	30 cm to 2 m	37.5
	Marsh	Northern Wimmera Riverine Chenopod Wetland	< 3 years in 10	1 month to > 1 year	Up to 30 cm	2.4
Harcoan's Swamp	Freshwater Meadow	Lake Bed Herbland	< 3 years in 10	1 month to > 1 year	30 cm to 2 m	40
		Black Box Wetland	3-7 years in 10	1 month to > 1 year	Up to 30 cm	2.1
Krong Swamp	Freshwater Meadow	Lignum Swampy Woodland	Once every 2 – 5 years	Up to 4 months	Up to 30 cm	4
		Lignum Shrubland	Only if dry for > 2 years	< 6 months	50 cm on average	11
		Black Box Wetland	3-7 years in 10	1 month to > 1 year	Up to 30 cm	18.6
Mutton Swamp	Freshwater Meadow	Lake Bed Herbland	< 3 years in 10	1 month to > 1 year	30 cm to 2 m	39
		Black Box Wetland	3-7 years in 10	1 month to > 1 year	Up to 30 cm	40
Pinedale	Shallow	Black Box Wetland	3-7 years in 10	1 month to > 1 year	Up to 30 cm	12.9
	Freshwater Marsh	Northern Wimmera Riverine Chenopod Wetland	Sporadic and uncommon	Not recommended to be artificially inundated		8.9
Sawpit Swamp	Shallow Freshwater Marsh	Intermittent Swampy Woodland	3-7 years in 10	1 month to > 1 year	30 cm to 1 m	17.4
		Floodway Pond Herbland	3-7 years in 10	< 12 months	30 cm to 2 m	18
		Floodway Pond Herbland- Riverine Swamp Complex	Only if dry for > 6 months	< 4 months	50 cm on average	65.5
Wal Wal Swamp	Shallow Freshwater	Red Gum Swamp-Cane Grass Wetland Complex	3-7 years in 10	1 month to > 1 year	30 cm to 1 m	24

Wetland name	Wetland category	Wetland EVCs	Optimum inundation frequency	Inundation duration	Inundation depth	Approximate Volume Required per EVC (ML)
	Marsh	Cane Grass Wetland-Aquatic Herbland Complex	8-10 years in 10	1 – 8 months	30 cm to 1 m	16.5
		Riverine Swampy Woodland	Sporadic and uncommon	Not recommended to be artificially inundated		2.2
Opie's Dam	NA – Dam	NA	Permanent	Maintenance of surface water for Growling Grass Frog population		4
Tarkedia	Shallow Freshwater Marsh	Lignum Swampy Woodland	Once every 2 – 5 years	Up to 4 months	Up to 30 cm	13.5
		Black Box Wetland	3-7 years in 10	1 month to > 1 year	Up to 30 cm	13.5
Fielding's Dam	Freshwater Meadow	Herb-rich Gilgai Wetland	3-7 years in 10	Up to 3 months	Up to 20 cm	10
Schultz/ Koschitzke	Freshwater Meadow	Plains Grassy Wetland/ Spike-sedge Wetland	3-7 years in 10	1 month to > 1 year	Up to 1 m	50
		Black Box Wetland	3-7 years in 10	1 month to > 1 year	Up to 30 cm	24



Kate Bennetts and Michelle Casanova undertaking vegetation quadrat monitoring for WETMAP at Carapunga, April 2017

6. Seasonal Review

There is a gradual increase in understanding regarding these wetlands including; their history of inundation prior to the delivery of environmental water, the ecological values they support and how these values may have responded to changes in water availability. The ongoing drought conditions that persisted from 1997 to 2009 would have meant that these wetlands would have been largely dry and the channel system would have only provided water infrequently to the dams in/adjacent to these wetlands. It is highly likely that most of these dams were dry from at least 2004-05 to 2010-11. Some (e.g. Crow Swamp) did not even contain water in 2010-11 despite record rainfall.

The period from September 2010 to January 2011 was exceptionally wet and the runoff generated led to significant inundation events. Conditions following the January 2011 floods were dry and the wetlands dried out so water was only present in locations where environmental water has been delivered. Sawpit Swamp was the first wetland connected to the Wimmera Mallee Pipeline and benefited from two watering events prior to 2014-15. Following the completion of wetland assessments and infrastructure works from mid-2014 through to early 2015, watering efforts escalated in early 2015. Including;

