



Broken Wetlands

Seasonal Watering Proposal

2022-2023



GOULBURN BROKEN
CATCHMENT MANAGEMENT AUTHORITY

Publication details

Published by:

Goulburn Broken Catchment Management Authority,
PO Box 1752, Shepparton 3632

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Please cite this document as: GB CMA (2022). Broken Wetlands Seasonal Watering Proposal 2022-2023. Goulburn Broken Catchment Management Authority, Shepparton.

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Executive Summary

This Seasonal Watering Proposal covers the environmental watering requirements for 2022-23 for the Broken catchment wetlands, of which there are three, as managed by the Goulburn Broken Catchment Management Authority (GB CMA). This includes Black swamp, Moodie swamp and Kinnairds wetland.

Environmental watering is proposed for Black Swamp and Kinnairds Wetland in the Broken catchment in 2022-2023. The promotion of drying Moodie Swamp is proposed for 2022-2023.

The water regime of these wetlands has been highly modified with changes to the frequency, duration and timing of wetting and drying. Environmental water is currently being used to restore a more natural wetting regime to these sites to protect, enhance and restore the health of the wetlands.

Environmental watering objectives for Broken Catchment wetlands are to:

- Provide a wetting cycle that promotes healthy wetland vegetation communities;
- Provide feeding and breeding habitat for a range of waterbirds, amphibians and reptiles and,
- Provide a drying period that assists with the completion of a nutrient cycle for wetlands.

Seasonal review 2021-2022

Environmental water deliveries were planned at all three Broken Catchment wetlands in 2021-2022 with a total of 1,680ML proposed to be delivered. Of this, 1,401ML was delivered with Black swamp and Moodie swamp receiving their full volumes, however Kinnairds wetland only received 279ML of the 600ML proposed due to a large rainfall event filling the wetland during delivery.

The key objective of the 2021-2022 Seasonal Watering Proposal was to deliver environmental water to Black Swamp and Kinnairds Wetland in spring 2021 and Moodie Swamp in autumn 2022.

A large rainfall event occurred in autumn 2021 and primed Moodie Swamp, which encouraged GB CMA staff to bring the proposed autumn 2022 watering forward to spring 2021. This occurred after four Brolga were observed displaying courtship behaviour at the site in winter 2021 (Figure 1).

Black Swamp received environmental water in spring 2021 and held water for three months. The minimum ponding duration of 2 months was met and assisted with the establishment of river red gum saplings planted at the swamp in autumn 2021. Monitoring of the site observed the red gum saplings to have successfully established in the swamp body.

Kinnairds wetland filled with rainfall and environmental water in spring 2021, which held water for two months only meeting the minimum ponding duration. This did not impact the ecological outcomes sought from the potential watering action and assisted with the improvement of Plains Grassy wetland and Red Gum EVCs.



Figure 1. Brolga courtship display at Moodie Swamp in July 2021

The 2021-2022 environmental water priorities, objectives and delivery status for Broken wetlands are summarised in Table 1.

Table 1: Watering priorities for 2021-2022

Priority	Wetland	Potential Watering Action	Achievement 2021-2022
1	Black Swamp	Partially fill Black Swamp in late winter/ spring (August/ September) 2021 to a maximum depth of 25cm for 2-4 months to maintain or improve Red Gum Swamp EVC. Fill will be incrementally delivered.	Successfully completed with potential watering action met.
1	Kinnaids Wetland	Fill Kinnaids Wetland in late winter/early spring 2021 to a maximum depth of 50cm for 3 months to improve growth of Red Gum Swamp and Plains Grassy Wetland EVCs.	Successfully completed watering, however duration was not met. This did not have a negative impact on the ecological outcomes which were still met.
1	Moodie Swamp	Fill Moodie Swamp in Autumn 2022 with a possible top-up in Spring 2022 to a variable depth of 0.5-1m for 6 -9 months to encourage flocking and breeding of Brolga (<i>Antigone rubicunda</i>) and to improve Cane Grass Wetland EVC and maintain Rigid Water-milfoil (<i>Myriophyllum porcatum</i>) population.	Watering brought forward to spring 2021. Brolga flocked and fed at the sight, Cane Grass EVC flourished and populations of Rigid Water Milfoil improved with five new populations discovered.

Priorities for 2022-2023

In consultation with Traditional Owners, the Goulburn Broken Wetland Technical Reference Group and the Goulburn Broken Environmental Water Advisory Group, the GB CMA proposes to deliver water for the environment to two Broken wetlands – Black Swamp and Kinnaids Wetland. The proposal for these sites is to deliver water for the environment in all climates. It is currently forecast that deliveries in 2022-2023 will occur under an average climate scenario.

Priorities for environmental watering of wetlands in the Broken catchment for 2022-2023 are as follows:

- Fill Black Swamp in autumn 2023 to promote vegetation growth and recruitment and provide habitat for waterbirds and frogs. Top up in spring 2023 if required to achieve desired wetting duration.
- Fill Kinnaids Wetland in early autumn 2023 to a maximum depth of 1m in the deepest parts for 6-8 months to promote vegetation growth and recruitment and provide habitat for waterbirds and frogs. Top up in spring 2023 if required to reach optimal ponding duration.
- Promote drying of Moodie Swamp for 2022-2023.

This proposal considers environmental water deliveries under a range of possible climate scenarios from extremely dry to wet. The potential watering actions under the different climate scenarios are outlined below (Table 2). These have been categorised into Tier 1 and Not Applicable. Tier 1 watering actions are the critically important watering actions that should be achievable based on estimates of supply and other available resources under each planning scenario (VEWH 2021).

Table 2: Summary of potential water actions for 2022-2023

Priority	Wetland	Potential Watering Action	Climate Scenario and ML Water			
			Ex. Dry	Dry	Average	Wet
1	Black Swamp	Fill Black Swamp in autumn 2023 to a maximum depth of 1m in the deepest parts, for 6-8 months to maintain or improve Red Gum Swamp EVC and provide habitat for waterbirds and frogs. Top up in spring 2023 if required to achieve desired wetting duration.	80	80	80	40
1	Kinnaids Wetland	Fill Kinnaids Wetland in early autumn 2023 to a maximum depth of 1m in the deepest parts for 6-8 months to promote vegetation growth and recruitment and provide habitat for waterbirds and frogs. Top up in spring 2023 if required to achieve desired wetting duration.	600	600	600	300
NA	Moodie Swamp	Promote drying at Moodie Swamp. Allowing the swamp to draw down and dry for at least 6 months will assist with the completion of the nutrient cycle and to reach its optimal drying period.	0	0	0	0
Total ML			680	680	680	340

Contents

Executive Summary	i
Seasonal review 2021-2022	ii
Priorities for 2022-2023	iii
Introduction.....	1
System overview.....	1
Black Swamp	3
Kinnairds Wetland	5
Moodie Swamp.....	6
Engagement.....	7
Aboriginal cultural values and use of waterways	9
Social, recreational and economic values and uses of waterways	11
Seasonal review 2021-2022.....	12
Climatic conditions	12
Assessment of watering actions 2021-2022	13
Key observations and findings in 2021-2022	15
Black swamp	15
Kinnairds wetland	16
Moodie swamp	17
Shared benefits 2021-2022.....	19
Environmental Objectives.....	20
Scenario planning	21
Potential watering actions 2022-2023.....	22
Delivery constraints	23
Confounding Factors.....	24
Increasing Knowledge.....	25
Knowledge Gaps and Limitations	25
Reporting	26
Risk Management	27
Approval	34
References	35
Appendices	36
Appendix 2a – Threatened fauna species recorded at Broken Wetlands	37
Appendix 2b – Threatened flora species recorded at Broken Wetlands	38

Figure 1. Brolga courtship display at Moodie Swamp in July 2021	ii
Figure 2: Broken Wetlands considered in this proposal	2
Figure 3: Black Swamp during environmental water delivery September 2021	3
Figure 4: Kinnairds Wetland during environmental water delivery October 2021	5
Figure 5: Observations being taken at Moodie Swamp during environmental water delivery November 2021	6
Figure 6. Map of Traditional Owner Country within the Goulburn Broken Catchment	9
Figure 7. Climate conditions for the Broken region over 2021 and early 2022	12
Figure 8. Dusky Woodswallow, ominous clouds over Black Swamp and Nardoo during environmental water delivery 2021	15
Figure 9. Kinnairds Wetland during environmental water delivery 2021	16
Figure 10. Moodie Swamp response to environmental water delivery in Spring 2021	17
Table 1: Watering priorities for 2021-2022	iii
Table 2: Summary of potential water actions for 2022-2023	iii
Table 3: Engagement undertaken in development of Seasonal Watering Proposal 2022-2023	8
Table 4. Traditional Owner values and uses of wetlands in the Broken Catchment	10
Table 5. Shared benefits of watering wetlands in the Broken Catchment in 2022-2023	11
Table 6: Watering of Broken Wetlands since 2012	13
Table 7: Watering priorities and delivery status for Broken wetlands in 2021-2022	14
Table 8: Wetting and drying patterns for each wetland from 2012 to 2022	18
Table 9: 2021-2022 Ecological outcomes for Broken Wetlands	18
Table 10: Shared benefits 2021-2022	19
Table 11. Potential watering actions and environmental objectives for Black Swamp	20
Table 12. Potential watering actions and environmental objectives for Kinnairds Wetland	20
Table 13. Potential watering actions and environmental objectives for Moodie Swamp	20
Table 14: Broken system outlook for seasonal determination of high reliability shares	21
Table 15: Scenario planning for Broken Wetlands to be watered in 2022-2023	21
Table 16: Potential Watering Actions for 2022-2023	22
Table 17. Possible delivery constraints to wetlands in the Broken system in 2022-2023	23
Table 18: Confounding factors for wetlands in Broken System	24
Table 19: Risk assessment of proposed water delivery	27

Introduction

This seasonal watering proposal outlines the Goulburn Broken Catchment Management Authorities priorities for the use of environmental water for delivery to Broken Catchment wetlands in 2022-2023 to protect and enhance their environmental values and health.

The purpose of the seasonal watering proposal is to:

- Identify the environmental water requirements of wetlands to adaptively manage their watering regime and enable water for the environment to be delivered under a range of climatic scenarios where applicable under a range of climatic scenarios.
- Identify the drying requirements of wetlands to assist with the completion of the nutrient cycle within wetlands.
- Provide information for the development of the VEWH seasonal watering plan as per section 192A of the *Water Act 1989* (Vic).

System overview

The Broken River basin is 772,386 ha or 3.4 per cent of Victoria's total area. The Broken River is a tributary of the Goulburn River where it joins the river at Shepparton. The basin also includes the catchment of the Broken Creek that diverges from the Broken River west of Winton Wetlands and flows north-west to the Murray River.

Within the catchment, several wetlands are formally recognised for their conservation significance. This includes the Ramsar listed Barmah Forest (Figure 2 – listed as Barmah National Park). Moodie Swamp is nominated in 'A Directory of Important Wetlands in Australia' (EA 2001) under the Broken Creek (VIC036) listing. Black Swamp is classified as bioregionally significant defined in the 'National Land and Water Audit' (CoA 2002).

Within the Broken catchment only four wetlands have currently received environmental water. These are Barmah Forest, Black Swamp, Kinnairds Wetland and Moodie Swamp. These wetlands have been prioritised due to their ecological values, significance to the community and traditional owners, and because they have the infrastructure required to receive environmental water. As the wetland environmental program progresses, other wetlands of high ecological and cultural values will be considered for watering, provided they have the necessary infrastructure in place to deliver water and land manager approvals are met.

