Restoring hydrological connectivity at Ryans Lagoon Nature Conservation Reserve

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Key points

- Operational flow constraints on the Hume to Yarrawonga reach of the Murray River limit overbank inundation of many floodplain wetlands.
- Connectivity between the nationally significant Ryans Lagoon wetland complex and the Murray River is now limited to very large and infrequent flooding events.
- Installation of pumping infrastructure was identified as the most viable mechanism to reinstate modelled natural inundation patterns to the complex
- Environmental watering delivered via temporary diesel pumping in 2024 and 2025 demonstrated positive ecological responses and validated the overall approach.
- For sustained long-term deployment, a grid-connected electric pump was identified as the preferred solution, delivering high operational reliability and system flexibility while minimising lifecycle expenditures.
- This project demonstrates how engineered environmental water delivery can restore ecological function and support cultural outcomes where natural inundation is no longer achievable.

Abstract

Ryans Lagoon Nature Conservation Reserve (185 ha) is a nationally listed wetland complex on the Murray River floodplain between Lake Hume and Lake Mulwala in North East Victoria, Australia. Decades of river regulation and floodplain modification have disrupted natural inundation patterns, with wetland inundation now only occurring during infrequent flooding or sustained flows >24,000 ML/day from Lake Hume; conditions seldom achieved under current operational constraints. The North East Catchment Management Authority (CMA) and Water Technology have assessed options to restore hydrological connectivity that include the construction of a regulator and supply channel, reinstatement of alternative flow paths, culvert modification, levee removal and three pump options.

Environmental water was delivered in spring 2024 and 2025 partially filling the wetlands via a mobile diesel pump. Wetland inundation stimulated a range of ecological responses that included germination of amphibious herbs, increased frog activity and waterbird abundance, improved tree vigor and strengthened habitat extent and quality for several of the site's threatened species.

Parallel changes to land management that included adoption of conservation stewardship over grazing occurred via an active partnership with Duduroa Dhargal Aboriginal Corporation and Parklands Albury Wodonga. This has supported the connection between ecological and cultural outcomes, with Traditional Owners advocating for a more natural hydrological regime that supports cultural values. North East CMA is now working with the Department of Energy, Environment and Climate Action (DEECA) and Goulburn-Murray Water to construct permanent water delivery infrastructure to improve watering reliability and underpin long-term ecological resilience. This project represents a key contribution to the Murray–Darling Basin Plan, Constraints Relaxation implementation and broader floodplain restoration.

Keywords

Operational constraints, wetland restoration, environmental water, Murray floodplain, Traditional Owner partnerships, cultural outcomes

Introduction

Ryans Lagoon is located on the Victorian Murray River floodplain on Duduroa/Dhuduroa Country, approximately 5 km downstream of Lake Hume, upstream of the Kiewa River confluence. The wetland complex, comprising Ryans Lagoon 1 and 2, is recognised as high-value ecological and cultural site. It is listed in the National Directory of Important Wetlands and provides habitat for at least 13 threatened species, including the endangered Sloane's Froglet and culturally significant totemic species. The wetland complex was a former field research site for the Murray-Darling Freshwater Research Centre and a wealth of literature describes the wetland function (Boon, P. I, et al. (1991, 1996, 1997), Nielsen, D. L. et al. (2002)). Traditional Owners, the Duduroa Dhargal Aboriginal Corporation (DDAC), are currently actively leading restoration and cultural management of the site.

While the site retains significant environmental values, hydrological disconnection due to river regulation and floodplain modification has significantly altered both ecological processes and the ability to maintain cultural connections. As such, restoring hydrology is both an ecological and cultural objective for land managers and partners. For Traditional Owners, the lagoon system forms part of a broader cultural landscape intrinsically linked to water. Rivers, wetlands and floodplains represent key sites for food, medicine, knowledge exchange and connection to Country.