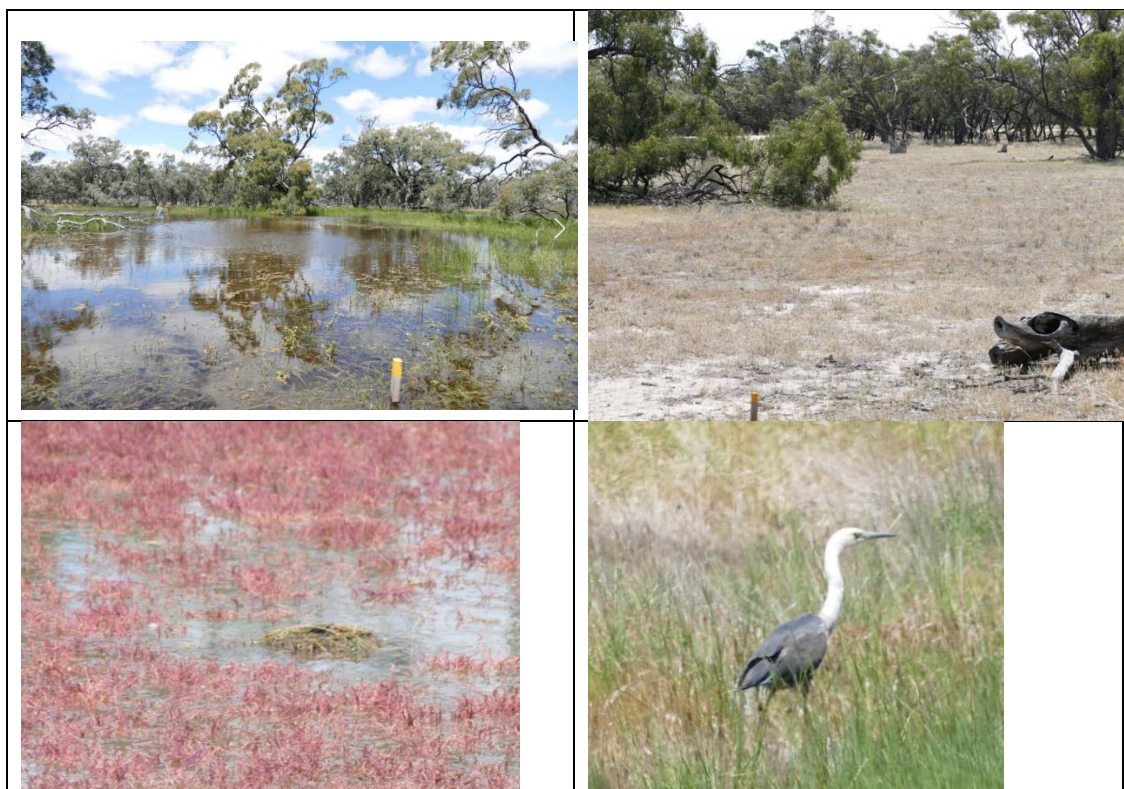
- Filling dams at: Fielding's Dam, Tarkedia, Harcoan's, Krong Swamp, Carapugna and Wal Wal Swamp; and
- Filling dams and providing shallow wetland inundation at: Mutton Swamp, Crow Swamp, Pinedale.

In 2015-16 watering took place in November and December to provide low level inundation at Sawpit Swamp, top up Fielding's Dam as well as fill Krong Swamp and Carapugna. During the off-peak pipeline delivery period in April-June 2016 there were top ups for dams at Mutton Swamp, Crow Swamp, Wal Wal Swamp, Tarkedia, Carapugna and Pinedale. Wet conditions in spring 2016 led to Wal Wal Swamp, Harcoan's, Krong Swamp, Mutton Swamp, Carapugna, Schultz/Koschitzke and Sawpit Swamp receiving good levels of natural runoff to achieve desired wetland water outcomes. Therefore environmental watering in 2016-17 was limited to topping up Fielding's Dam in summer/autumn 2017 and in May/June 2017 dams at Carapugna, Crow Swamp, Challambra, Mutton, Pinedale and Tarkedia were topped up with some low level wetland inundation at Carapugna, Crow Swamp and Mutton Swamp. The inundation history of these wetlands from 2004/05 is outlined in Table 4.

Outcomes from watering to date in 2017/18 are summarised as follows:

Carapugna

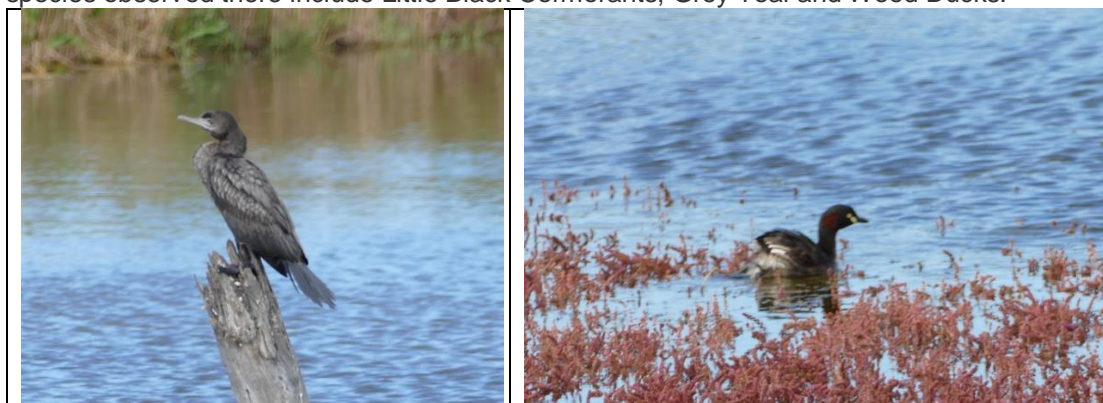
This wetland's reputation continues to be enhanced with spectacular responses to environmental watering. 2017/18 saw the first trialling of the additional pipeline connections constructed through the reserve in 2015. A series of several small Black Box wetland and Lake Bed Herbland areas were inundated in a sequence over winter/spring to determine the effect of environmental watering on wetland vegetation as part of the WETMAP program. A large array of wetland plants (sedges, nardoo, milfoils etc.) were observed in the wetland areas. The dam is becoming increasingly filled with red milfoil which is providing nesting habitat for Australasian Grebes. The wetting/drying regime for the wetland is also seeing the colonisation of mudflat species like Common Sneezeweed which is replacing the exotic annual weed coverage. White-necked Herons, White-faced Herons, Black Ducks and Wood Ducks have all been observed there as well.



Carapugna – November 2017 - Contrast between watered and unwatered areas (top), Australasian Grebe nest (bottom left), White-necked Heron (right).

Crow Swamp

The condition of Crow Swamp is affected by a heavy cover of annual exotic grasses (barley-grass, rye-grass). The vegetation outcomes from watering were limited due to the grasses covering most of the wetland. However there was a positive response by nardoo in patches (Phil Papas, ARI, *pers. comm.*) and the recent recruits from what was once the sole Spiny Lignum plant (a threatened species) continue to do well. Within the dam area, red water milfoil is now very abundant, becoming valuable habitat for Australasian Grebes. Other bird species observed there include Little Black Cormorants, Grey Teal and Wood Ducks.



Crow Swamp – November 2017 – Little Black Cormorant and Australasian Grebe

Sawpit Swamp

The 'dam' area at Sawpit Swamp is not good at holding water and so the main vegetation values relate to mudflat species once the wetland dries out, in particular prolific growth of Common Sneezeweed and Pale Beauty Heads.