A separate seasonal watering proposal will be developed for Barmah Forest and is not considered in this document.

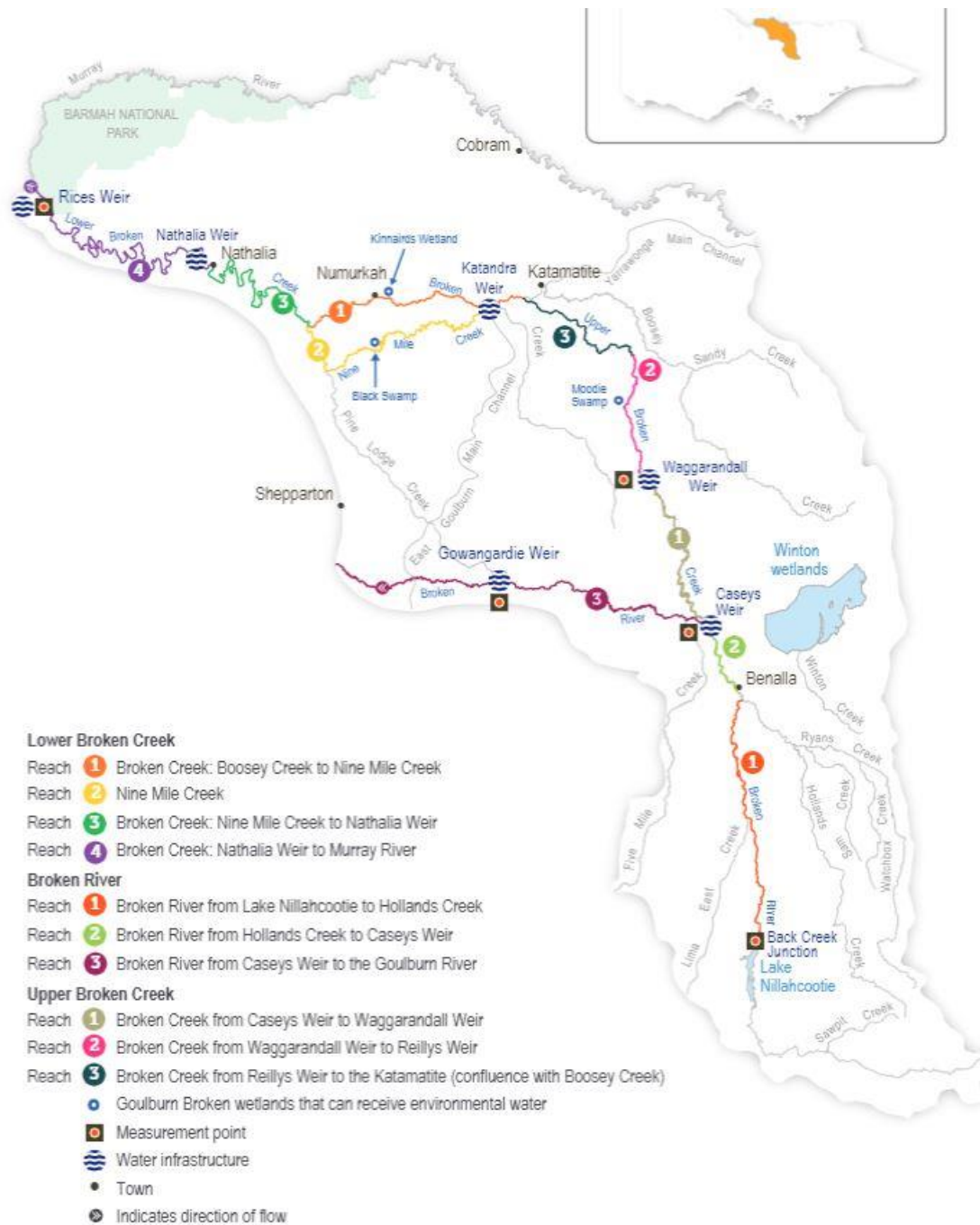


Figure 2: Broken Wetlands considered in this proposal

Black Swamp

Black Swamp is a 16.5-hectare red gum swamp managed by Parks Victoria and is part of the Black Swamp Wildlife Reserve (Figure 3). Prior to European settlement Black Swamp would have filled on a near annual basis from rainfall and flooding from the Nine-Mile Creek. Due to the wetlands relatively shallow depth it would have dried out most years over the summer-autumn period. The water regime of the wetland changed in the 1960's when irrigation was introduced to the area resulting in higher flows into the wetland during the irrigation season (August-May). In the 1970's a channel was constructed from Nine Mile Creek to flood the wetland during duck hunting season. The high irrigation flows in Nine Mile Creek and construction of the channel caused the swamp to become almost permanently inundated, reducing the diversity and abundance of biota found at the swamp. In 2008, the GB CMA upgraded water delivery infrastructure and delivered environmental water to the wetland for the first time. This has reinstated a more natural wetting and drying regime to the swamp.



Figure 3: Black Swamp during environmental water delivery September 2021

Environmental water can be delivered by a channel connected to the swamp from the Nine Mile Creek. Black Swamp is listed as bioregionally significant in the *National Land and Water Resource Audit* (CoA 2002). Environmental flows can only be delivered to the swamp when flows in the Nine Mile Creek exceed 100ML/day (GBCMA 2010). This regularly occurs during the irrigation season (August – May). The wetland may only require environmental water during extended dry periods or to enhance natural inundation events to ensure the success of bird breeding events or to provide optimal growth conditions for water dependent vegetation. Black Swamp also meets several criteria under *Schedule 8* of the Basin Plan – *Criteria for identifying an environmental asset*. This includes criteria 3a (i), 3a (iii), 3b, 4a and 4c (refer to appendix 1 for criteria description).

Black Swamp provides habitat for a wide variety of aquatic and terrestrial fauna and flora species. To date 67 wetland dependent fauna and 82 wetland dependent flora species have been recorded at the site. Wetland dependent fauna and flora species listed as threatened can be found in Appendix 2a and 2b. Black Swamp contains a significant population of the *Environmental Protection Biodiversity Conservation Act 1999* (EPBC 1999) listed River Swamp Wallaby-grass (*Amphibromus fluitans*) which emerges in autumn. Water Nymph (*Najas tenuifolia*), which is classified as rare in Victoria was first recorded at Black Swamp in February 2016.

Kinnairds Wetland

Kinnairds Wetland is a 96-hectare red gum swamp jointly managed by Goulburn-Murray Water and Moira Shire (Figure 4). It is located on the floodplain of the lower Broken Creek, approximately two kilometres north-east of Numurkah. It consists of a natural depression, part of which has been modified into a constructed wetland. It is a significant wetland for Royal Spoonbill (*Platalea regia*) breeding and has the largest known recorded population of the EPBC (1999) listed Ridged Water Milfoil (*Myriophyllum porcatum*) in Victoria. The numerous walking tracks, bird hides, picnic shelters, interpretive signage and opportunities to spot wildlife attracts 100's of visitors to the wetland each year.



Figure 4: Kinnairds Wetland during environmental water delivery October 2021

Environmental Water is currently delivered to the wetland by out-falling water from an irrigation channel (MV5/3) into the Muckatah Depression approximately 16 km upstream of the wetland (GBCMA 2011). The water takes approximately one week to reach the wetland and can take 40-50 days to deliver the required volume of water. A project to design new water delivery infrastructure is currently underway and if constructed would significantly improve the efficiency, measurement, flexibility and control of environmental water deliveries to the wetland.

Kinnairds Wetland meets several criteria outlined in *Schedule 8* of the Basin Plan – *Criteria for identifying an environmental asset*. This includes criteria 1b, 3a(i), 3a(iii), 4a, 4c (refer to appendix 1 for criteria description).

A total of 83 wetland dependent fauna species and 85 wetland dependent flora species have been recorded at the site. Of these species, 26 are listed as threatened (refer to appendix 2a and 2b).

Moodie Swamp

Moodie Swamp is a 180-hectare Southern Cane-grass (*Eragrostis infecunda*) wetland managed by Parks Victoria and is part of the Moodie Swamp Wildlife Reserve (Figure 5). It is located on the floodplain of the upper Broken Creek approximately 40 km north of Benalla. The wetland is listed under 'A Directory of Important Wetlands in Australia' (EA 2001) as part of the Broken Creek.



Figure 5: Observations being taken at Moodie Swamp during environmental water delivery November 2021

Water can be delivered to Moodie swamp via a water delivery channel from the upper Broken Creek (GBCMA 2012). There has been no survey or modelling of catchment conditions to determine changes to the natural frequency and duration of flooding events at Moodie Swamp. However, it is likely the frequency and duration of flooding at Moodie Swamp has been reduced by the regulation of the Broken River and Broken Creek (SKM 2006). Therefore, the wetland may require environmental water to provide a more natural flooding regime and enhance natural inundation events to ensure the success of bird breeding events or to provide optimal growth conditions for water dependent vegetation.

Moodie Swamp meets several criteria outlined in *Schedule 8* of the Basin Plan – *Criteria for identifying an environmental asset*. This includes criteria 3a (i and iii), 4a and 4c (refer to appendix 1 for criteria description).

Moodie Swamp provides important Brolga (*Antigone rubicunda*) breeding habitat and habitat for other wetland dependent fauna species. Since monitoring of the site began in 2008, 65 species of wetland dependent fauna and 42 species of wetland dependent flora have been recorded at the site. Of these species 26 are listed as threatened (refer to appendix 2a and 2b).

Flora at Moodie Swamp continues to change as a more natural wetting and drying regime has been returned with the assistance of environmental water. Monitoring in 2008 indicated that Southern

Cane-grass (*Eragrostis infecunda*) was a dominant species within the wetland. Since the wetlands watering regime has changed, it has begun to show signs of an aquatic herb land EVC. This includes a large population of the EPBC (1999) listed Rigid Water-milfoil (*Myriophyllum porcatum*).

Engagement

This proposal was prepared by the Goulburn Broken CMA with input from Traditional Owners of Taungurung Land & Waters Council (1st March 2022), Yorta Yorta Nation Aboriginal Corporation (2nd March 2022), Goulburn Broken Wetland Technical Reference Group (GB WTRG) and the Goulburn Broken Environmental Water Advisory Group (GB EWAG).

The GB WTRG is made up of members from Rakali Consulting, Water's Edge Consulting and Senior Scientists from Department of Environment Land Water and Planning and Arthur Rylah Institute for Environmental Research. Traditional Owners were also invited to be part of this formal, scientific group in 2022. The group met via Microsoft Teams™ on the 23rd February 2022.

The GB EWAG meets at least three times a year and additionally if required to discuss findings from wetland monitoring, wetland condition, watering objectives and watering for the coming year. The group met via Microsoft™ Teams 24th February 2022 and members were provided with a copy of the draft proposal for comment. Comments have been incorporated into this report.

The GB EWAG (previously Goulburn Broken Wetland Management Group), established in 2012, is made up of delivery partners, Traditional Owners, industry, community groups and community members. Current membership includes Parks Victoria, Taungurung Land & Waters Council, Yorta Yorta Nation Aboriginal Corporation, Goulburn Murray Landcare Network, Goulburn-Murray Water, Moira Shire, City of Greater Shepparton, Victorian Environmental Water Holder and community members. Meetings are usually held two or three times a year to discuss the current conditions of the wetlands, the outcomes of the previous season's delivery of environmental water, and proposed watering. When possible, the group visits the wetlands to hear and see firsthand the delivery and wetland responses to environmental watering.