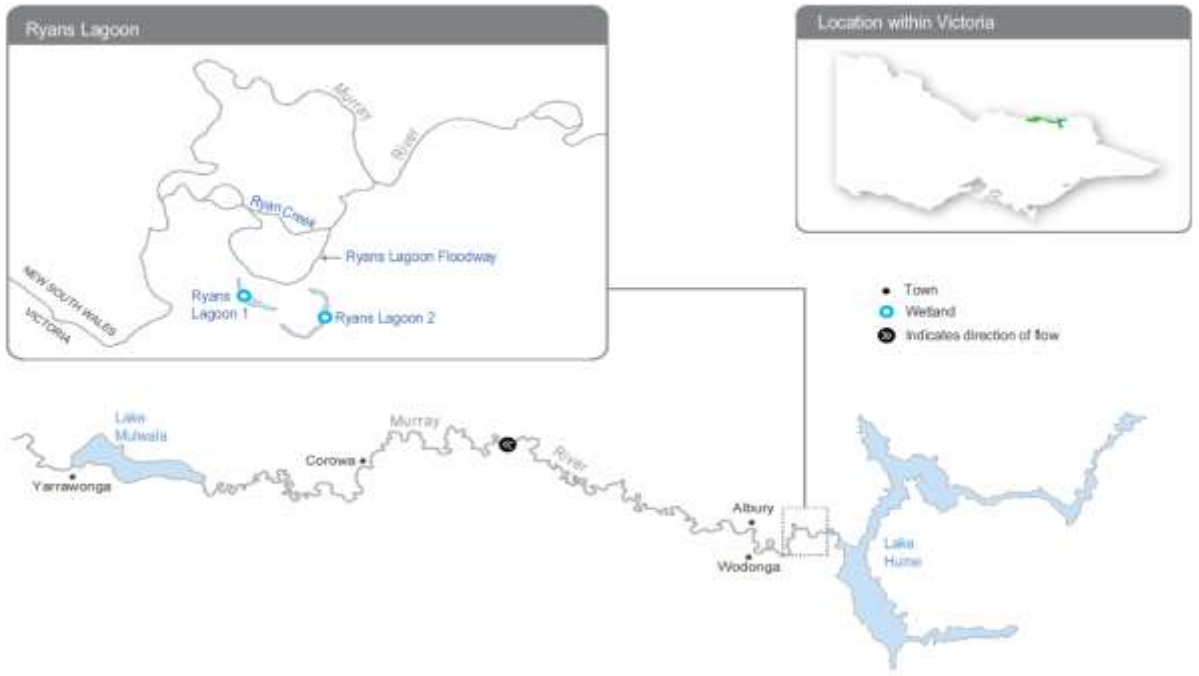

Figure 1 Location of Ryans Lagoon Wetland Complex

Hydrological disconnect has led to several investigations into the optimal approach to restore a pre-regulation hydrological regime to the lagoons. These have included the construction of a regulator and supply channel, reinstatement of alternative flow paths, culvert modification, levee removal and three pump options: diesel, mains electric and solar electric.

The North East CMA facilitated environmental water delivery to the site in spring 2024 and 2025, utilising allocation from the Commonwealth Environmental Water Holder (CEWH), with support from the Victorian Environmental Water Holder (VEWH). Water was pumped from Ryans Floodway using a

mobile diesel pump, supplied and operated by North East Water. Subsequent feasibility assessments have determined that an electric pump would offer a more efficient and suitable long-term solution.

Hydrological disconnect

Inundation of the Ryans Lagoon wetland complex is controlled primarily by regulated releases from Lake Hume, with the exception of large unregulated flood events. Water released from Lake Hume travels via Ryans Creek, an anabranch of the Murray River, before entering the Ryans Floodway. A levee along the south bank of Ryans floodway limits inundation of the lagoon system. For over 50 years, a 375 mm culvert has provided the only hydraulic connection between the Ryans Floodway and Lagoons 1 and 2 under regulated flow conditions, significantly constraining floodplain connectivity.