Sawpit Swamp – November 2017 – White-faced Heron (left) and Stumpytails amongst the sneezeweeds (right)

Challambra

Through spring there was an attempt to overtop the dam into the adjacent channel and wetland area. Unfortunately the flow rate was much less than modelling work indicated would be possible at the site. Therefore only small volumes spilled out into the adjacent wetland area however this was enough to trigger frog breeding. Deliveries continued into late spring to ensure that this was completed. There is also a steady improvement in the fringing vegetation with milfoils, callitriches and sedges recolonising previously exposed banks. The dam supports Grey Teal and Wood Ducks as well as breeding Australasian Grebes.



Challambra Swamp – November 2017 – Inundation of adjacent wetland (left) and enhanced fringing vegetation on dam bank (right)

Tarkedia

Whilst the top up to the dam supported a range of plant and bird life including Black Tailed Native Hens and Black Ducks, a trial watering of the adjacent wetland via the pipeline resulted in only a muted response due to the water spreading out and infiltrating before reaching the base of the wetland. Additional investigations and works such as lengthening the pipeline (subject to approvals) will improve this in the future.



Tarkedia – November 2017 - Fringing vegetation at dam has increased following several years of wetting/drying and flowering Swamp Goodenia following inundation of wetland area.

In late summer deliveries also took place to top up Fielding's Dam. From April 2018 onwards, deliveries are planned to commence for the other wetlands, such as took place in 2017 to top up dams to ensure that they contain water through winter and into spring. This includes Wal Wal Swamp, Mutton Swamp, Carapugna, Pinedale. Also filling of Opie's Dam and the dams at Harcoan's and Krong Swamp are planned to take place so they hold water in winter/spring before drying out given they cannot hold water for a long time.

Local fauna, especially wetland bird and frog populations have benefitted from wetlands and/or dams receiving water and positive vegetation outcomes have been observed which is leading to a gradual increase in the environmental values of these wetlands. Localised heavy rainfall is enough to maintain many of the values (e.g. threatened aquatic plants species have been observed in areas not supplied with environmental water). However in dry years this will not happen and so water supplied by the pipeline plays a more important role. Similarly in very wet years, water supplied by the pipeline may keep wetlands topped up to meet recommended durations of inundation subject to delivery rates.

Table 4. Historical watering regime of wetlands from 2004/05 up to March 2018

Key	WET					WET-DRY					DRY					Ecological outcomes/observations 2017/18
Wetland Name	Water regime															
	2004/ 05	2005/ 06	2006/ 07	2007/ 08	2008/ 09	2009/ 10	2010/ 11	2011/ 12	2012/ 13	2013/ 14	2014/ 15	2015/ 16	2016/ 17	2017/ 18		
Carapugna	D O	D	D	D	D	D	U		D	D	E D	E D	U	E P	Spectacular vegetation response to watering including Ridged-Water Milfoil (threatened species)	
Challambra Swamp	D O	D					U		D	D	E D	E D	P	E P	Water in dam leads to benefits for local fauna, overtopping into adjacent wetland led to frog breeding event in spring 2017.	
Harcoan’s Swamp	D O						U				E D		U P	P	None observed to date being dry through 2017/18. Dam does not hold water well.	
Mutton Swamp							U	D	D		E D	E D	U P	P	Water in dam leads to benefits for local fauna, especially waterbirds. Low level inundation leads to improved wetland vegetation and waterbird outcomes including wetland bird breeding (White Necked Heron and Australasian Grebe) in spring 2017.	
Pinedale	D O						U				E	E	D P	D P	Water in dam leads to benefits for local fauna including Australasian Grebe breeding. Wetland flora (black box) still showing benefits of prior watering.	
Sawpit Swamp							U			E	E	E	U P	E D	Positive flora response to flooding (<i>Centipeda cunninghamii</i>). Dam does not hold water well so may alternate between inundating dam and adjacent wetland area.	
Wal Wal Swamp							U				E	E	U P	E D P	Positive fauna response to flooding (waterbird habitat – mostly Grey Teal and Black Tailed Native Hens). Presumably carp are impacting aquatic vegetation outcomes, being limited to date.	
Krong Swamp	D O						U				E D	E	U P	P	None observed to date being dry through 2017/18. Dam does not hold water well.	
Crow Swamp											E D	E D	D P	E P	Water in dam leads to benefits for local fauna. Low level inundation leads to improved wetland vegetation recruitment (<i>Duma horrida</i>) and waterbird outcome habitat and breeding.	
Opie’s Dam (Dam only)	D O						U D	D	D				D P	P	None observed to date being dry through 2017/18.	
Tarkedia							U				E D	E D	D P	E P	Water in dam leads to benefits for local fauna. Watering adjacent wetland let to limited flora outcome – potential adjustment to outlet.	
Fielding’s Dam	D O	D					U	D	D		E D	E D	E D	E D	Water in dam leads to benefits for local fauna (habitat for waterbirds and drinking water source for local fauna).	
Schultz/Koschitzke	D O						U					E	U P	P	Minor pipeline leakage (being addressed) has provided isolated positive wetland vegetation outcomes but no environmental water delivered in 2017/18 to date	

Key- O: Received consumptive water U: Received unregulated water E: Received environmental water D: Dam contains water only (i.e. wetland dry) P: Planned delivery for April-June 2018

7. Scenario Planning and Prioritisation

Increased information around the watering of these wetlands has been developed during the development of the relevant Environmental Water Management Plan (EWMP). It has established recommendations around the frequency and duration of wetland inundation events. Given the highly episodic nature of the wetlands' hydrology, they would not naturally be inundated every year. In fact during droughts, it might be over a decade between significant inundation events. Providing water to these wetlands can be done on a rotational basis, watering several every year unless wet conditions occur which effectively resets the cycle. It is valuable for dams to be watered annually for a variety of reasons and Native Fish Australia (Wimmera) is applying for funding for a project to potentially use dams (Carapugna, Challambra Swamp, Tarkedia, Pinedale, Crow Swamp, Mutton Swamp) as breeding locations for a threatened species recovery project (Yarra Pygmy Perch). If this was to be the case it would not lead to any changes from watering actions and priorities for these locations described in the EWMP as keeping water in the dams is an ongoing objective, it would only enhance the value of this watering action.

