



Victorian Mallee Irrigation Region Land and Water Management Plan / 2020–29



Acknowledgements

The Mallee Catchment Management Authority (CMA) acknowledges and respects Traditional Owners, Aboriginal communities and organisations. We recognise the diversity of their cultures and the deep connections they have with Victoria's lands and waters. We value partnerships with them for the health of people and country. The Mallee CMA Board, management and staff pay their respects to Elders past and present, and recognise the primacy of Traditional Owners' obligations, rights and responsibilities to use and care for their traditional lands and waters.

A Steering Committee involving key regional partners was established to oversee the development of this Victorian Mallee Irrigation Region Land and Water Management Plan.

The committee was chaired by Tony Martin, Mallee CMA Board member, and had community representation from: the Mallee CMA Board, Mallee CMA Land and Water Advisory Committee and the Mallee CMA Aboriginal Reference Group; and agency representation from Lower Murray Water; Grampian Wimmera Mallee Water; Agriculture Victoria; the Department of Environment, Land, Water and Planning; and the Mallee CMA. The project was also supported by the management and staff of the Mallee CMA.

The Victorian Mallee Irrigation Region Land and Water Management Plan was supported by the Mallee CMA, through funding from the Victorian Government.

Image Credits

- 1 Almond and orange orchards.
- 2 Centre pivot.
- 3 Private divertor pumps.
- 4 Irrigated agriculture next to the Murray River.

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Victorian Mallee Irrigation Region Land and Water Management Plan 2020-29

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Preface

With such an intensive industry reliant on water, it is essential that we manage it sustainably.

Our region has a long association with horticultural irrigation that predates the commonly accepted founders of irrigation, the Chaffey Brothers of the 1880s. Early explorers recorded observations of Aboriginal horticulture in the Murray-Darling Basin with accounts of planting, irrigating and seed harvesting. While the history of horticultural irrigation is long, the last 20 years have seen the modern-day irrigation area within our region more than double in size to over 80,000 hectares.

The Victorian Mallee irrigation region produces approximately \$1 billion annually in agricultural production, making our region one of the most productive in the State and the Murray-Darling Basin. This production is generated from less than 5% of the region's arable land, delivering substantial economic and social benefits. With such an intensive industry reliant on water, it is essential that we manage it sustainably. Critically, we must deliver water-efficient practices and effectively manage the risks to our environment, cultural heritage and the Murray River, to ensure the social licence to irrigate is maintained and supported, particularly in times of climate change and water constraint.

Since the development of the community-driven salinity management plans of the 1990s, which established a far-reaching salinity management framework, our region has been at the forefront of salinity management. It is this framework which has improved Murray River water quality while supporting irrigation development, a task initially seen as optimistic. We have clearly shown that with careful management you can have both.

The Mallee Catchment Management Authority (CMA) recognises and seeks to maintain the momentum of previous plans through the development of the Victorian Mallee Irrigation Region Land and Water Management Plan.

The plan seeks to rehabilitate degraded floodplains impacted by irrigation and river operations. Importantly, it aims to support Aboriginal partnerships, mutual awareness and encourage the irrigation community to be forward-looking and resilient.

An extensive consultative process was undertaken in developing this plan, with stakeholder input integral in identifying actions that meet local priorities and align with government policy, to refine the salinity management framework and renew the effort to protect landscapes and water quality in the Murray River. I wish to thank everyone who provided comment, attended workshops and meetings, and made individual submissions throughout this process.

All sectors of our community including individual land managers, industry and community based groups, along with government agencies and authorities are fundamental to the success of this Plan. It will only be through sustained and collaborative efforts that our aspirations for the region's irrigated agriculture can be realised.

The Mallee has a proud history of identifying and addressing key natural resource management issues through practical solutions and effective partnerships. This capacity continues to be a vital resource for the region, and one which I believe can be further enhanced through implementation of this Victorian Mallee Irrigation Region Land and Water Management Plan.



A handwritten signature in black ink that reads "Sharyn Peart".

Sharyn Peart
Board Chair
Mallee Catchment
Management Authority
December 2020



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Part 1

Our vision, objectives and targets

The Victorian Mallee Land and Water Management Plan's (LWMP's) vision and objectives are designed to align with the Victorian Sustainable Irrigation Program (SIP) and give effect to the Mallee Regional Catchment Strategy (RCS). This approach ensures the overarching State program and regional priorities are central to the development, implementation and evaluation phases of the LWMP.