Inflows from Ryans Floodway via the culvert which discharges to Lagoon 1 occur when flows in the Murray River immediately downstream of Lake Hume (Heywoods gauge #409016) reach 23,000 ML/day. However, sustained flows above 24,000 ML/day for 10-20 days (Water Technology, 2024) are required to fully inundate both lagoons. Under current regulated river operations, these thresholds are rarely achieved, as flows are typically constrained to below 25,000 ML/day at the downstream Doctors Point gauge (#409017), which is downstream of the Kiewa River confluence. Even when such flows do occur, their duration is generally insufficient to support meaningful inundation.

The modelled natural flow suggests inundation of the Lagoons was likely to have occurred annually, predominantly in winter and spring (Water Technology, 2011). In contrast, the current regulated flow regime is seasonally inverted, with higher flows occurring during the hotter, drier months to meet downstream consumptive demand, primarily for irrigation. Previous to the flow reductions in the Murray River system during the Millenium Drought from the late 1990s to the summer of 2010 (MDBA, 2016.), the Lagoons were still reaching the inundation threshold annually on average, but with increases in summer inundation; 49% of years compared to 13% of years in the modelled natural flow record (Water Technology, 2011).

Changes in river operations associated with implementation of the Murray–Darling Basin Plan after the Millenium Drought have resulted in regulated flows being more tightly controlled. Discharge in this reach of the Murray River now seldom exceeds 20,000 ML/day, as illustrated in Figure 2 for the post-2014 period, with the exception of major flood events of 2016 and between 2021–2023. Consistent with this, Figure 3 shows that the long-term average annual duration of flows exceeding the critical threshold of 24,000 ML/day has approximately halved, declining from a mean of 39.4 days/year (1980–2015) to 20.8 days/year (2015–2026). As a result, since 2003 the lagoons have only filled during major flood events, notably in 2010, 2016 and 2021–2023 when unregulated and pre-spill releases (allowing the flow constraint to be exceeded) from Lake Hume occurred.

This reduced frequency and duration of inundation has not only likely to have diminished ecological values but has also limited opportunities for Traditional Owners to engage with the wetland in accordance with cultural practices that depend on water presence and seasonal cycles.

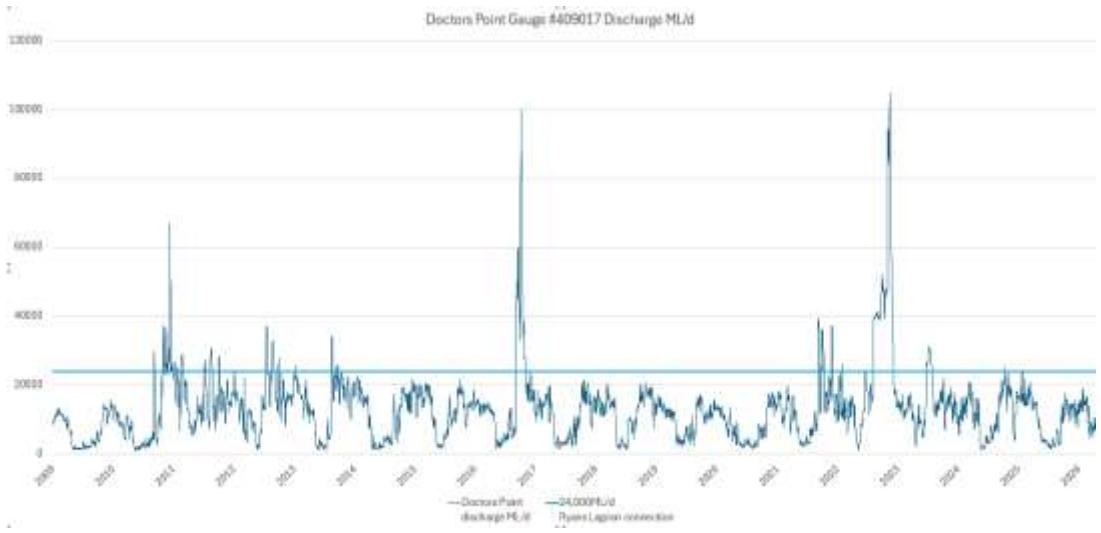

Figure 2 Daily mean (max) discharge on the Murray River at Doctors Point (409017) from 01/09/2009 to 01/04/2026. Light blue line representing flow threshold required to provide commence to flow for both Lagoon 1 and 2