Table 5 lists the priority watering actions for the Wimmera Mallee Pipeline wetlands in 2018-19 in the Wimmera region. Table 6 outlines where these priority watering actions fit within the context of different climate scenarios. Table 7 lists these watering objectives in more detail with associated priorities and volumes.

7.1. Priority Watering Actions

Table 5. Priority watering actions 2018-19

Priority	Wetland watering action	Rationale
Very high	Fill/ top up dams at all wetland sites (not wetland areas).	Provide refuges for local fauna especially wetland birds in a semi-arid region under dry conditions for dams that retain water well. For dams that do not retain water well – provides opportunity to enable recruitment of local flora and fauna.
High	Water adjacent wetland areas outside dams at, Crow, Challambra Carapugna, Pinedale.	Enhance high value wetland flora including threatened species. Crow and Carapugna need inundation for WETMAP monitoring outcomes, Pinedale has been dry since at least early 2015 and Challambra since 2011.
Medium	Water adjacent wetland areas at, Mutton, Sawpit, Tarkedia	Enhance high value wetland flora including threatened species. Recent inundation reduces priority for 2018-19.
Low	Water adjacent wetland areas at Harcoans, Krong	Enhance high value wetland flora including threatened species (Krong), provide wetland bird habitat (Harcoans). Inundation in recent years reduces priority for 2018-19.

The timing of water deliveries will typically be during cooler months (May to October) which are off-peak demand periods from the pipeline. There are occasional exceptions to this, for instance if capacity is available just prior to or after the off-peak period and Fielding's Dam which tends to need a top up in summer, subject to pipeline capacity.

7.2. Scenario Planning

Table 6. Scenario Planning

Scenario outcomes	Drought	Dry	Average	Wet
Expected climatic conditions and water availability	Carryover approx. 1050 ML Allocation 0 ML	Carryover approx. 1050 ML Allocation 0 ML	Carryover approx. 1050 ML Allocation 250 ML	Carryover approx. 1050 ML Allocation 1000 ML
Expected inflows	Nil	Nil	Shallow inundation (< 0.2 m)	Moderate inundation (<0.5 m)
Environmental objectives	Refuges for fauna and enhancing flora at priority wetlands			
Priority watering actions (Tier 1)	Fill/ top up dams at all wetland sites. Water adjacent wetland areas at Crow, Challambra, Carapugna, Pinedale			
Estimated environmental water requirement (Tier 1)	63 ML all dams, 20 ML Carapugna, 45 ML Challambra, 20 ML Crow Swamp, 13 ML Pinedale (161 ML – total)			
Priority watering actions (Tier 2)	Water adjacent wetland areas at Mutton Swamp, Sawpit Swamp, Tarkedia			

Estimated environmental water requirement (Tier 2)	40 ML Sawpit Swamp, 45 ML Mutton Swamp, 9.5 ML Tarkedia (94.5 ML – total)
High priority carryover	NA – allocations sufficient
Additional water demand and use	Nil

The inclusion of Carapugna and Crow Swamp in WETMAP program meant that, following preliminary monitoring in 2017, there is a desire to undertake further watering actions to complete the assessment into the impact of environmental water on wetland vegetation and waterbirds. Advice from Phil Papas (Arthur Rylah Institute) indicates it should involve watering vegetation transects established in 2017 whilst leaving some counterfactual transects dry (Figures 5 and 6).

Figure 5: Aerial photograph of Crow Swamp showing location of vegetation transects. Water flows out from the south-western edge of the dams when full on to Transects 1,2 and 6. Transects 3, 4 and 5 remain dry as counterfactuals. Source: Phil Papas (ARI)



Figure 6: Aerial photograph of Carapugna showing location of vegetation transects. Water is able to be delivered to Transects 4, 5, 7 and 2. Transect 3 cannot be watered currently and Transect 1 may not be able to be watered depending on rates of losses and deliveries. Source: Phil Papas (ARI)



Zonation of wetland vegetation at Mutton Swamp – May 2017

Following wet conditions in 2016 and limited use in 2017-18 there is good entitlement water availability coming into 2018-19 which should enable all priority watering actions to be achieved. The estimated environmental water requirement volumes are sufficient to fill/top up all dams as well as a volume to inundate wetlands at Crow Swamp, Challambra Swamp, Pinedale and Carapugna. The volume for these wetlands are slightly more than the maximum modelled volume that can delivered (Table 8) given pipeline demands are likely to be less than assumed modelled rates. Following watering events, it seems the actual delivery rate at Challambra is much less than that modelled whilst at Crow Swamp and Carapugna, greater flow rates than modelled have been achieved.

Table 7. Priority watering actions proposed for wetlands supplied by the Wimmera Mallee Pipeline in the Wimmera CMA area and priority for watering in 2018-19.