The LWMP vision is:

Healthy, productive irrigation communities actively avoiding or minimising environmental impacts.

Table 1 below, gives guidance on how this vision will be achieved. The objectives within further define the strategic directions for land and water management in the Victorian Mallee Irrigation Region while also helping to guide priorities for action.

These objectives are:

A forward looking, resilient and water use efficient irrigation industry maximising productivity from available water;

An aware irrigation community avoiding or minimising negative effects on the region's natural and cultural landscapes; and

An engaged irrigation community encouraged to be collaborative and innovative.

A range of targets set quantitative measures for the region's progress towards the vision and objectives over the life of the plan. Collectively, the vision, objectives and targets set out the plan's program logic.

Table 1 | Program logic for the Victorian Mallee Irrigation Region Land and Water Management Plan.

VISION	Healthy, productive irrigation communities actively avoiding or minimising environmental impacts							
Objectives	A forward looking, resilient and water use efficient irrigation industry maximising productivity from available water		An aware irrigation community avoiding or minimising negative effects on the region's natural and cultural landscapes			An engaged irrigation community encouraged to be collaborative and innovative		
Resource Condition Targets	An increase in community involvement in actions to deal with low and variable water availability	Improve the community's adaptability during low and variable water availability	Increase in sustainable water delivery methods to irrigated properties	Increase in uptake of best management practice and continual improvement of irrigation management on existing developments	Maintain protection of quality of irrigation region's water resources through management of groundwater infiltration and drainage disposal	Monitor the cumulative effects of irrigation water use in the region in order to evaluate and report on those effects and to identify cost-effective options for improvement	An increase in community understanding and management of the impacts of irrigation on the region's natural, productive and cultural landscapes	
Management Outcome Targets	An increase in target audiences' awareness and understanding	An increase in target audiences' skills and participation/adoption	Cultural heritage values are maintained	Groundwater resources are managed for optimum benefits	Recovery in landscapes impacted by irrigation induced salinity or offset areas established.	An increase in best management practices implemented	Continued compliance with basin salinity obligations	An increase in the uptake of biodiversity requirements integrated into regional and on-farm irrigation planning

Part 2

About the plan

The long history of irrigation throughout the world provides ample evidence that irrigation communities must constantly guard against the potential negative side-effects of waterlogging, land salinisation and water salinisation if they are to remain sustainable.

Since the late 1980s, Victoria has evolved a series of salinity, and more recent land and water management plans (LWMPs), tailored to each of its major irrigation regions. They guide and evaluate government investment aimed at delivering sustainable productive irrigated agriculture. They also help agricultural communities adapt to reduced water availability, climate change, and global market forces. The plans to date have been remarkably successful in helping communities adjust to these changes, but LWMPs must continue to evolve to take account of changing community expectations, new knowledge, changes in technology and changes in irrigation practices.

LWMPs set out how irrigation regions across Victoria identify community requirements and prioritise actions to meet Government objectives, implement policy and comply with regulations. Victoria's LWMPs are predominantly funded and overseen by the Victorian government through the Sustainable Irrigation Program. They are regionally developed plans that set out objectives and actions to deliver sustainable irrigation in Victoria's catchment management areas. It is a partnership approach between regional communities, catchment management authorities (CMAs), rural water corporations and State government agencies including the Department of Environment, Land, Water and Planning (DELWP) and Agriculture Victoria (Ag Vic).

This Victorian Mallee Irrigation Region LWMP is a sub-strategy of the Mallee Regional Catchment Strategy (RCS). As shown in Figure 1, the LWMP integrates with the Mallee RCS, with other Victorian programs and the Murray-Darling Basin Authority's (MDBA) Basin Salinity Management Strategy 2015–2030 (BSM2030).



Merbein Cluster Box.