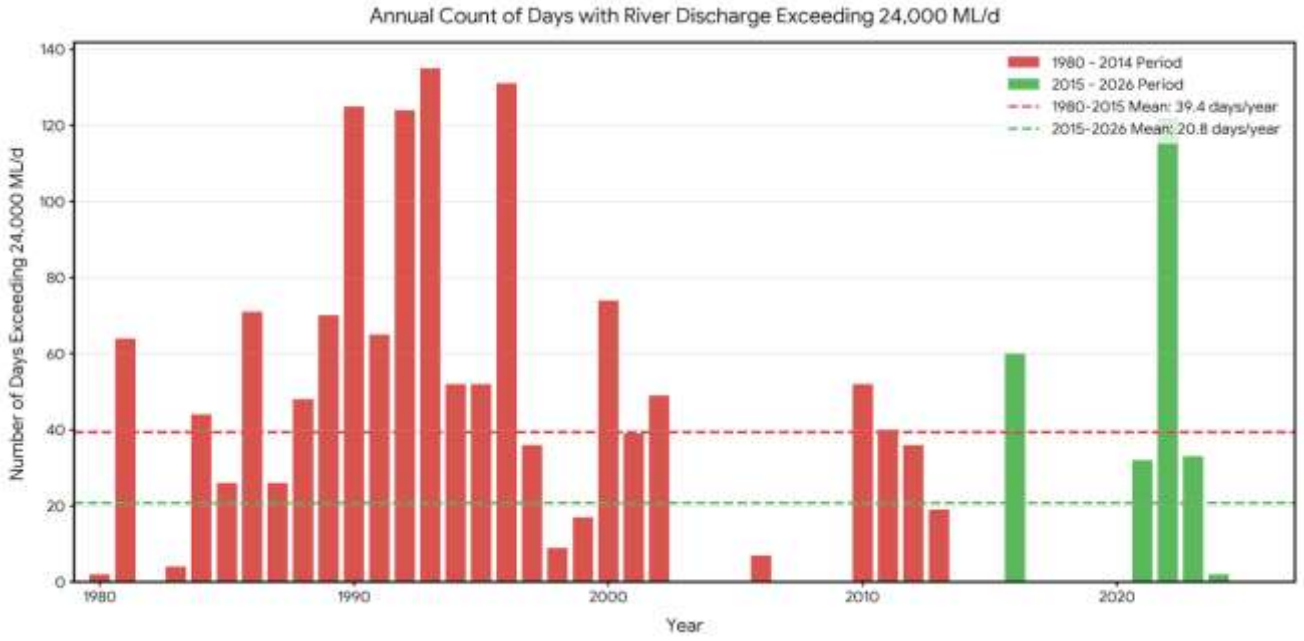

Figure 3 Annual frequency of threshold exceedance for the Murray River at the Doctors Point gauge (MDBA gauge 409017, 1980-2026). Bars represent the total number of days per calendar year that discharge surpassed 24,000 ML/d, the critical flow required to initiate wetland inundation. Horizontal dashed lines indicate a near-halving of the long-term average, dropping from a mean of 39.4 days/year (1980-2015) to 20.8 days/year (2015–2026)

Options assessments

A number of options were assessed, primarily through the development of a TUFLOW hydraulic model by Water Technology in 2023, which was updated in 2025. The inputs to this model are displayed in Figure 4.