Wetland	Priority watering actions	Estimated max. volume required (ML)		Priority (Dam)	Priority (Wetland)
		Dam	Wetland		
Carapugna	Refill dam and priority wetland EVC	8	22	Very High	High
Challambra Swamp	Refill dam and priority wetland EVC	5	45	Very High	High
Crow Swamp	Refill dam and provide a small volume of water to commence watering wetland priority wetland EVC	3	22	Very High	High
Harcoan's Swamp	Refill dam and provide a small volume of water to commence watering wetland priority wetland EVC	5	35	Very High	Low
Krong Swamp	Refill dam and provide a small volume of water to commence watering wetland priority wetland EVC	3	12	Very High	Low
Mutton Swamp	Refill dam and provide a small volume of water to commence watering wetland priority wetland EVC	5	45	Very High	Medium
Pinedale	Refill dam and provide a small volume of water to commence watering wetland priority wetland EVC	4	13	Very High	High
Sawpit Swamp	Refill dam and provide a small volume of water to commence watering wetland priority wetland EVC	10	40	Very High	Medium
Wal Wal Swamp	Refill dam	5	15	Very High	NA
Opie's Dam	Refill dam	4	NA	Very High	NA
Tarkedia	Refill dam and provide a small volume of water to commence watering wetland priority wetland EVC	4	9.5	Very High	Medium
Fielding's Dam	Refill dam	2	NA	Very High	NA
Schultz/Koschitzke	Refill dam and priority wetland EVC	5	45	Very High	NA
<i>Total</i>	<i>For wetland watering actions listed above</i>	63	303.5		

8. Delivery Constraints

The information provided by Australian Ecosystems (2013) and Rakali Consulting (2014) provides a solid foundation for undertaking watering actions through the mapping of EVCs and development of watering recommendations based on DSE (2012). For each wetland there needs to be consideration of the modelled pipeline capacity to deliver water compared to the volumes required to meet the recommended water level and duration (see Table 8).

There are some wetlands where hydraulic modelling indicates that the amount that can be delivered on an annual basis is close to or above that required to inundate the lowermost EVC within the wetlands (highlighted in green). Whilst in others the hydraulic capacity to supply the wetland is much lower than the volume required to supply sufficient water to fill the wetland to the recommended level within a year (highlighted in yellow).

Table 8. Comparison between modelled maximum annual demand delivered from the pipeline outlet (from GWMWater 2012, 2013), compared to the initial target wetland EVC volume (from Australian Ecosystems, 2013) and (Rakali, 2014). Dam volumes within the wetland area would be much smaller (several megalitres).

Wetland	Modelled Maximum Demand (ML)	Wetland target EVC Approximate Capacity
Carapugna	20	50.4
Challambra Swamp	45	46.4
Crow Swamp	12	37.5
Harcoans	30	40
Krong Swamp	15	11
Mutton	50	39
Pinedale	25	12.9
Sawpit Swamp	50	83.5
Wal Wal Swamp	15	16.5
Opie's Dam	2	2
Tarkedia	8	13.5
Schultz/Koschitzke	20	50
Fielding's Dam	4	10

Some other key factors are worth noting:

- Given the long period of delivery (a number of months) there is likely to be seepage and evaporation losses within the wetlands whilst deliveries are occurring. They will increase during the warmer months although deliveries are typically during cooler months.
- The period for delivery is typically 'off-peak' which are months where demand on the Wimmera Mallee Pipeline for supplying towns and farms is lowest (May-October). This maximises the delivery rate of water to wetlands. It may not be possible to deliver water to these wetlands in peak periods due to other demands. In some cases, actual delivery rates are much less than those modelled (e.g. Challambra) whereas for others (e.g. Crow Swamp) the opposite applies.
- Some wetlands have had infrastructure constructed in February 2015 to enable much better environmental outcomes to be achieved from the application of environmental water. The details of which are included in RPS (2014) and an example is included in Figure 7. This enables targeted watering of the wetland or both the dam and wetland.
- The estimates of the volumes required to be supplied to these wetlands are very coarse (i.e. calculated from area of EVC multiplied by the recommended depth) and so does not take into account variations in topography within the wetlands themselves. Given they are depressions within the landscape it is likely that they are underestimates. Given that the estimated volume is calculated to achieve the maximum height recommended within these wetland EVCs, shortfalls will still achieve a similar outcome (i.e. a wetland requiring inundation level of 0.3 m to 1m will still benefit if the inundation is 0.7 m compared to 1m). Adaptive management based on observed

outcomes through environmental water delivery will be crucial to ensuring that watering outcomes are obtained into the future (i.e. volumes required to inundate the wetland to a certain level and how long the water persists).