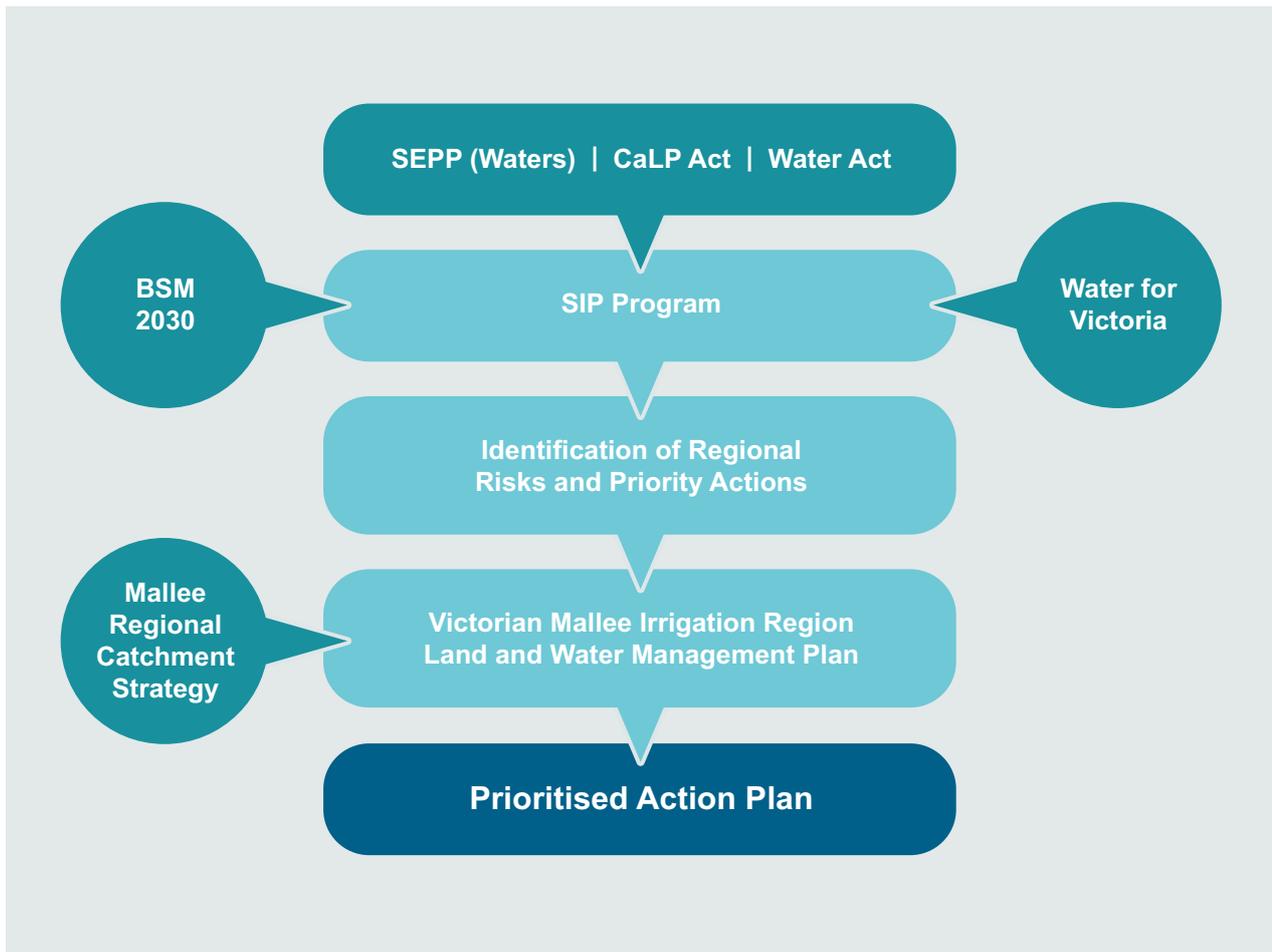


Figure 1 | The LWMP is integrated with other regional strategies and plans.

The Mallee LWMP provides the strategic framework for determining priority investment in works and measures to achieve the plan’s vision and fulfil its objectives. It:

- provides the accountability framework that ensures public funds are targeted to actions that align with government and local priorities;
- demonstrates how actions are delivering on agreed objectives and irrigation management priorities; and
- establishes how outcomes are monitored and reported to demonstrate the benefits of the program to the community and government.

2.1 Purpose and scope of this Land and Water Management Plan

The purpose of the Victorian Mallee Irrigation Region LWMP is to identify community requirements and prioritise actions to meet Government objectives, implement policy and comply with regulation. To achieve the LWMP vision and comply with the purpose calls for planning that builds on past achievements, considers key threats and opportunities, accounts for government directions and partners with community. Developed in partnership with regional stakeholders, the LWMP will be implemented over a ten year timeframe (2020-2029) with a five year review to evaluate performance and inform the next iteration in 2030.

The LWMP covers all irrigated areas and all areas affected or potentially affected by Irrigation in the Mallee CMA Region. As shown in Figure 2, it covers a 25km strip along the Murray River (on the Victorian side) and the Murrayville Groundwater Management Area.