Figure 4 Datasets used in the updated TUFLOW modelling (Water Technology, 2025)

The assessment of options included the following:

Modification of existing connection

Water Technology (2024) assessed options to improve hydrological connectivity, including replacing the existing culvert with a 1200 × 300 mm box culvert, removing the levee, and regrading the inlet channel. In combination, these measures could enable flows of approximately 17,000 ML/day from Lake Hume (measured at the Heywoods gauge) to be delivered into Lagoon 1. However, flows of this magnitude typically occur only during the irrigation season (December–March), which does not align with optimal wetland filling period in late winter and spring. Lagoon 2 is more elevated than Lagoon 1, requiring a higher water level (discharge) in Ryans Floodway to initiate filling of Lagoon 2. Modelling indicates that filling Lagoon 2 via these same modifications would require flows exceeding 24,000 ML/day. Such flow magnitudes are both operationally constrained and infrequent, and even when achieved, must be sustained over extended durations (10–20 days) to produce meaningful inundation outcomes (Water Technology, 2024).

Reinstating flow paths

The potential to provide connection via an existing flow path (Lagoon 2 tributary in Figure 5) was assessed by North East CMA and Water Technology in 2023. This option would require investment in new infrastructure at multiple blockages (up to 12 sites) on predominantly private land to upgrade and maintain access crossings. Given the significant cost and landholder support challenges, and with the availability of alternative delivery options via Ryans Floodway, further investigation of the Lagoon 2 tributary was not considered worthwhile.

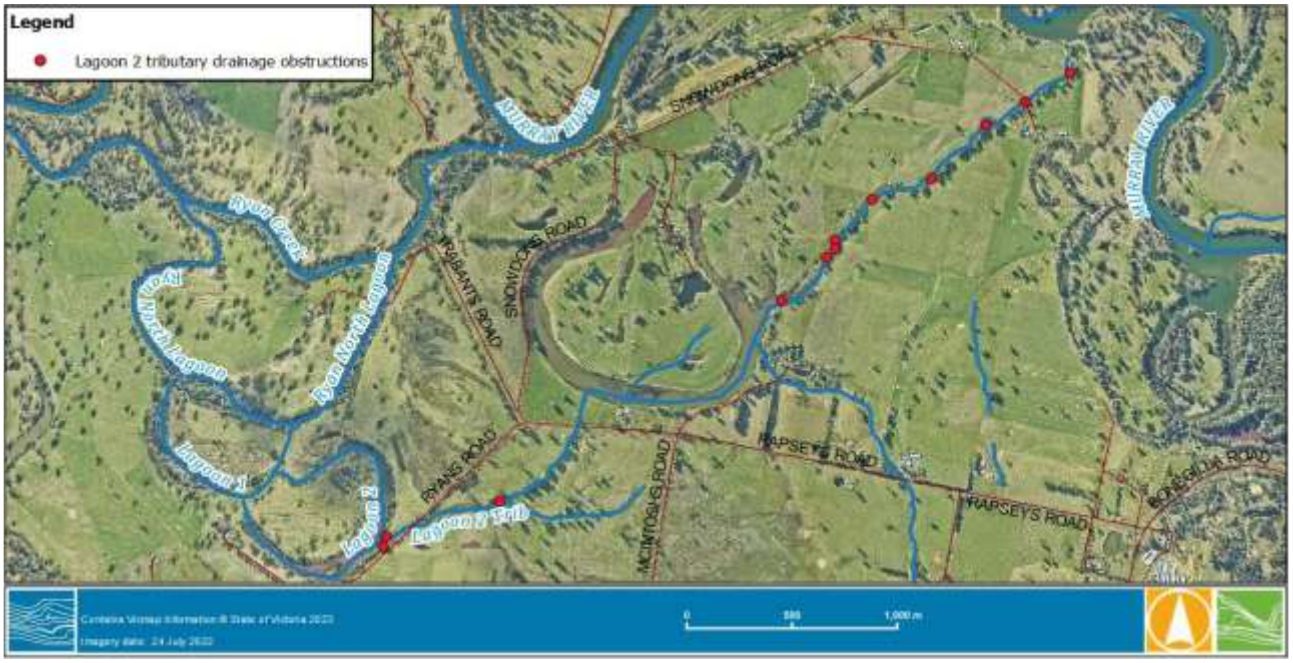

Figure 5 Potential drainage obstructions into Lagoon 2

Gravity fed option (regulator and channel)