The Goulburn Broken CMA has an agreement with Yorta Yorta Nation Aboriginal Corporation that outlines the legal requirements that GB CMA need to abide by when undertaking natural resource management works in areas covered by these agreements.

The Aboriginal Cultural Heritage Land Management Agreement (ACHLMA) is an agreement between the GB CMA and Yorta Yorta Nation Aboriginal Corporation which is legislated by the *Aboriginal Heritage Act 2006*. This includes the following activities that are permissible under the agreement:

- Environmental Monitoring Activities at wetlands.
- Environmental water – returning natural flows at wetlands across the catchment.

Some wetlands are not included in this agreement which are situated along the Lower Goulburn National Park (not relevant to this plan).

The Goulburn Broken CMA will continue to build community understanding of how natural wetland wetting regimes have changed and how water for the environment is being used to protect and restore the wetlands. This will be achieved through reports, traditional and social media and direct contact with special interest groups and school groups.

The engagement process the Goulburn Broken CMA has undertaken during the development and implementation of this seasonal water proposal is outlined in Table 3. All communication activities will be undertaken in accordance with the communication and media protocols of the VEWH.

Table 3: Engagement undertaken in development of Seasonal Watering Proposal 2022-2023

Category	Who	IAP2 level of engagement	Engaged on 2022-23 seasonal watering proposal	Engagement methods	Engagement Purpose
Government Agencies	Delivery Partners	Collaborate	Goulburn-Murray Water (River Operations Planning, Diversions) VEWHP Parks Victoria Moira Shire Council of Greater Shepparton DELWP (Land Manger, Environmental Water)	Formal advisory group (GB WMG) Direct engagement Review of draft proposal	Seek input into the development of the proposal. Ensure program partners understand the watering proposed and intended outcomes
Traditional Owners	Traditional Owners	Involve	Yorta Yorta Nation Aboriginal Corporation Taungurung Land & Water Council	Formal advisory groups (GB WMG) Site visits	Seek input into the development of the proposal by reviewing document, providing feedback and writing a letter of endorsement. Assist with the monitoring of the watering events
Recreational Users	Field and Game Australia Local fishing clubs	Involve	Field and Game Trellys Fishing and Hunting	Formal advisory groups (GB WMG) Direct engagement	Ensure understanding of the watering proposed and intended outcomes. Review SWP and provide feedback/ input.
Community Groups	Environment Groups	Involve	Goulburn Murray Landcare Network Goulburn Valley Environment Group Turtles Australia	Formal advisory groups (GB WMG) Direct	Ensure understanding of the watering proposed and intended outcomes. Review SWP and provide feedback/ input.
Local Landholders	Landholders	Involve	Landowners that adjoin wetlands that receive environmental water and/or use the delivery channel	Direct engagement (one-on-one) or email/mail drop.	Ensure understanding of the watering proposed and intended outcomes. Seek feedback – local knowledge
Technical experts	Scientists and Consultants	Collaborate	Research Scientists from Arthur Rylah Institute Rakali Consulting Water's Edge Consulting	Formal advisory group (GB WTRG) Direct engagement	Seek input into the development of the proposal and ecological and hydrological objectives. Review SWP and provide feedback/ input.

Aboriginal cultural values and use of waterways

Traditional Owner consultation and involvement with the development of this Seasonal Watering Proposal is imperative for the conservation and protection of cultural sites, connection to country and establishing strong linkages.

The Broken Wetlands in this Seasonal Water Proposal are all part of Yorta Yorta Nation Aboriginal Corporation Country (Figure 6 shaded dark blue). The GB CMA have engaged with Yorta Yorta to discuss potential watering of wetlands in 2022-2023, including on-line meetings and on country.

Yorta Yorta Nations Aboriginal Corporation country lands lie on both sides of the Murray River roughly from Cohuna to Albury / Wodonga. They include towns such as Echuca, Shepparton, Benalla, Corowa and Wangaratta and extend northwards to just south of Deniliquin (Figure 6 shaded dark blue). Moodie Swamp, Black Swamp and Kinnairds Wetland are in Yorta Yorta country.

The GB CMA have engaged with YYNAC to discuss potential watering of wetlands in 2022-2023, including on-line meetings and on country.

GOULBURN BROKEN CATCHMENT



Figure 6. Map of Traditional Owner Country within the Goulburn Broken Catchment

Traditional Owners were asked to complete the table below (Table 4) to assist the GB CMA in ensuring environmental water can support the cultural values of wetlands in our catchment. Yorta Yorta Nation Aboriginal Corporation have also approved this seasonal watering proposal by reviewing the proposed watering actions and providing a letter of endorsement.

Table 4. Traditional Owner values and uses of wetlands in the Broken Catchment

Wetland	Traditional Owner Group	Values	How will this be considered in 2022-2023?
Black Swamp	Yorta Yorta	Black Swamp has significant diversity within the landscape, multiple varieties of Nardoo (food source), native grasses, Old man Weed (medicinal) and basket weaving sedges/rushes are in the area. The ephemeral wetlands support a wide array of bird life and other fauna that provide a variety of cultural values i.e. food, clothing etc. Evidence of cooking mounds present around perimeter of the swamp.	Partially fill Black Swamp to maintain and promote growth of plant communities which include plant species important to Yorta Yorta people.
Kinnairds Wetland		Presence of Moira Grass and other culturally important species including but not limited to Old Man Weed/Sneezeweed, Nardoo (food), grasses used for weaving.	Fill Kinnairds Wetland to promote and improve the diversity of plant communities including culturally significant food and medicinal plants.
Moodie Swamp		Nardoo (food source), native grasses, Old man Weed (medicinal) and basket weaving sedges/rushes are in the area. The ephemeral wetlands support a wide array of bird life and other fauna that provide a variety of cultural values ie food, clothing etc.	Promoting the drying of the site may prevent native food sources becoming available.

Social, recreational and economic values and uses of waterways

Water for the environment is used to protect and restore the environmental condition of rivers and wetlands. In addition, there are recreational, social, economic and Aboriginal cultural benefits in delivering environmental water. Environmental watering of wetlands increases opportunities and visitation of wetlands for community events, bird watching, picnicking, photography, walking, camping and hunting (previously State Game Reserves reclassified as Wildlife Reserves). Wetlands provide resources for Traditional Owners for hunting, food, medicinal and traditional activities.

A summary of potential shared benefits of the 2022-2023 proposed environmental water deliveries are listed in Table 5.

Table 5. Shared benefits of watering wetlands in the Broken Catchment in 2022-2023

Wetland	Beneficiary	Connection to wetland	Value	How have these benefits been considered?
Black Swamp	Bird watchers Photographers	Recreation and tourism play an important role in the Moira shire. Tourism is the seventh largest contributor to economic output with an estimated \$90 million for the local community.	Environmental watering provides opportunities for activities such as bird watching and photography.	Environmental watering will provide for passive recreational activities such as bird watching and photography through increased communications around planned delivery via social media, radio and local newspaper notifications. The GB CMA is constantly revising its communications strategy to expand networks to capture new audiences.
Kinnaids Wetland	Recreation users including: Bird watchers Photographers Walkers Community members Wildlife watchers	Recreation and tourism play an important role in the Moira shire. Tourism is the seventh largest contributor to economic output with an estimated \$90 million for the local community. The local community are able to access the wetland site. It provides a location for community gatherings and encourages outdoor activity, promoting wellbeing and mental health.	Environmental watering provides opportunities for activities such as walking, bird watching and photography. The site provides highly pleasing aesthetics and amenity. There is a walking path around the wetland along with interpretive signage, wildlife viewing platforms and picnic spots.	Water for the environment will provide a winter/spring fill at the site. This will improve the growth of vegetation at the site and improve amenity and aesthetics for locals and tourists visiting the site.
Moodie Swamp	Bird watchers Photographers Walkers	Recreation and tourism play an important role in the Moira shire. Tourism is the seventh largest contributor to economic output with an estimated \$90 million for the local community.	Environmental watering provides opportunities for activities such as walking, bird watching and photography.	Even dry, Moodie Swamp and its surrounding woodland provide good habitat for terrestrial bird species.

Seasonal review 2021-2022

Climatic conditions

Climatic conditions (BoM 2022) observed from the Cobram Station (Station ID 80109) indicate that rainfall over the 2021 year was slightly below the long term mean average except for large rainfall events that occurred in Summer (January and February 2022), Autumn (March 2021), Winter (June, July 2021) and Spring (October, November 2021) (Figure 7). These large rainfall events contributed to a wet catchment and provided natural inflows that either filled or partially filled some of the wetlands including Moodie Swamp and Kinnairds Wetland. Water for the environment was still delivered to Black Swamp, Kinnairds Wetland and Moodie Swamp.

Average conditions have meant most of the wetlands in the Broken catchment are now dry except for Moodie Swamp due to its prolonged environmental watering delivery (September – December 2021) and large rainfall events in December 2021, January and February 2022 causing unregulated flows to enter the swamp. The wetting and drying pattern for each wetland from 2012-2022 is shown in Table 8. Further information regarding key observations and findings from the watering actions is provided in the below sections.

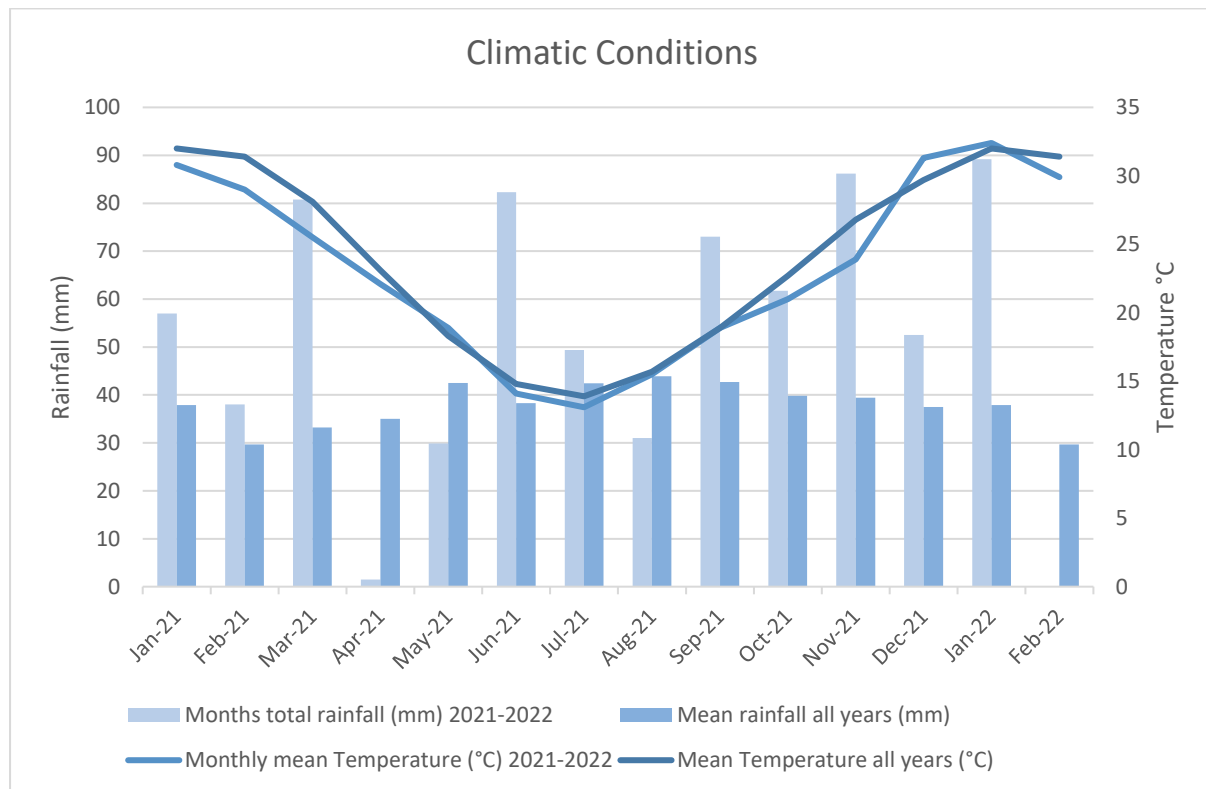


Figure 7. Climate conditions for the Broken region over 2021 and early 2022

Assessment of watering actions 2021-2022

The environmental watering objectives for the Broken Wetlands in 2021-2022 were to:

- Provide wetting cycles that promote healthy wetland vegetation communities; and
- Provide feeding and breeding habitat for a range of waterbirds.