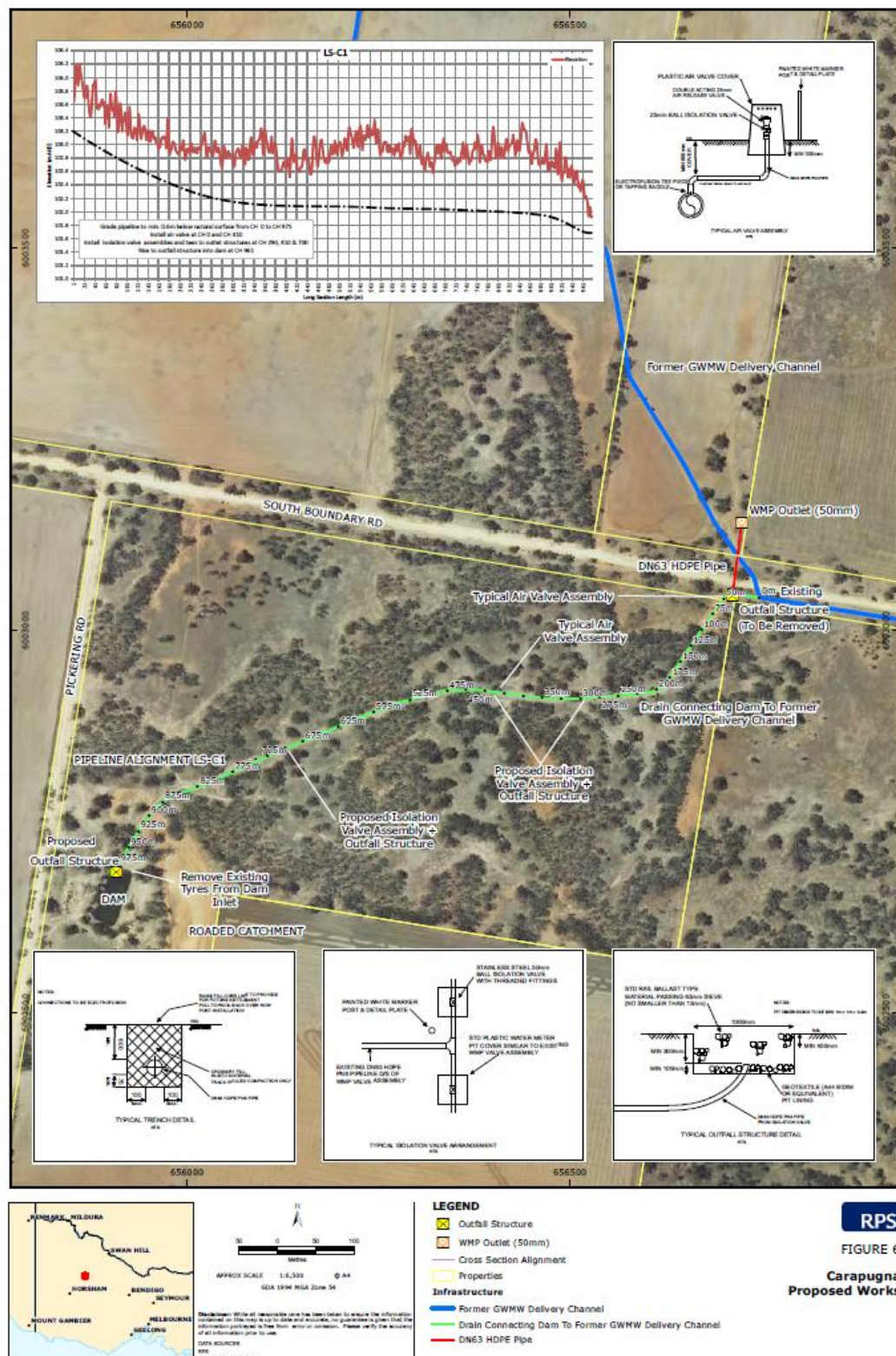


Figure 7. Example diagram of works undertaken at Carapugna in February 2015 to enhance wetland hydrology.

9. Increasing Knowledge

The work undertaken by Australian Ecosystems in 2012 and Rakali Consulting in 2013 has provided an invaluable initial benchmarking exercise and fills some key knowledge gaps in watering requirements and values to be enhanced. DELWP (2015, draft) also provides useful information on the watering needs of wetland vegetation, waterbirds and wetland dependent fauna, namely frogs and turtles. There is still limited data available for these locations given their isolated nature and lack of previous watering activities so adaptive management through effective monitoring is a critical process going forward.

Wimmera CMA and Birchip Landcare Group have in the past deployed equipment including frog monitoring equipment and motion sensor cameras at several wetlands receiving environmental water in the Wimmera CMA region. Recently the results of motion sensor cameras were intended to inform rates of filling/drying at Carapugna. Carapugna and Crow Swamp have been included in WETMAP and have been monitored for vegetation and birds in 2017 and this will continue in 2018.

Monitoring of environmental water releases is a critical component of adaptive management and enables meaningful reporting of environmental outcomes generated by these activities and justification for the significant amounts of public investment made in environmental water recovery and management. Some resources have been made available for monitoring these wetlands prior to and after the application of environmental water which is reflected in the monitoring activities that are proposed in Table 9. Wimmera CMA will work with relevant landholders with respect to monitoring and including local knowledge into decision making processes. This will include a trial of a community wetland bird monitoring program after a training workshop run in Watchem in April.

Should more funding be available, a more comprehensive assessment of vegetation would be beneficial in order to quantify changes that have resulted from watering activities. Monitoring undertaken can not only facilitate reporting on outcomes of environmental watering activities but fill knowledge gaps regarding the effectiveness of these activities going forward.

Table 9. Proposed monitoring for Wimmera Mallee Pipeline Wetlands

Wetland	Objective	Hypotheses	Indicator(s)	Frequency
All	Area/depth inundated	Need to establish a relationship between volumes delivered and habitat provided	Depth (bathymetry data) and volume (meters) including using pressure sensors and soil moisture probes	Periodic
	Water quality	Water will be of sufficient quality to sustain aquatic and wetland ecosystems	Salinity, pH and dissolved oxygen	Periodic
	Wetland condition (vegetation etc.)	Watering will lead to an increase in wetland condition and any declines in condition (e.g. too frequent inundation) will be captured	IWC Scores, established transects and photopoints, WETMAP	Subject to funding
	Frogs	Watering will trigger a response in the frog population	Frog audio surveys	Periodic
	Wetland birds and other fauna	Watering will attract wetland birds and other fauna in a dry region to use habitat	Motion sensor camera, WETMAP	Periodic

10. Risk assessment and management

Risk assessment and management is a critical aspect of long-term environmental water planning, Table 10 illustrates the various risks (likelihood and consequence) associated with planned environmental flow components. The risk assessment was developed in conjunction with VEWH and GMMWater.

Table 10. Risk assessment and where appropriate mitigation measures for environmental watering

Legend: <ol style="list-style-type: none"> 1. Risk category abbreviations are: Env. – environment/sustainability; BC – business cost; Safety – People/safety/wellbeing; Rep – Political/reputation; Legal – legal consequence; Service – service delivery 2. L refers to the Likelihood of a risk occurring. Abbreviations for consequence ratings are: AC – almost certain; L – likely; P – possible; U – unlikely; R - rare 3. C refers to the Consequence if the risk occurs. Abbreviations for consequence ratings are: N – negligible; Min – minor; Mod – moderate; Maj – major; Ext - extreme 							
No.	Risk category ¹	Risk description	L ²	C ³	Risk rating	Mitigation actions	Lead org. for action
1	Env	Insufficient water available for proposed watering actions to meet environmental objectives.	U	Mod	Medium	Adaptively prioritise and revise watering actions to optimise outcomes from water available considering seasonal conditions. Prioritise sites and/or watering actions Consider reserving contingency volume for current year and balancing against carryover needs for future years. Communicate with community and stakeholders around planned watering actions and any revisions required. Undertake complementary actions (e.g. carp removal, fencing).	CMA VEWH VEWH CMA CMA