This option involved the construction of a regulating structure in the Ryans Floodway and a new channel to enable gravity-fed flow into Lagoon 2. Hydraulic modelling indicated that a direct gravity-fed connection between Ryans Floodway and Lagoon 2 is not feasible (Water Technology, 2025). The invert level of Ryans Floodway is approximately 152.2m AHD, while the invert of Lagoon 2 is 1 m higher, at 153.2 m AHD. As a result, a direct connection would only allow flows to enter Lagoon 2 when discharges exceed approximately 17,000 ML/d and even flows of 25,000 ML/d are insufficient to fully fill Lagoon 2.

Flows above 25,000 ML/d exceed current operational constraints. Flows capable of generating sufficient hydraulic head are infrequent and generally associated with flood events, which may already have the capacity to naturally inundate the site.

Pump options

Recent watering experience via a temporary pump demonstrated water can be pumped into Ryans Lagoon 2 from the Ryans Lagoon Floodway. This requires releases from Lake Hume (measured at Heywoods) to exceeds 12,000 ML/day to enable flows to spill over Ryans Weir on Ryans Creek, subsequently filling Ryans Floodway to a sufficient depth to support pump operation and recharge.

This lower flow threshold should enable delivery during late winter and spring. This aligns with key ecological processes, including vegetation recruitment, waterbird breeding, and amphibian activity, while reducing risks associated with high summer temperatures and hypoxic conditions

Three pump options were assessed by Water Technology (2025) which are summarised in Table 1. Of the options assessed, an electric pump powered by mains electricity provides the optimal balance of cost, reliability, automation, and environmental performance, while diesel pumping remains a fallback option and solar pumping is constrained by high capital cost and limited operational flexibility.

Table 1 Summary of pump option analysis

Pump Type	Strengths	Limitations	Outcome
Diesel Pump	• Proven, flexible, and relatively simple to implement • Low capital cost • Can respond to flow conditions without reliance on grid or weather	• High operating costs (fuel, maintenance, labour) • Limited automation and high operational input required • Environmental impacts (emissions, noise, spill risks)	Viable as a short-term or fallback option, but less favourable long-term due to high costs, environmental impacts, and operational burden
Electric Pump (Mains Power)	• Lowest overall cost (capital + operating) • Highly reliable with long run times and easy automation • Low noise, lower emissions than diesel, smaller footprint than solar • Strong performance aligned with water availability	• Requires mains power connection and approvals • Exposure to power outages and energy price variability	Preferred option; performs best across cost, operability, environmental impact, and watering effectiveness
Solar Pump	• Lowest operating costs • Minimal emissions • Strong sustainability credentials	• High capital cost (~double other options) • Limited to daylight operation (batteries could be added, but cost even more prohibitive) • Large footprint (~150 solar panels) and weather variability risk	Less favourable overall; high capital cost and operational limitations outweigh sustainability benefits

Integrated cultural and land management outcomes

Restoration of Ryans Lagoon is being delivered through a partnership between North East CMA, Duduroa Dhargal Aboriginal Corporation (DDAC) and other stakeholders, with Traditional Owners playing a central role in stewardship and decision-making.

Environmental water delivery is a critical component of this approach. For DDAC, water is fundamental to landscape function and cultural continuity: *"Water is Life. Without water we are nothing… Rivers, streams, wetlands and floodplains are all equally important."* The return of water to the lagoons supports habitat for culturally important species, the regeneration of wetland plants used for traditional purposes and opportunities for On-Country learning and knowledge transfer.