The aim of the 2021-2022 seasonal watering proposal was to:

- Partially fill Black Swamp in late winter/ spring (August/ September) 2021 to maintain or improve Red Gum Swamp EVC.
- Fill Kinnairds Wetland in late winter/early spring 2021 to improve growth of Red Gum Swamp and Plains Grassy Wetland EVCs.
- Fill Moodie Swamp in Autumn 2022 with a possible top-up in Spring 2022 to a variable depth of 0.5-1m for 6-9 months to encourage waterbird breeding and improve EVCs whilst maintaining threatened aquatic plant species.

The emphasis of the 2021-2022 seasonal watering proposal was to deliver water to Black Swamp and Kinnairds Wetland in spring 2021 and Moodie Swamp in autumn 2022. Deliveries to Black Swamp and Kinnairds Wetland occurred at the proposed time. Moodie Swamp delivery was brought forward to Spring 2021, due to the swamp being primed after a large rainfall event in July 2021 and Brolga displaying courtship behaviour at the site. Table 6 outlines watering of wetlands in the Broken System since 2012 and the outcome. Table 7 outlines the potential watering actions from 2021-2022 and an assessment of how they were achieved.

Table 6: Watering of Broken Wetlands since 2012

Wetland	Proposed Water in 10 years	Optimal Ponding (months)	Optimal Drying (months)	Unregulated events	Unregulated events that met wetting duration	E-flow deliveries	E-flows that met ponding duration	Watering (unreg and e-flows)	Watering (unreg and e-flows)
Black Swamp	5	6 to 8	6	4	1 (Between 2013-2014)	5	3 (2014 and 2015, 2021)	Watered 9 in 10 years	Duration meets 3 in 10 years
Kinnairds Wetland	5 to 7	6 to 8	6 to 9	6	3 (2 combined with e-flows)	5	3 (2014, 2015/15, 2020)	Watered 9 in 10 years	Duration meets 6 in 10 years
Moodie Swamp	5	6	6 to 9	7	4 (2021 being partial e-water and Unregulated flows)	5	3(2014, 2016 and 2021)	Watered 7 in 10 years	Duration meets 6 in 10 years

Table 7: Watering priorities and delivery status for Broken wetlands in 2021-2022

Priority	Wetland	Flow component	Timing	Potential Watering Action	Achievement 2021-2022
1	Black Swamp	Partial fill	Late winter/ Spring 2021	Partially fill Black Swamp in late winter/ spring (August/ September) 2021 to a maximum depth of 25cm for 2-4 months to maintain or improve Red Gum Swamp EVC. Fill will be incrementally delivered.	Successfully completed with potential watering action met. Successfully delivered the full volume in 21-22 winter/spring to achieve the desired depth which saw the swamp hold water for 2months. Black swamp is adaptively managed to deliver 5 events in 10 years with variable ponding and drying intervals to promote various ecological outcomes. Over the last 10 years, black swamp has filled or partially filled 9 out of 10 years through natural inflows and environmental water. This has exceeded the optimum watering regime to promote diversity of wetland vegetation whilst providing waterbird and frog breeding opportunities as outlined in the key observations. However, it has not be detrimental to the site.
1	Kinnaids Wetland	Fill	Late winter/ Spring 2021	Fill Kinnaids Wetland in late winter/early spring 2021 to a maximum depth of 50cm for 3 months to improve growth of Red Gum Swamp and Plains Grassy Wetland EVCs.	Successfully completed watering, however duration was not met. This did not have a negative impact on the ecological objectives.
1	Moodie Swamp	Fill	Autumn 2022	Fill Moodie Swamp in Autumn 2022 with a possible top-up in Spring 2022 to a variable depth of 0.5-1m for 6 -9 months to encourage flocking and breeding of Brolga (<i>Antigone rubicunda</i>) and to improve Cane Grass Wetland EVC and maintain Rigid Water-milfoil (<i>Myiophyllum porcatum</i>) population.	Watering brought forward to spring 2021. Brolga flocked and fed at the sight, Cane Grass EVC flourished and populations of Rigid Water Milfoil improved with five new populations being discovered.

Key observations and findings in 2021-2022

Black swamp

Black Swamp received an environmental water delivery of 80ML in Spring 2021. This allocation was delivered in two increments of 40ML to prevent the flooding of red gum saplings that had been planted in the swamp in autumn 2021. These were planted to improve the Red Gum EVC that had been both drowned out in the 1980s-1990s due to over watering. The site dried in late November 2021 and has since remained dry. Field observations conclude the watering was successful at assisting with the establishment of the red gum saplings. The site is currently dry and the proposed autumn watering for 2023 will have exceeded its optimal drying period of 6 months by a further 11 months (max drying period 54 months). It is expected that this will not be detrimental to the health of the swamp. To inundate the wetland to the desired depth and duration including delivery losses, approximately 80ML of water will be required, with possible top-up in spring 2023 if no natural inflows occur over winter 2023 and water begins to recede. Water will no longer need to be delivered incrementally due to the establishment of the Red Gum saplings.

An Index of Wetland Condition assessment of the site was undertaken in 2010 which found the swamp to be in a moderate condition at the time. Water for the environment has been delivered five out of ten years with an additional four events as a result of unregulated natural conditions (Tables 8 and 9). This has provided optimum conditions for the wetland to achieve desired ecological outcomes for aquatic vegetation and birdlife.



Figure 8. Dusky Woodswallow, ominous clouds over Black Swamp and Nardoo during environmental water delivery 2021

Kinnairds wetland

Kinnairds Wetland received an environmental water delivery of 207 ML in September 2021. A volume of 600ML was planned but due to a large rainfall event in late September, the delivery was stopped to prevent flooding of the site and its surrounds. The rainfall event filled the wetland which remained wet for two months until it dried in November 2021. The use of e-water in summer months was not considered due to the possible increased risk of weed growth and development. The optimum wetting regime for Kinnairds wetland is 6-8 months, however aquatic vegetation, aquatic insects, frogs and waterbirds responded well to watering in 2021 (refer figures 9 & 10). Spotted Marsh Frog bred at the site with eggs being laid within the first few days of the environmental water delivery (Figure 9).

An Index of Wetland Condition (IWC) assessment in 2010 indicated that Kinnairds Wetland was in moderate condition. A combination of both environmental water and unregulated flows have provided water to the wetland nine years in ten (Table 8 and 9). This is above the optimum requirement of five to seven years in ten for floristic diversity, however, does not seem to have a detrimental effect on the wetland due to the duration of wetting. Unregulated flows over the past ten years have ponded for approximately 4.5 months and environmental flows for six months.



Figure 9. Kinnairds Wetland during environmental water delivery 2021

Looking across Kinnairds from northern bird hide (Left), Water enters Kinnairds at southern end near Boardwalk (top right), Spotted Marsh Frog eggs (bottom right).

Moodie swamp

Moodie Swamp was primed in July 2021 after a large rainfall event occurred. The proposed autumn 2022 delivery was brought forward to spring 2021 after the observation of four Brolga were observed displaying courtship behaviour. Delivery of 1000ML began in September and finished in late December. The swamp was still holding water at the time of writing this report (February/March 2022). This was due to the environmental water delivery and some large rainfall events that occurred in January and February 2022. As expected, Brolga (*Antigone rubicunda*) were observed feeding, scoping and displaying courtship behaviour (Figure 10) and may have potentially bred in the area however this was not confirmed. The EPBC listed Rigid Water Milfoil (*Myriophyllum porcatum*) responded well to the watering with five new populations being recorded at the site.

An Index of Wetland Condition (IWC) assessment in 2010 found Moodie Swamp to be in good condition. Monitoring by Rakali consulting since 2008 has indicated that Moodie Swamp vegetation condition and EVC condition has improved since the beginning of environmental water delivery to the site, with ecological objectives for EVCs having been met (Cook and Just, 2019). Moodie Swamp has been wet nine in ten years with five of these years being unregulated flows into the swamp (Table 8 and 9). Environmental water has been delivered to the site four in the last ten years, with an average ponding duration of six months, compared to unregulated flows which average 8.5 months ponding.

Optimal watering conditions for the swamp which were identified in the Moodie Swamp Environmental Water Management Plan (2010) was an optimal ponding duration of six months with five in ten years being wet. Water for the environment is critical to maintaining ecological objectives at the site, as the swamp would only receive water via Geary's channel in times of high flows or flooding in the Broken creek otherwise, and in a drying climate this has the potential to impact upon the significant values at the site. A drying cycle is now required at the site, with no water proposed to be delivered until Spring 2023. This will surpass the optimal drying period of 6-9 months, however, consultation with the GB Scientific Reference Committee determined this would be the most beneficial outcome for the swamp to complete its nutrient cycle.



Figure 10. Moodie Swamp response to environmental water delivery in Spring 2021

Photos: Geary's Channel (Left), Four Brolga in July 2021 (top right), Frogs eggs, EPBC listed Rigid Water Milfoil and Wavy Marshwart (bottom L to R).

Table 8: Wetting and drying patterns for each wetland from 2012 to 2022

Wetland Name	2012-13				2013-14				2014-15				2015-16				2016-17				2017-18				2018-19				2019-20				2020-21				2021-22			
	W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su	A	W	Sp	Su					
Black Swamp	U	D	D	D	U	U	D	E	E	DD	D	D	D	E	E	D	D	D	U	D	D	D	U	D	D	E	D	D	D	D	D	E	D	D	D	E	D	D		
Kinnairds Wetland	U	D	D	D	U	U	D	E/U	E/U	DD	D	D	D	E	E	DD	D	D	U	D	D	U	U/DD	D	D	E	D	D	D	D	D	E	E	D	D	D	E/U	D	D	
Moodie Swamp	U	D	D	D	U	U	D	E	E	E	D	D	D	D	D	E	E	U	U	U	DD	U	D	E	D	D	D	D	D	D	U	U	U	D	D	U	E	E/U	E/U	

Legend

Dry (D)	Drawing Down (DD)	Unregulated event and drawing down (U/DD)	Environmental Water Event (E)	E-water event and unregulated flows (E/U)	Unregulated flows (U)
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Table 9: 2021-2022 Ecological outcomes for Broken Wetlands

Wetland	2021-22 Ecological outcomes
Black Swamp	Black Swamp is currently dry. Black Swamp received an environmental water delivery spring 2021 which resulted in inundation for two and a half months. The site dried in late November 2021 and has since remained dry.
Kinnairds Wetland	Kinnairds Wetland is currently dry. Kinnairds Wetland received a partial environmental water allocation in September 2021 before a large rainfall event filled the wetland. The wetland remained wet for two months until it dried in November 2021.
Moodie Swamp	Moodie Swamp did not receive its proposed environmental water allocation in autumn 2022. This was due to naturally priming in winter 2021 and the environmental water allocation being brought forward to spring 2021 which remained in the swamp until February 2022. During December 2021 and February 2022, large rainfall events assisted with keeping the swamp wet. The swamp now requires a drying regime of 6-9 months (up to 12-36 months).