It is important to note however, that while the LWMP strives to protect the quality of the associated water resources, it does not include the management of those resources. That work is done at the state level and is done in the context of the Murray-Darling Basin Plan (the Basin Plan) and the Murrayville Groundwater Management Area Local Management Plan.

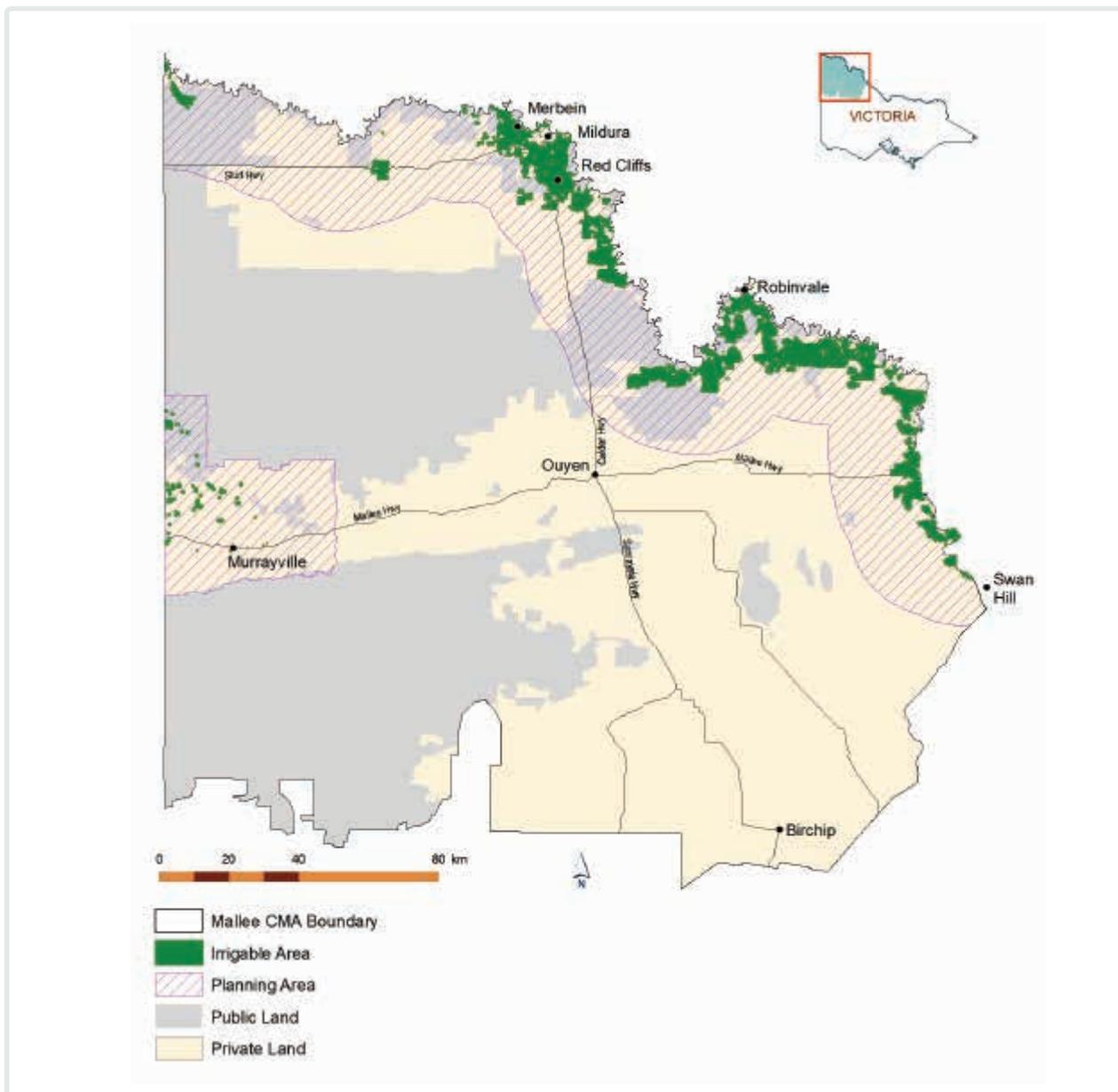


Figure 2 | Area covered by the Victorian Mallee Irrigation Region LWMP.