The site is increasingly used for cultural education, workshops and youth engagement activities, strengthening connection to Country while supporting emerging career pathways in land and water management. This integrated model demonstrates how environmental watering infrastructure can enable both ecological restoration and culturally led landscape management outcomes. The Ryans Lagoon project demonstrates how Traditional Owner-led stewardship can be integrated with environmental water management, delivering outcomes that extend beyond biodiversity to include intergenerational knowledge transfer, cultural renewal, employment, and community wellbeing.

It represents a practical example of applying Traditional Owner knowledge and practices in contemporary water management, consistent with regional and state policy objectives for self-determined First Nations-led environmental management.

Ecological outcomes

Environmental watering at Ryans Lagoon in the Spring of 2024 and again in 2025, has resulted in clear ecological responses, demonstrating rapid reactivation of floodplain wetland processes. Vegetation monitoring showed shifts toward wetland-dominated communities, with increased cover of amphibious and native wetland species in inundated areas and suppression of terrestrial species, despite short-term declines in species richness associated with post-inundation transitions. River Red Gum condition improved across much of the site, with increases in crown extent and density and a marked rise in reproductive activity, indicating enhanced tree vigour under restored soil moisture conditions. These responses were most pronounced where inundation was achieved, confirming the importance of water delivery in driving vegetation outcomes.

Frog monitoring recorded an increase in species richness from six species in 2023 (unwatered but after flooding) to eight in 2024 (watered), along with substantially higher calling activity and the presence of species only detected following inundation, indicating the creation of suitable breeding habitat (Durkin, 2025). The EPBC-listed threatened Sloane's Froglet (*Crinia sloanei*) has also been recorded at the site.

Increased waterbird abundance and diversity and the presence of culturally significant species such as freshwater turtles were also observed. Collectively, these outcomes indicate that even partial and short-duration watering can reinstate key habitat provision, vegetation recruitment and faunal breeding—although longer-term and repeated watering will be required to consolidate these gains and support sustained ecological resilience.

Conclusion

The Ryans Lagoon case study highlights a broader challenge across regulated floodplains, where ecological objectives are often misaligned with achievable flow regimes under current operational constraints. In this context, engineered water delivery provides a practical mechanism to restore wetland function. At Ryans Lagoon, this approach has demonstrated capacity to deliver not only ecological benefits but also support Traditional Owner aspirations for restoring water to Country and enabling cultural practices linked to wetland systems. Importantly, the project shows that infrastructure solutions can be designed to complement natural and cultural landscape conservation.

Permanent environmental water delivery infrastructure which includes an electric pump, permanent pipeline and integrated fish screening has been funded by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) and the Department of Energy, Environmental and Climate Change (DEECA) for the Ryans Lagoon Conservation Nature Reserve. The permanent infrastructure will replace temporary diesel pumps previously used to delivery water for the environment to Ryans Lagoon wetlands; due to be constructed later in 2026. The infrastructure is intended to be used for the delivery of an annual environmental water entitlement from the Ryans Floodway to the Ryans Lagoon wetlands. It also provides the ability to deliver cultural water in the future, supporting ongoing cultural values and practices.

Acknowledgements

We acknowledge the organisations and groups whose ongoing work in and around the wetlands complements environmental water deliveries and helps protect, restore and enhance this unique environment for future generations. We recognise the commitment of Duduroa Dhargal Aboriginal Corporation (DDAC), Parklands Albury Wodonga (PAW), North East Water, the Department of Energy, Environment and Climate Action (DEECA), Department of Climate Change, Energy, the Environment and Water (DCCEEW), the Victorian Environmental Water Holder (VEWH), the Commonwealth Environmental Water Holder (CEWH), La Trobe University, Turtles Albury-Wodonga, BirdLife Australia,

and the many other partners, volunteers and community members who continue to support and fund this important work.

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