Shared benefits 2021-2022

A review of the shared benefits of the Broken wetlands in 2021-2022 is listed Table 10 below.

Table 10: Shared benefits 2021-2022

Beneficiary	Review of benefits
Landholders	The environmental water delivered to Moodie Swamp also assisted in filling smaller wetlands and dams surrounding the swamp. This assisted landholders with water and green feed for stock and was also aesthetically pleasing. Landholders surrounding Moodie Swamp are supportive of Brolga (<i>Antigone ruicunda</i>) that utilise the area and were pleased to report sightings of them to GB CMA staff on a regular basis.
Recreational users/ local groups	The environmental water deliveries to Black Swamp, Kinnairds Wetland and Moodie Swamp encouraged many waterbirds to move into these areas. Bird observer groups utilised these events to record species at the site.

Environmental Objectives

Long-term ecological and hydrological objectives have been established in Environmental Water Management Plans for the three wetlands considered in this proposal. The ecological objectives for the Broken wetlands are outlined below in Tables 11-13. The objectives vary by wetland, but all have an objective relating to either providing feeding and roosting habitat for waterbirds, waterbird breeding opportunities and/or maintaining/improving populations and species diversity of native wetland flora.

Table 11. Potential watering actions and environmental objectives for Black Swamp

Potential Watering action	Fill Black Swamp in late autumn 2023 to a maximum depth of 60cm for 6 months to improve Red Gum Swamp EVC.
Expected Watering Effects	Fill Black Swamp in autumn 2023 to a maximum depth of 1m in the deepest parts, for 6-8 months to maintain or improve Red Gum Swamp EVC and provide habitat for waterbirds and frogs. Top up in spring 2023 if required to achieve desired wetting duration.
Environmental Objectives	Maintain or improve Red Gum Swamp EVC 292 at Black Swamp. Provide habitat for waterbirds and frogs to promote breeding at the site.
Rationale for proposed application in 2022-2023	Black Swamp received an environmental water delivery in spring 2021 which resulted in inundation for 3 months. The site dried in December 2021. To improve the extent of Red Gum EVC at the site. Unless natural inundation occurs in 2022 a partial fill of the site, to a depth of 60cm in the area in which saplings have been planted, in autumn 2023 will assist and promote the growth of aquatic grasses, sedges and herbs. Water will be delivered with the ability to "top up" water levels if evaporation rates are high and water recedes before the 6-month period.

Table 12. Potential watering actions and environmental objectives for Kinnairds Wetland

Potential Watering action	Fill Kinnairds Wetland in autumn 2023 to a maximum depth of 1m for 6-8 months to improve growth of Red Gum Swamp and Plains Grassy Wetland EVCs, providing habitat for fauna.
Expected Watering Effects	Fill in early autumn 2023 to a maximum depth of 1m in the deepest parts for 6-8 months to promote vegetation growth and recruitment and provide habitat for waterbirds and frogs. Top up in spring 2023 if required to achieve desired wetting duration.
Environmental Objectives	Maintain or improve Red Gum Swamp EVC 292 at Kinnaird's Wetland. Maintain or improve Plains Grassy Wetland EVC 125 at Kinnaird's Wetland. Provide habitat for waterbirds and frogs to promote breeding at the site.
Rationale for proposed application in 2022-2023	Kinnairds Wetland received a partial environmental water allocation in spring 2021 before it filled after a large rainfall event at the end of September 2021. The wetland remained wet for 2 months until it dried in November 2021. Aquatic vegetation responded well to watering. A complete fill in autumn 2023 (unless natural inundation occurs in 2022) will be required as the wetland will have surpassed its optimal drying period of 6-9 months by a further 6 months. This is not expected to be detrimental to the wetland as it can withstand up to 54 months between phases if required. A top up in Spring 2023 may be required to achieve desired wetting duration.

Table 13. Potential watering actions and environmental objectives for Moodie Swamp

Potential Watering action	Promote drying at site.
Expected Watering Effects	None
Environmental Objectives	Promote drying of the site to prevent prolonged inundation and allow swamp to reach optimal drying period.
Rationale for proposed application in 2022-2023	Moodie Swamp became primed in autumn 2021 due to a large rainfall event that occurred. Delivery to the swamp proposed for autumn 2022, was bought forward to September 2021 due to Brolga displaying courtship behaviours at the site in July 2021. The swamp held water for 6 months and was still holding water at the time of writing this plan. Brolga (<i>Antigone rubicunda</i>) were observed scoping the area however breeding at the site was not confirmed. Allowing the swamp to draw down and dry for at least 6 months will assist with the completion of the nutrient cycle and to reach its optimal drying period.

Scenario planning

The demand and utilisation of environmental water will vary according to climatic conditions. In drier periods reduced natural inflows and restricted water resources may mean that less environmental water is available and hence strategic planning of sites that provide refuge or require protection to avoid critical loss. However, in wetter periods the ecological and hydrological objectives of a wetland may be largely met by natural inflows and only small volumes of environmental water may be required.

According to the latest weather outlook information from the Bureau of Meteorology, April to June has a slightly higher chance of wetter than average conditions in the Goulburn and Broken Catchments. Lake Nillahcootie is currently 94% full and water is continuing to be released to meet irrigations demands. At the same time last year Lake Nillahcootie was only 81% full.

The current (February 2022 – Table 14) Broken system outlook for seasonal determinations indicate:

- an opening high security water share seasonal determination of 36 % in a wet Climate scenario, 6% in average scenario and 0% in dry and extreme dry scenarios;
- a high security water share seasonal determination of 100% by October 2022 in wet and average Climate scenarios and 22% in a dry Climate scenario; and
- a high security water share seasonal determination of 0% all season in an extreme Climate scenario.

Table 14: Broken system outlook for seasonal determination of high reliability shares

Climate Scenario	1 July 2022	15 August 2022	17 October 2022	15 February 2023
Wet	36%	39%	100%	100%
Average	6%	39%	100%	100%
Dry	0%	0%	22%	41%
Extreme Dry	0%	0%	0%	0%

The scenarios are based on receiving catchment inflows with a Probability of Exceedance (PoE) and the likely availability of environmental water, based on data from Goulburn-Murray Water. The scenarios are extreme dry/drought (99% PoE), dry (90% PoE), average (50% PoE) and wet (10% PoE). These scenarios were chosen as they may result in different natural inflows to the wetlands and the volume of environmental water required. Table 15 rationalises the volumes required for delivery at proposed watering sites for 2022-2023.

Table 15: Scenario planning for Broken Wetlands to be watered in 2022-2023

Wetland	Scenario 1 Extreme Dry 99% PoE No natural inflow to wetlands	Scenario 2 Dry 90% PoE Little to no natural inflow to wetlands, rainfall	Scenario 3 Average 50% PoE Average natural inflow to wetland	Scenario 4 Wet 10% PoE Above average inflow to wetland
Black Swamp	80ML – provide drought refuge and maintain wetland to avoid critical loss of threatened species such as River Swamp Wallaby Grass. Wetland of such small volume of water required to fill may also be less demand on	80ML – provide refuge and maintain wetland to avoid critical loss of threatened species such as River Swamp Wallaby Grass.	80ML – maintain water levels or fill swamp if primed due to natural inflows. Provide conditions for bird breeding and improve or maintain EVCs.	40ML – maintain water levels if swamp holding water. Provide optimal conditions for bird breeding events and improve or maintain EVCs.

	environmental water account. 2008-2009 watering of site proved it to be a great drought refuge area.			
Kinnairds Wetland	600ML - provide drought refuge and maintain wetland to avoid critical loss of threatened species such as Rigid Water-milfoil. 2008-2009 watering proved the site to be a good drought refuge. Populations of Rigid Water-milfoil were preserved during these watering events and provided refuge to a large number of waterbirds.	600ML – provide refuge and maintain wetland to avoid critical loss of threatened species such as Rigid Water-milfoil.	600ML - maintain water levels or fill swamp if primed due to natural inflows. Provide conditions for bird breeding events and improve or maintain EVCs.	300ML - maintain water levels if swamp holding water. Provide optimal conditions for bird breeding events and improve or maintain EVCs.

Potential watering actions 2022-2023

The environmental water management priorities currently being considered for inclusion in 2022-2023 Seasonal Watering Proposal are listed below (Table 16). These have been categorised into Tier 1 and Not Applicable. Tier 1 watering actions are the critically important actions that should be achievable based on estimates of supply and other available resources under each planning scenario.

In 2022-2023, in all climatic scenarios from extremely dry to wet it is proposed to deliver water for the environment to Black Swamp and Kinnairds Wetland. The natural hydrological regime of these wetlands has been altered due to catchment changes and river regulation and require water for the environment to fill in all climatic conditions. Black Swamp and Kinnairds Wetland are classified as Tier 1 due to the optimal drying period having been exceeded. An Environmental Water delivery is not proposed for Moodie Swamp under any climate scenarios as it enters a drying phase.

Table 16: Potential Watering Actions for 2022-2023

Priority	Wetland	Potential Watering Action	Climate Scenario and ML Water			
			Ex. Dry	Dry	Average	Wet
1	Black Swamp	Fill Black Swamp in autumn 2023 to a maximum depth of 1m in the deepest parts, for 6-8 months to maintain or improve Red Gum Swamp EVC and provide habitat for waterbirds and frogs. Top up in spring 2023 if required to achieve desired wetting duration.	80	80	80	40
1	Kinnairds Wetland	Fill Kinnairds Wetland in early autumn 2023 to a maximum depth of 1m in the deepest parts for 6-8 months to promote vegetation growth and recruitment and provide habitat for waterbirds and frogs. Top up in spring 2023 if required to achieve desired wetting duration.	600	600	600	300
NA	Moodie Swamp	Promote drying at Moodie Swamp. Allowing the swamp to draw down and dry for at least 6 months will assist with the completion of the nutrient cycle and to reach its optimal drying period.	0	0	0	0
Total ML			680	680	680	340

Delivery constraints

A notice period of one to two days minimum, preferably four days, is required for environmental water orders from Broken system storages. If constraints, such as high irrigation demand, in making environmental water available are foreseen by Goulburn-Murray Water, the Environmental Water Manager will be advised accordingly. The physical delivery of environmental water to the wetlands may only take 1-3 days during the irrigation season depending on system demands.

Black Swamp can only receive environmental water when the Nine Mile creek is running at approximately 100ML/day. This regularly occurs during the irrigation season however, if irrigation demand is high during the required delivery period, environmental water delivery into the Swamp may be delayed.

Kinnairds Wetland environmental water delivery occurs via the Muckatah Main Drain. Water is delivered to the drain via the channels entering the drain approximately 15km upstream which can cause some transition losses along the way. Kinnairds Wetland does not have a delivery share, therefore environmental water can only be delivered when there is spare capacity to carry water in the channels and drain. Investigations into a more efficient delivery channel to the site are currently being undertaken. Reasonable notification to Goulburn-Murray Water of a potential delivery to the site will assist with this issue.

The Goulburn Broken Catchment Management Authority will coordinate any planned delivery of environmental water in 2022-2023 with the VEWH, Goulburn-Murray Water, Moira Shire and Parks Victoria. Further delivery arrangements will be outlined in delivery plans.