No.	Risk category ¹	Risk description	L ²	C ³	Risk rating	Mitigation actions	Lead org. for action
2	Env	Environmental water deliveries may generate or mobilise poor quality water (e.g. blackwater, BGA), with adverse water quality and environmental outcomes ; or Areas not targeted for environmental watering actions experience poor quality water (e.g. blackwater, BGA), with adverse water quality and environmental outcomes	R	Mod	Low	Ongoing monitoring to inform water deliveries, including arranging improved access to data. Adapt flow management based on antecedent conditions and local knowledge. Communicate around current conditions and revised objectives (e.g. provide public information via signage, social media etc.) Undertake complementary actions, including provision of information to the community	CMA VEWH CMA CMA
3	Env	Environmental deliveries create improved conditions for non-native species (e.g. carp, invasive weeds) leading to adverse environmental impacts. <i>(Note: This risk addresses the incremental impact of environmental water deliveries on pest plant and animal populations, noting that even in the absence of environmental delivery actions these pests are likely to spread in waterways with adverse environmental impacts)</i>	P	Min	Medium	Adaptively manage flow to incorporate new knowledge from monitoring and research. Monitor invasive species extent and control existing populations (e.g. opportunistic removal of carp in dry conditions). Install physical barrier to prevent translocation (e.g. carp barriers). Develop management agreements with landholders that include pest plant and animal control measures.	CMA CMA CMA CMA
4	Rep	Inability to demonstrate that environmental water objectives have been achieved, which may lead to a loss of public/political support for activities.	L	Mod	High	Seek additional funding for and undertake targeted local monitoring (leveraging existing data sets where possible). Invest in monitoring and research to address knowledge gaps and influence existing monitoring programs.	CMA VEWH

No.	Risk category ¹	Risk description	L ²	C ³	Risk rating	Mitigation actions	Lead org. for action
						Share new knowledge to promote adaptive management. Communicate monitoring results to local communities.	VEWH CMA
5	Legal	Environmental releases cause unauthorised inundation of private land, resulting in impacts on landowner activities and assets.	U	Mod	Medium	Ongoing communication with GWMWater and land managers in planning and delivery phases. Consider weather forecasts when planning releases and reschedule deliveries if forecasts indicate potential for flooding. Test and monitor delivery rate and respond to potential incidents. Maintain and inspect infrastructure, including upgrading infrastructure where required before delivery occurs. Identify likely areas of impact by understanding historical impacts and previous experience, and modify flow planning, or undertake works to reduce risk of inundation.	CMA GWMWater GWMWater GWMWater CMA
6	BC	Insufficient staff resources available to deliver all planned environmental watering actions, leading to cancellation or interruption of deliveries.	P	Mod	Medium	Ongoing communication with the GWMWater to understand constraints and develop a schedule of delivery to manage staff resources. Implement remote monitoring to minimise staff time in the field, within available funding.	CMA GWMWater CMA

No.	Risk category 1	Risk description	L ²	C ³	Risk rating	Mitigation actions	Lead org. for action
						Continue to actively prioritise actions to match available resources and ensure key actions are delivered.	
7	BC	Volume delivered or released exceeds volume approved and/or ordered for use in the event or year.	P	Mod	Medium	<p>Communicate seasonal watering statements to all partners.</p> <p>Monitor delivery rate, provide delivery data to CMA/VEWH and respond to potential incidents.</p> <p>Monitor water use against volume approved for use in seasonal watering statement and adapt water orders if required.</p> <p>Monitor water use against volume approved and undertake regular communications with CMA and GMMWater as part of portfolio management activities.</p> <p>Prioritise sites and/or watering actions if insufficient water is available.</p>	<p>VEWH</p> <p>GMMWater</p> <p>CMA</p> <p>VEWH</p> <p>VEWH</p>
8	Safety	Where delivery structures are unsafe and have limitations on their operation, planned environmental deliveries may not be feasible leading to a failure to achieve environmental outcomes.	R	E	High	<p>Upgrade or modify infrastructure to improve safety.</p> <p>Modify method of operation to avoid unsafe work practices and update safety procedures to reflect this (note: safe work procedures may need to be communicated to community/volunteer resources as well as agency staff where they undertake structure operations).</p>	<p>Asset owner</p> <p>Asset owner</p>

No.	Risk category ¹	Risk description	L ²	C ³	Risk rating	Mitigation actions	Lead org. for action
9	Env	Expected inundation not occurring due to environmental conditions, (for example high losses at very dry sites, hot weather causing excessive evaporation, antecedent conditions and inflow rates) and environmental benefits not being achieved.	L	Mod	High	Monitor flow rate and adjust delivery volume within approved volume.	CMA
10	Env	Flow rate at environmental flow release or measurement point limited, leading to sub-optimal environmental outcomes.	P	Mod	Med	Monitor flow rate and undertake actions to improve water pressure if feasible. Ongoing communication with the CMA to manage infrastructure or maintenance constraints.	GWMWater GWMWater
11	Safety	Environmental releases create rapid or unexpected changes in water conditions, resulting in injury	R	E	High	Communicate water deliveries to communities and key stakeholders. (e.g. using community SMS update services). Flow rates are very low.	CMA and Land Manager
12	Rep	Community groups not supportive of environmental watering delivery.	P	Mod	Medium	Engage with the local community through a variety of avenues (e.g. workshops, forums, individually to communicate benefits of environmental watering). Develop Statewide communication products and engage with peak bodies Each organisation will share their intended environmental water related communications plans with all partners	CMA VEWH CMA/VEWH
13	Env	Inadequate monitoring of wetland water levels leads to over delivery to wetlands with local flooding and environmental impacts.	L	Min	Medium	Inspection of wetlands immediately prior to commencement of deliveries to confirm levels and water needs, with regular monitoring of levels during events.	CMA CMA