The delivery constraints for Broken catchment wetlands with proposed environmental water deliveries in 2022-2023 are summarised below in Table 17.

Table 17. Possible delivery constraints to wetlands in the Broken system in 2022-2023

Priority site	Delivery Constraint	Impact/Consequence	Mitigation Action	Temporary/ Systemic Constraint
Black Swamp	Nine Mile creek (delivery source) must be running at 100ML/day to be able to deliver water to Black Swamp so may be not able to deliver to wetland at desired times.	Delivery may not occur if creek is not running high enough. This may impact upon promotion of EVCs and the loss of threatened species populations such as River Swamp Wallaby Grass	GB CMA to discuss appropriate timing of watering with GMW to meet both irrigation demands and environmental water delivery requirements.	Systemic
Kinnairds Wetland	No delivery share for this wetland, therefore environmental water can only be delivered when there is spare channel capacity.	Impact on delivery timing and duration if water not available. Impact on target waterbird breeding. May also impact upon threatened species populations such as the Rigid Water-milfoil.	GB CMA to discuss appropriate timing of watering with GMW to meet both irrigation demands and environmental water delivery requirements.	Systemic

Confounding Factors

Confounding factors are other environmental factors that have the potential to limit or impact desired environmental watering outcomes. Regulation of the Broken River and land use changes have altered the landscape reducing and changing vegetation and therefore habitat for many species. Species diversity and richness has been severely impacted which may result in some of the watering outcomes not able to be realised. Many wetlands are small and often disconnected from the main river channel and each other resulting in a disconnected landscape limiting the movement of plants and animals. Invasive animals and plants such as foxes, carp and blackberry can have serious impacts on native flora and fauna. Table 18 below identifies confounding factors for the Broken wetlands to be watered in 2022-2023 and the proposed and planned mitigating actions.

Table 18: Confounding factors for wetlands in Broken System

Wetland	Confounding factor	Mitigating Action
Black Swamp	Cannot deliver to wetland at desired time due to capacity and delivery share constraints	GB CMA to discuss appropriate timing of watering with GMW to meet both irrigation demand and environmental water delivery requirements
	Introduction of carp to the wetland during delivery – impacts on aquatic vegetation and water quality.	
	Black Swamp is a State Game Reserve managed by Parks Victoria and is popular with duck hunters. Duck hunting reduces the number of waterbirds both directly and indirectly.	GB CMA to install temporary carp screen prior to delivery.
	Traffic noise from highway may impact frog breeding pobblebunks as acoustic recording detected fewer calls when higher traffic volumes.	To work with Parks Victoria to close swamp to duck hunters during delivery and if threatened species are present.
Kinnairds Wetland	Foxes predating visiting water birds and raiding nests. Eating frogs and spreading weeds and disease.	Work with Parks Victoria and surrounding landholders to undertake co-ordinated fox control program – baiting, soft jaw trapping, fox drives.

Increasing Knowledge

WetMAP - Victoria's Wetland Monitoring and Assessment Program for environmental water is a state-wide monitoring program designed to assess the ecological response of vegetation, waterbirds and fish to the delivery of environmental water in Victorian wetlands. The WetMAP program objectives are:

- Build on current knowledge and conceptual models to improve the understanding of the relationships between environmental flows and ecological response/ outcomes.
- Determine whether the current ecological objectives for environmental watering are being met.
- Inform environmental flow management for CMAs – inform the development of objectives and planning for environmental water delivery.
- Communicate the ecological outcomes of environmental water delivery in Victorian wetlands to the Minister, water industry stakeholders and broader community.
- Contribute to Victoria's Murray Darling Basin Plan reporting requirements.

WetMAP monitoring began at Moodie Swamp and Black Swamp in late 2017 (<https://www.ari.vic.gov.au/research/wetlands-and-floodplains/assessing-wetland-response-to-water-for-the-environment>). This monitoring will complement the monitoring being undertaken by the GB CMA staff.

Compliance monitoring is also undertaken during the delivery of environmental water. This includes monitoring regulator operation and the volume of water delivered. This has been complimented by regular field observations by staff and acoustic monitoring to help determine the presence and number of waterbirds and frogs, and wetland condition. The information collected has been highly valuable in informing the ongoing management of these wetlands, and State Government and VEWB reporting.

During any environmental water delivery in 2022-2023 monitoring of the vegetation response including EPBC (1999) listed species Rigid Water-milfoil (*Myriophyllum porcatum*) and River Swamp Wallaby-grass (*Amphibromus fluitans*) will occur on a regular basis at Black Swamp and Kinnairds Wetland.

In the event of wetlands naturally filling, waterbird monitoring, water depth and extent will be monitored on a regular basis to determine when and if environmental water is required. If environmental water is delivered to a wetland these attributes will continue to be monitored along with the volume of water delivered. Attention will be paid to water levels to ensure nests are not exposed by water losses and nests close to the water surface are not inundated by environmental water deliveries. Monitoring of ecological attributes such as vegetation will be dependent upon available funding and staff resources.

Knowledge Gaps and Limitations

One of the key knowledge gaps associated with wetland environmental water management in the Broken Catchment is the limited information on the flood regime tolerances of aquatic dependent ecological vegetation communities and their associated flora species such as cane grass (*Eragrostis infecunda*) and the EPBC (1999) listed Rigid Water-milfoil (*Myriophyllum porcatum*) and River Swamp Wallaby-grass (*Amphibromus fluitans*).

These knowledge gaps do not prevent environmental water being delivered to the wetlands. However, more information on the flood regime tolerances of aquatic dependent ecological vegetation communities and their associated flora species would help refine wetland flood regimes and the management of environmental water.

Reporting

The first level of reporting is on the use of environmental entitlements. Weekly reporting advises environmental entitlement holders of progressive water use and on any adaptive water deployment decisions made.

The second level of reporting is on environmental outcomes achieved. Information on the use of environmental water, environmental outcomes recorded, and any knowledge gained will be reported to GB CMA partners and the board monthly and summarized in the 2023-2024 Broken System Wetlands Seasonal Watering Proposal. WETMAP also produces annual reports on the results of the program.

Risk Management

The risks associated with the proposed delivery of environmental water to the wetlands in the Goulburn Broken Catchment are outlined in Table 19 below, along with their mitigation actions and the organisation responsible for their implementation. These will be reviewed and updated prior to the delivery of environmental water in site specific environmental water delivery plans.

Table 19: Risk assessment of proposed water delivery

Pre-Mitigation Risk													
FY	Region	System	Waterway Manager	Risk ID	Risk category	Risk description	Likelihood	Consequence	Risk Rating	Mitigation actions	Lead organisation for action	Remains medium/high after mitigation	Risk type Static or Dynamic
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-01	Environment	Specified flow rates are insufficient to achieve the intended extent of wetland inundation or magnitude and duration of river flows, resulting in a failure to achieve planned environmental outcomes.	Possible	Major	Medium	• Include contingency allowance in estimated watering requirements, based on previous event data, and consider a contingency in the duration of the event to achieve desired wetland inundation. • Monitor event (especially for deliveries to new sites or for previously untested events) and adjust flows as necessary, or terminate event if it becomes clear that insufficient water is available. • Identify and address constraints that may limit the flow rates for environmental deliveries.	CMA CMA CMA/GMW		Static
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-02	Reputational	Specified flow rates are insufficient to achieve the intended extent of wetland inundation or magnitude and duration of river flows, resulting in a failure to achieve planned environmental outcomes and loss of community support.	Possible	Major	Medium	• Communications on the environmental benefits of watering actions. • Monitor event (especially for deliveries to new sites or for previously untested events) and adjust flows as necessary, or terminate event if it becomes clear that insufficient water is available. • Communicate the need for complimentary measures to optimise the benefits of environmental watering actions.	CMA		Static
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-03	Environment	Overestimates of environmental water demand prevents planning for supplying demands at other locations <i>Notes: Planning watering actions also includes decisions around the carryover and trade of water as alternatives to current year water use decisions.</i>	Possible	Minor	Low	• CMAs review demand estimates and targets met by unregulated flows throughout the delivery cycle and regularly advise VEWH of any changes so unused water can be reallocated. • CMAs 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. • River operators provide regular updates on flows, including through OAG meetings • Manage Water Holdings to maximise supply opportunities for all sites	CMA CMA MDBA/GMW VEWH		Static

Broken System Wetlands Seasonal Watering Proposal 2022-2023

2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-04	Environment	Inaccurate accounting and measurement or operational error results in target flows either not being achieved or being exceeded, leading to a failure to achieve planned environmental outcomes Occurring in Upper Broken CK below Casey's weir offtake due to weed growth, which is also limiting flow capacity (likelihood for Broken is "possible")	Unlikely	Moderate	Low	- Review accounting and measurement processes to be used to ensure that techniques are agreed, and monitoring/measurement sites are operational. - Apply agreed arrangements as documented in the Murray and Goulburn Systems Operating Arrangement documents - GMW to undertake additional gaugings - Weed control in Bkn Ck programmed for autumn (weather conditions permitting)	GMW (MDBA in some waterways such as Barmah) GMW/VEWH GMW GMW/CMA	Dynamic
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-05	Business Costs	Volumes of environmental water delivered or released exceed volumes approved for use in the event, leading to potential overdraw of accounts or preventing other planned actions being undertaken. <i>Notes: Planning watering actions also includes decisions around the carryover and trade of water as alternatives to current year water use decisions.</i>	Unlikely	Major	Low	- Ensure that deliveries are reported progressively throughout the event and are monitored against ordered volume. - Ensure ordering and delivery procedures are kept up-to-date and adhered to. - Ensure metering and reporting processes for temporary pump operations are suitable and effective	CMA & GMW GMW/CMA/VEWH CMA	Static
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-06	Environment	Environmental water account is overdrawn, leading to water not being available as per approved watering statement to complete planned actions and environmental benefits not being achieved. <i>Notes: Planning watering actions also includes decisions around the carryover and trade of water as alternatives to current year water use decisions.</i>	Unlikely	Major	Low	- Monitor ABA balances and undertake regular communications with CMA and RWC as part of portfolio management activities. - Ensure that deliveries are reported progressively throughout the event and are monitored against ordered volume.	VEWH CMA & GMW	Static
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-07	Environment	Planned maintenance of water delivery infrastructure results in planned/specified flows not being achieved, leading to a failure to achieve planned environmental outcomes.	Likely	Minor	Low	- Undertake early planning and communications between the CMA and storage operator to minimise likelihood of constraints, enable scheduling of maintenance outside of high demand periods or identify alternative environmental water delivery windows to avoid scheduled maintenance activities. - Consider adding time contingencies to planned maintenance schedules to ensure works are completed prior to commencement of watering actions.	CMA and GMW CMA	Static
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-08	Environment	Failure of poorly maintained environmental delivery infrastructure results in planned/specified flows not being achieved, reducing the ability to achieve planned environmental outcomes.	Likely	Moderate	Medium	- Asset ownership is clarified, and the asset owners perform regular maintenance, and pre-event asset inspections, on delivery infrastructure. <i>*Note that insufficient resources are likely to limit the asset owner's ability to regularly inspect and maintain infrastructure. Increased resources for these activities may further reduce the likelihood and risk ratings.</i> - Report vandalism to police. - Review asset design to minimise opportunities for interference or damage. - For privately owned assets, arrange approvals to use/operate assets and undertake pre-delivery inspections - Communicate failures to the CMA - Initiate documentation of asset ownership and management arrangements in national parks.	Asset Owner Asset Owner Asset Owner CMA Asset Owner PV	Static

Broken System Wetlands Seasonal Watering Proposal 2022-2023

2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-09	Environment	Poor condition of delivery infrastructure results in the asset owner being unable to operate the structure due to OH&S risks, leading to failure to deliver environmental flows and to achieve environmental objectives. Note: This issue may affect multiple sites GMW to confirm OH&S status and likelihood rating	Likely	Moderate	Medium	- Asset owner to undertake regular maintenance and pre-event asset inspections on delivery infrastructure. <i>Note that insufficient resources are likely to limit the asset owner's ability to regularly inspect and maintain infrastructure. Increased resources for these activities may further reduce the likelihood and risk ratings.</i> - Communicate failures to the CMA - Develop design for new regulating structure and seek funding to implement necessary upgrades in conjunction with asset owner. <i>Note: PV proposing to issue operating licences for BMF regulators</i>	Asset Owner Asset Owner CMA (MDBA in Barmah Forest)	Dynamic
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-10	Environment	High operational and consumptive water demands lead to reduced access for environmental deliveries, with the result that target flows/volumes cannot be achieved, impacting on environmental outcomes Note: Goulburn R is a particular risk - see new separate Goulburn risk added	Likely	Minor	Low	- Event planning will seek to avoid peak demand periods, and events will be monitored and adjusted as necessary. - System operators to provide longer term forecasts for future consumptive demands as an input to planning watering proposals - Develop longer term agreements on river capacity access for environmental deliveries. - Investigate opportunities to undertake deliveries outside the irrigation season with consideration of appropriate delivery costs	CMA and GMW GMW/MDBA VEWH CMA and VEWB	Dynamic
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-11	Environment	High downstream demands may lead to flows that exceed local environmental requirements and targets (including rates of river rise and fall), leading to negative environmental outcomes, including negating previous environmental improvements. Recent monitoring and assessment is confirming consequences in Goulb and Lwr Bkn - high water avail. in 22-23 increases likelihood	Almost certain	Major	Extreme	- Seek to negotiate and formalise acceptable seasonal flow limits for river systems, with annual negotiation and management of release plans and reviews during the season as required. - Monitor impacts of new trade limits and revised operating rules and review as necessary (Note: This risk may still be rated as <i>extreme</i> after mitigation actions.)	VEWH and DELWP DELWP/GBCMA	High Dynamic
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-12	Legal	Environmental releases, either on their own or potentially in combination with unexpected tributary inflows, cause unauthorised inundation of private land, resulting in impacts on landowner activities and assets.	Possible	Major	Medium	- Ensure currency of any landholder agreements for inundation of private land. - Release plans designed to avoid exceeding operational thresholds or unauthorised flooding. - Monitor events and adjust releases to avoid overbank flows. This may include limiting deliveries to daylight hours only, where feasible and consistent with watering requirements. - Monitor forecast rainfall and tributary inflows and adjust releases to avoid overbank flows. - Monitor deliveries to new locations to build an understanding of flow patterns and inundation thresholds and adjust releases accordingly.	CMA CMA GMW/MDBA GMW/MDBA CMA	Static
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-13	Reputational	Public land and/or access routes into public land areas may be inundated by delivery of environmental water, leading to potential impacts on recreational opportunities for park users (e.g. access to boat ramps, fishing spots, firewood collection etc.).	Almost certain	Moderate	High	Watering proposals to identify potential impacts. communication of planned events, access closures, alternative recreational opportunities and alternative access routes	CMA Land Manager	Static

Broken System Wetlands Seasonal Watering Proposal 2022-2023

2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-14	Reputational	Environmental water delivery results in inundation of roads and recreation areas (e.g. Barmah Forest campsites) during their use, potentially stranding recreational users.	Possible	Moderate	Medium	- Watering proposals to identify potential impacts (e.g. flooding footprint overlaid with key land roads and recreational assets). - Land Managers implement the required management activities prior to and during environmental watering events. This includes: - identification of impacted assets - preparation of resources required (e.g. signage, maintenance of alternative recreational sites) to implement road and campsite closures and to direct users to alternative sites - communication of planned events, access closures and alternative recreational opportunities. - Land managers to seek powers to temporarily close roads without the need for a gazettal process. - Land managers given powers to remove people from affected areas and establish day visitor areas. - Consider rationalisation of road networks to remove unwanted access tracks and improve the standard of retained tracks. <i>*Note that insufficient resources may limit the land manager's ability to implement management activities and hence ability to effectively mitigate the described risk.</i>	CMA Land Manager	Static
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-15	Business Costs	Public land visitor vehicles cause damage to tracks, or to other assets in the surrounding landscape, due to off-road activity (by users going off track to avoid floodwaters) during and after environmental watering	Likely	Moderate	Medium	Land Managers: - implement management activities to prevent access to flooded roadways (e.g. close roads, communicate planned events, install signage) - repair damage during and after environmental watering events - maintain key higher ground tracks to enable alternative access routes during environmental watering. <i>*Note that insufficient resources may limit the land manager's ability to implement management activities and hence ability to effectively mitigate the described risk.</i>	Land Manager	Static
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-16	Legal	Access routes into public land areas may be inundated by delivery of environmental water, leading to potential economic impacts on commercial operators who are unable to undertake activities (includes timber and firewood harvesting, apiarist, tourism operators).	Likely	Moderate	Medium	Communication and advice to commercial operators to alert them of environmental watering, via Land Manager as licensing authority.	Land Manager	Static
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-17	Service Delivery	Access routes into public land areas may be inundated by delivery of environmental water, leading to potential impacts on land management and maintenance activities (e.g. fire mgmt. works)	Almost certain	Moderate	High	Early planning and communications of proposed actions with land manager to minimise likelihood of impacts, and scheduling of maintenance works outside of planned delivery periods.	CMA	Static
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-18	Environment	Environmental water deliveries result in low dissolved oxygen (DO) levels, with adverse environmental impacts. <i>Note: Advice is that annual leaf litter accumulation is sufficient to cause risk, even if previously inundated</i> <i>- Rainfall rejection or high consumptive deliveries may drive risk issues here, rather than e-water</i>	Unlikely	Moderate	Low	- Where possible implement a full annual suite of flow components in river systems, including those designed to control build of organic matter (such as winter flushes). Plan deliveries with consideration of high temperature periods where appropriate. - Develop monitoring and response plans and reserve contingency volumes in delivery plans for dilution flows if DO concentrations drop to levels of concern. - Monitor leaf litter loads and avoid exceeding any flow thresholds likely create hypoxic black water events - where possible, and considering temperature drivers - Assess new/proposed actions for DO impact potential and adjust watering plans as needed.	CMA	Dynamic

Broken System Wetlands Seasonal Watering Proposal 2022-2023

2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-19	Reputational	Environmental water deliveries result in low DO levels, with adverse environmental impacts.	Unlikely	Major	Low	• Communicate benefits of environmental water management to the broader community and engage with recreational user peak bodies and management agencies. • Communicate the benefits of environmental water management and inform the local community of environmental water management activities and the underlying rationale, including black water mitigations. - Inform communities of black water vs hypoxic black water issues, to build understanding and support	VEWH CMA - VEW/CEWO	Dynamic
2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-20	Environment	Environmental water deliveries may generate or mobilise BGA blooms, with adverse water quality and/or health impacts (including to people, livestock and pets), resulting in cessation of releases and environmental impacts	Possible	Major	Medium	• Consider likelihood of initiating BGA blooms in event planning and amend as required to manage risk. • Land managers or water corporation implement a risk-based monitoring program during environmental watering events, and where issues are identified, activate BGA response processes. <i>*Notes: Parks Victoria are currently writing a BGA risk management plan for Northern Victoria Region that considers the potential risk of environmental water events. This plan will outline proactive and reactive monitoring and management responsibilities that Parks Victoria commits to as a Local Waterway Manager for BGA. Adequate BGA resourcing is being considering as part of this plan.</i> • Regional monitoring and advice on BGA status.	CMA / GMW Land Manager GMW GMW	Static
2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-21	Reputational	Environmental water management activities may conflict with or not complement water based recreational objectives, leading to loss of community support for activities.	Almost certain	Moderate	High	• Communicate benefits of environmental water management to the broader community and engage with recreational user peak bodies. • Engage with local recreational user groups to inform them of environmental water management activities and the underlying rationale. • Adjust events or actions to reduce/avoid impact where practical without reducing environmental outcomes. • Communicate alternate recreational opportunities. • Enhance community understanding of water system operations and entitlement frameworks (water literacy).	VEWH CMA CMA Land Manager VEWH	Static
2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-22	Business Costs	Insufficient resources available (including staff, funding for maintenance of roads, regulators etc.) across partner organisations to deliver all planned environmental watering actions, leading to cancellation or interruptions of deliveries.	Possible	Major	Medium	• Partners notify the CMA and VEW of resource constraints in advance of deliveries and VEW convene OAG meetings to consider implications and potential solutions. • Continue to actively prioritise actions to match available resources and ensure key actions are delivered. • Reallocate tasks and available funds to ensure highest priority watering actions are delivered.	VEWH CMA CMA	Static
2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-23	Environment	Insufficient information and knowledge available to inform environmental water deliveries	Unlikely	Moderate	Low	• Identify important knowledge gaps and secure funding to improve scientific understanding. • Consider deferring deliveries until sufficient information is available to mitigate unacceptable risks. • Implement adaptive management processes and undertake trials to collect data.	CMA	Static
2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-24	Legal	Failure to recognise cultural heritage issues at a site targeted for watering may result in necessary permits and approvals not being obtained, leading to prosecution and fines.	Possible	Moderate	Medium	• Undertake desktop reviews and site assessments with archaeologists, traditional owners and land managers, to identify approval needs and contingency measures. • Obtain any necessary formal approvals/permits and implement required actions.	CMA	Dynamic
2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-25	Cultural heritage	Environmental watering causes harm to identified cultural heritage <i>Note: difficult to assess consequence under cultural heritage category - needs further testing with TOs. Hard for non-TOs to try and assess, so doesn't really fit</i>	Unlikely	Moderate	Low	• Work with Traditional Owners to ensure that the potential impact of environmental water deliveries on cultural heritage is understood and agreed, minimised or avoided. - Consider opportunities for additional resourcing for TO groups to engage in risk assessments	CMA DELWP/VEWH	Dynamic