No.	Risk category ¹	Risk description	L ²	C ³	Risk rating	Mitigation actions	Lead org. for action
						Enlisting the assistance of local interest groups and landholders to provide feedback on wetland levels during delivery events.	
14	Env	Overestimates of environmental water demand causes a water shortfall of supply for meeting demands at other locations	U	Min	Low	<p>CMA's review demand estimates throughout the delivery cycle and regularly advise VEWH of any changes so unused water can be reallocated.</p> <p>CMA's review demand estimates at the conclusion of the watering year, prior to the development of the following seasonal watering proposal, so estimates of future requirements are more accurate.</p> <p>Manage Water Holdings to maximise supply opportunities for all sites</p>	<p>CMA</p> <p>CMA</p> <p>VEWH</p>

11. Approval and Endorsement

APPROVAL

I, the authorised representative of the agency shown below, approve the Seasonal Watering Proposal for the *Wimmera Mallee Pipeline Wetlands – Wimmera CMA Region 2018-19*.

SIGNED FOR AND ON BEHALF OF Wimmera Catchment Management Authority

Signature of authorised representative

Name of authorised representative

David Brennan, Chief Executive Officer

Date:

References

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12. Appendices

12.1. Acronyms

ARI: Arthur Rylah Institute
CMA: Catchment Management Authority
DELWP: Department of Land, Water and Planning
DSE: Department of Sustainability and Environment
EVC: Ecological Vegetation Class
IWC: Index of Wetland Condition
VEWH: Victorian Environmental Water Holder

12.2. Guidance Material – Risk Assessment

Tables sourced from *Seasonal Watering Proposals Guidelines 2018-19* (VEWH, 2017)

Table 11. Risk likelihood

Rating		Description
Rare	1	Event may occur only in exceptional circumstances
Unlikely	2	The event could occur at some time
Possible	3	The event might occur
Likely	4	The event will probably occur in most circumstances
Almost certain	5	The event is expected to occur in most circumstances

Table 12. Risk Consequence

Rating		Environment Impact on the surrounding environment, including habitats and species, as well as the broader landscape	Business Costs Cost to the state	People Workers, local communities and other stakeholders		Political/ Reputational How media, public and stakeholder perception of State is influenced	Legal Legal consequence	Service Delivery Effect on the business
				Safety and Well-being	People and Culture			
RISK								
Negligible Harm	1	No material effect on the environment, contained locally within a single site/ area. Environment affected for days	Cost impact of up to 2.5% of allocated operational budgets (including capital budget); OR a cost impact of up to \$2.5m	On-site first aid treatment only	Staff disgruntlement	Minimal adverse local attention (1 day only)	Non-compliance with legislation, identified internally and resulting in internal acknowledgement and process review.	Insignificant impact to the Organisation's capability in providing its services - no inconvenience to customers/ stakeholders
Minor Harm	2	Limited effect on the environment, restricted to a single township or locality. Environment affected for weeks.	Cost impact between 5%-10% of allocated operational budgets (including capital budget); OR a cost impact of up to \$5m	Minor injuries/illness requiring medical attention	Complaints, passively upset, and uncooperative	Adverse localised public attention on a single issue over a short period. (up to 1 week)	Non-compliance with legislation or breach of duty of care, identified externally and either (1) resolved without prosecution of or civil action, or (2) resulting in prosecution or civil action involving low level of resourcing required to defend, exposure to low level remedies or damages, and low level risk of negative precedent	Minimal short term temporary impact to the Organisation's capability in providing its services - customers/ stakeholders slightly inconvenienced
Moderate Harm	3	Moderate effect on the environment, impacting on a municipality or multiple localities. Environment affected for months.	Cost impact >10% of allocated operational budgets (including capital budget); OR a cost impact of up to \$10m	Significant injury/illness requiring in-patient hospitalisation	Low morale, disengagement, increased absenteeism and workplace conflict	Adverse localised negative public attention on a single issue over a sustained period (up to 2 months)	Non-compliance with legislation or breach of duty of care resulting in prosecution of, or civil action, with one of high level of resourcing required to defend; exposure to high level remedies or damages or high level risk of negative precedent.	Significant impact to the Organisation's capability in providing its services - customers/ stakeholders inconvenienced
Major Harm	4	Major effect on the environment, impacting on a region or multiple municipalities. Environment affected for 1-3 years.	Cost impact between \$10m-\$50m	Extensive and/or permanent injury/illness	Major morale issues, high absenteeism and resignations of key staff	Serious adverse public attention on more than one issue over a prolonged period (up to 2 years)	Non-compliance with legislation or breach of duty of care resulting in prosecution of or civil action (with all of high level of resourcing required to defend, exposure to high level remedies or damages, and high level risk of negative precedent); or public enquiry	Continuing difficulties in the Organisation's capability in servicing customers/stakeholders over a protracted period - delays caused beyond target)
Extreme Harm	5	Very serious effect on the environment, impacting on the state or multiple regions. Environment affected for >3 years	Cost impact of over \$50m	Death or permanent disability/illness	Organisation wide morale issues, mass resignations and absenteeism	Very serious public outcry over a prolonged period (greater than 2 years), or leading to a formal inquiry, serious investigation of other major political event	Non compliance with legislation or breach of duty of care resulting in prosecution of or civil action (leading to imprisonment of an officer and/or uninsured compensation payments).	Long term detrimental effect on the Organisation's capability in providing services to customers/ stakeholders

Table 13. Risk Rating

Likelihood	Consequence				
	Negligible	Minor	Moderate	Major	Extreme
Almost certain	Low	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	Extreme	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Low	Medium	High	Extreme
Rare	Low	Low	Low	Medium	High