Broken System Wetlands Seasonal Watering Proposal 2022-2023

within a traditional risk assessment process													
2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-26	Reputational	Inability to demonstrate outcomes achieved through environmental watering activities may lead to a loss of public/political support for activities	Possible	Major	Medium	- Rationalise and refocus current monitoring programs (e.g. Wetmap) to better identifying outcomes. - Seek additional funds to address gaps in monitoring programs and knowledge. - Communicate the benefits of environmental watering and monitoring results (Note: It may not be possible/affordable to address all monitoring gaps, so this risk may still be rated as medium after mitigation actions.)	DELWP VEWH CMA	Medium	Static
2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-27	Environment	Environmental deliveries improve conditions for non-native species (e.g. carp, invasive species, feral horses) and over-abundant native species (e.g. kangaroos, Red Gum encroachment) leading to adverse environmental impacts.	Likely	Moderate	Medium	- Study/understand life history of species and develop high level management strategies. - Develop and implement site specific management strategies aimed at eradication/control of existing populations (e.g. carp management strategy, willow removal program, water-lily spraying program, feral animal programs). - Implement pest reduction efforts prior to delivery of water, to ensure increases in populations remain within "tolerable" levels (Note: This risk is still rated as medium after mitigation actions.)	DELWP CMA/Land Manager	Medium	Static
2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-28	Environment	Environmental watering actions trigger non-targeted environmental responses (e.g. bird breeding) causing unintended consequences (or lost opportunities) for other environmental values.	Likely	Moderate	Medium	- Undertake monitoring and communicate these issues as they arise and apply adaptive management and review of delivery plans. - Consider including contingency allowance in delivery plan water volumes to complete breeding events.	CMA		Dynamic
2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-29	Environment	Ineffective planning and/or uncoordinated water ordering results in administrative obstacles that prevent watering opportunities.	Unlikely	Moderate	Low	- Enable the full range of watering actions possible in seasonal watering proposals and the seasonal watering plan (as per SWP guidelines) - Review and update the Murray system environmental watering ordering template	CMA/VEWH VEWH/MDBA		Static
2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-30	Business Costs	River operators release water for flood mitigation which causes downstream flooding and debits those releases to environmental water accounts <i>*Note that debits of releases to environmental accounts is specific to Lake Hume and pre-releases from other storages could not be debited to environmental accounts</i>	Unlikely	Moderate	Low	- Resolve appropriate water accounting treatment as part of the development of the Enhanced Environmental Water Deliveries SDL Adjustment Measures project (aka Hydrocues project) - Refer to MDBA Environmental Water Management Group for development of suitable accounting arrangements.	VEWH/DELWP MDBA		Static
2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-31	Reputational	River operators release water for flood mitigation which causes downstream flooding and public perceive the releases are for environmental purposes.	Unlikely	Moderate	Low	River operators to clearly communicate to customers and the broader community when large releases are for operational purposes	MDBA/GWM		Static
2019-20	Northern	Murray, Goulburn, Broken & Owens	GBCMA & NECMA	NOGB2020-32	Reputational	Sections of the community perceives (incorrectly) that high river flows are due to environmental releases in dry conditions, leading to a loss of support for watering activities.	Possible	Moderate	Medium	Communications to inform the community on the drivers/reasons for high flows in river systems, especially under dry scenarios	System operator & CMA		Dynamic

Broken System Wetlands Seasonal Watering Proposal 2022-2023

2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-33	Reputational	Community concern over environmental releases under dry seasonal conditions may lead to a loss of support for environmental watering actions.	Unlikely	Moderate	Low	- Communicate benefits of environmental watering to the community, especially in relation to strategic watering in dry periods. - Enhance community understanding of water system operations and entitlement frameworks (water literacy).	CMA VEWH	Dynamic
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-34	Reputational	Under dry conditions, community expectations of the extent of environmental watering that can be achieved are not met, leading to a loss of support for environmental watering actions. Note - e-water deliveries may be constrained in 22-23 due to high consumptive avail.	Possible	Moderate	Medium	Communications to inform the community on the limits of environmental water holdings and the extent of actions possible under dry conditions. <i>Note that public concern in this regard may be heightened as a result of the Menindee 2019 fish death events.</i>	CMA	Dynamic
2019-20	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2020-35	Environment	Limited environmental deliveries may reduce opportunities to test ecological responses to environmental flows, impacting on effectiveness of research projects.	Unlikely	Minor	Low	- Review monitoring program and adjust if possible. - Reprioritise future flow targets.	CMA	Dynamic
2020-21	Northern	Murray, Goulburn, Broken & Ovens	GBCMA & NECMA	NOGB2021-36	Safety	Environmental releases create rapid or unexpected changes in flow conditions, resulting in injury to river users	Unlikely	Moderate	Low	- Include consideration of ramp-ups and ramp-down phases in release plans to reduce rapid water level changes. - Appropriate notification actions to alert general river users, especially for high use sites and high use periods. - Provide information on proposed changes to PV for inclusion in Change of Conditions Section of their website - Implement communications plan about environmental water releases - Undertake notifications to water users with assets potentially at risk due to changing river levels	CMA CMA CMA GMW	Static
2019-20	Northern	Broken	GBCMA & NECMA	NOBR2020-40	Environment	Continuing dry conditions in the Broken system lead to a Qualification of Rights in the Broken system, resulting in an inability to undertake planned watering events. Note: Broken R may have limits on allocation	Unlikely	Moderate	Low	Negotiate alternate water delivery opportunities and seek best possible environmental outcomes under the circumstances that prevail (e.g. including delivery to drought refuge sites).	CMA	Dynamic

Approval

I, Chris Cumming, the authorised representative of the Goulburn Broken Catchment Management Authority, approve the Seasonal Watering Proposal for the Broken Wetlands 2022-2023.

SIGNED FOR AND ON BEHALF OF Goulburn Broken Catchment Management Authority

A handwritten signature in black ink, appearing to read 'CC', is positioned above the signature line.

Signature of authorised representative

Name of authorised representative

Chris Cumming, CEO

Date: 13 April 2022

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Appendices

Appendix 1 - Schedule 8 – Criteria for identifying an environmental asset

Taken from the Basin plan <https://www.legislation.gov.au/Details/F2012L02240>

Item	Criteria
Criterion 1: The water-dependent ecosystem is formally recognised in international agreements or, with environmental watering, is capable of supporting species listed in those agreements	
1	Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it is: (a) a declared Ramsar wetland; or (b) with environmental watering, capable of supporting a species listed in or under the JAMBA, CAMBA, ROKAMBA or the Bonn Convention.
Criterion 2: The water-dependent ecosystem is natural or near-natural, rare or unique	
2	Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it: (a) represents a natural or near-natural example of a particular type of water-dependent ecosystem as evidenced by a relative lack of post-1788 human induced hydrologic disturbance or adverse impacts on ecological character; or (b) represents the only example of a particular type of water-dependent ecosystem in the Murray-Darling Basin; or (c) represents a rare example of a particular type of water-dependent ecosystem in the Murray-Darling Basin.
Criterion 3: The water-dependent ecosystem provides vital habitat	
3	Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it: (a) provides vital habitat, including: (i) a refugium for native water-dependent biota during dry spells and drought; or (ii) pathways for the dispersal, migration and movements of native water-dependent biota; or (iii) important feeding, breeding and nursery sites for native water-dependent biota; or (b) is essential for maintaining, and preventing declines of, native water-dependent biota.
Criterion 4: Water-dependent ecosystems that support Commonwealth, State or Territory listed threatened species or communities	
4	Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it: (a) supports a listed threatened ecological community or listed threatened species; or Note: See the definitions of listed threatened ecological community and listed threatened species in section 1.07. (b) supports water-dependent ecosystems treated as threatened or endangered (however described) under State or Territory law; or (c) supports one or more native water-dependent species treated as threatened or endangered (however described) under State or Territory law.
Criterion 5: The water-dependent ecosystem supports, or with environmental watering is capable of supporting, significant biodiversity	
5	Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it supports, or with environmental watering is capable of supporting, significant biological diversity. This includes a water-dependent ecosystem that: (a) supports, or with environmental watering is capable of supporting, significant numbers of individuals of native water-dependent species; or (b) supports, or with environmental watering is capable of supporting, significant levels of native biodiversity at the genus or family taxonomic level, or at the ecological community level.

Appendix 2a – Threatened fauna species recorded at Broken Wetlands

Common Name	Scientific Name	Black Swamp	Kinnairds Wetland	Moodie Swamp	EPBC	FFG	VROT
Australasian Bittern	<i>Botaurus poiciloptilus</i>	Y	Y	Y	Endangered	Listed	Endangered
Australasian Shoveler	<i>Anas rhynchos</i>	Y	Y	Y			Vulnerable
Australian Little Bittern	<i>Ixobrychus dubius</i>	Y				Listed	Endangered
Baillon's Crake	<i>Porzana pusilla</i>	Y	Y			Listed	Vulnerable
Blue-billed Duck	<i>Oxyura australis</i>		Y	Y		Listed	Endangered
Brolga	<i>Antigone rubicunda</i>		Y	Y		Listed	Vulnerable
Brown Quail	<i>Coturnix ypsilophora australis</i>		Y	Y			Near Threatened
Caspian Tern	<i>Hydroprogne caspia</i>			Y		Listed	Near Threatened
Eastern Great Egret	<i>Ardea modesta</i>	Y	Y	Y		Listed	Vulnerable
Eastern Long-necked Turtle	<i>Chelodina longicollis</i>	Y		Y			Data deficient
Freckled Duck	<i>Stictonetta naevosa</i>	Y	Y				Endangered
Glossy Ibis	<i>Plegadis falcinellus</i>	Y	Y	Y			Near Threatened
Hardhead	<i>Aythya australis</i>	Y	Y	Y			Vulnerable
Intermediate Egret	<i>Ardea intermedia</i>	Y	Y	Y			Endangered
Latham's Snipe	<i>Gallinago hardwickii</i>		Y				Near Threatened
Little Egret	<i>Egretta garzetta nigripes</i>		Y			Listed	Endangered
Magpie Goose	<i>Anseranas semipalmata</i>	Y	Y				Near Threatened
Musk Duck	<i>Bizura lobata</i>			Y			Vulnerable
Nankeen Night Heron	<i>Nycticorax caledonicus</i>	Y	Y	Y			Near Threatened
Pied Cormorant	<i>Phalacrocorax varius</i>	Y	Y	Y			Near Threatened
Royal Spoonbill	<i>Platalea regia</i>	Y	Y	Y			Near Threatened
Sloane's Froglet	<i>Crinia sloanei</i>	Y		Y	Endangered		
Whiskered Tern	<i>Chlidonias hybridus javanicus</i>		Y	Y			Near Threatened
White-bellied Sea Eagle	<i>Haliaeetus leucogaster</i>	Y	Y	Y		Listed	Vulnerable
White-throated Needletail	<i>Hirundapus caudactis</i>		Y		Vulnerable		

Appendix 2b – Threatened flora species recorded at Broken Wetlands

Common Name	Scientific Name	Black Swamp	Kinnairds Wetland	Moodie Swamp	EPBC	FFG	VROT
Bluish Raspwort	<i>Haloragis glauca</i> f. <i>glauca</i>	Y	Y	Y			Poorly known
Dwarf Brooklime	<i>Gratiola pumilo</i>			Y			Rare
Floodplain Fireweed	<i>Senecio campylocarpus</i>	Y		Y			Rare
In-land Club-sedge	<i>Isolepis australiensis</i>			Y			Poorly known
Rigid Water-milfoil	<i>Myriophyllum porcatum</i>		Y	Y	Vulnerable	Listed	Vulnerable
River Swamp Wallaby-grass	<i>Amphibromus fluitans</i>	Y			Vulnerable		Poorly known
Riverine Bitter-cress	<i>Cardamine moirensis</i>		Y	Y			Rare
Slender Water-milfoil	<i>Myriophyllum gracile</i> var. <i>lineare</i>		Y	Y		Listed	Endangered
Slender Water-ribbons	<i>Triglochin dubia</i>	Y		Y			Rare
Small-flower Mud-mat	<i>Glossostigma cleistanthum</i>		Y				Vulnerable
Smooth minuria	<i>Minuria integerrima</i>	Y					Rare
Smooth Nardoo	<i>Marsilea mutica</i>	Y					Poorly known
Variable Spike-sedge	<i>Eleocharis minuta</i>		Y				Endangered
Water Nymph	<i>Najas tenuifolia</i>	Y					Rare
Wavy Marshwort	<i>Nymphoides crenata</i>			Y		Listed	Endangered
Winged Water-starwort	<i>Callitriche umbonata</i>	Y	Y	Y			Rare