2.2 History of the Land and Water Management Plan

The LWMP 2020-29 recognises and builds on the achievements of the Victorian Mallee Irrigation Region LWMP 2011-2019, the 2006 Draft Victorian Mallee Salinity and Water Quality Management Plan and the Nangiloc-Colignan, Sunraysia and Nyah to the South Australian Border Salinity Management Plans, which were released in the 1990s.

The original salinity management plans of the 1990s focussed on addressing the causes of salinity and establishing the Victorian Mallee salinity management framework, which is still the basis for the current approach. The LWMPs of the 2000s focused on

irrigation, water use efficiency, modernisation and continuous improvement.

This plan maintains the momentum of previous plans. It strives for continuous improvement in the adoption of best management practices for irrigation. It refines the salinity management framework by updating salinity models and reviewing salinity offsetting charges. It renews efforts to mitigate or offset the environmental impacts of irrigation and river operations. It helps meet Victoria's obligations under the BSM2030. It refocuses support for Aboriginal partnerships and encourages the irrigation community to be forward looking and resilient.

2.3 Achievements of the Land and Water Management Plan 2011 – 2019

The previous LWMP set out to increase community awareness of, and involvement in, regional actions to deal with low and variable water availability. While some irrigators remain confused about some aspects of Victoria's water entitlement framework, irrigators at large have become increasingly sophisticated in using the water market to deal with low and variable allocations.

Irrigators have an ongoing responsibility to keep themselves informed about the water market and their carryover options. Water corporations and DELWP support them by providing information to assist in keeping abreast of water market developments and options. As will be discussed in more detail in Section 2.5, a key challenge is how to respond to the difficulties involved in delivering water to all Victorian Mallee irrigators during sustained heatwaves.

The LWMP 2011-2019 was successful in ensuring the continued coordination and monitoring of irrigation development through the implementation of the Victorian Mallee Irrigation Development Guidelines. It helped to ensure continual improvements in water use efficiency for existing irrigated horticulture through increased community awareness and providing incentives to encourage the adoption of technologies that increase irrigation efficiency and decrease salinity. This objective is ongoing, but the priorities for this LWMP have been informed by a range of other investigations including a review of the Mallee Irrigation Incentives Program (MCMA 2018a) and An Assessment of Irrigation Best Practice in the Victorian Mallee (Hornbuckle & Ballester 2019).

The LWMP 2011-2019 also sought to maintain improvements in river salinity and groundwater levels by meeting obligations under Federal and State Water

legislation and Basin Salinity Management Strategy 2001-2015. A 2015 review of drain flow and groundwater monitoring data found that the past plans were extremely successful in managing and minimising the impacts of irrigation and drainage in the region. A number of key targets and objectives have been achieved, including:

- reducing drain flows and salt loads;
- increasing the uptake of efficient irrigation practices; and
- guiding new irrigation development to areas where river salinity impacts are minimised.

While the basin salinity management obligations are being met, and the past plans were very effective in reducing salinity, the threat remains. Highly saline groundwater levels are still above river level at a number of locations, which drives groundwater and salt towards low areas in the landscape, floodplains and the Murray River thereby causing ecological degradation and river salinity.

During the life of the last LWMP, BSM2030 superseded the Salinity Management Strategy 2001-2015. That resulted in the future salinity impacts of environmental watering being managed at the basin scale rather than the regional scale envisaged by the previous LWMP. Similarly, all other aspects of environmental watering are now covered through the Mallee Waterway Strategy 2014-22.

The LWMP 2011-2019 helped to improve community awareness of natural and cultural assets, their values and the threats posed by irrigation. There is more work to be done in this regard, but as will be discussed in the next section, there are new policy directions and clear advice to help ensure this comes into practice.



Grapes grown in Sunraysia.

2.4 New policy directions

This LWMP should be understood in the broader context of the planning framework that applies throughout Victoria. Since the LWMP 2011-2019 was completed, the Victorian Government has provided new policy directions and clear advice on what it wants to achieve through its water and environmental policies and legislative changes. These are reflected in:

- *Water for Victoria: Water Plan*;
- *Water and Catchment Legislation Amendment Act 2019*
- *Victoria's Climate Change Framework*;
- *Victoria's Climate Change Adaptation Plan*;
- *the State Environment Protection Policy (Waters)*;
- *Victorian Waterway Management Strategy*; and
- *the Guidelines for Preparing Land and Water Management Plans*.

These planning directions are augmented by a new concept for Victoria's environment protection laws – the *General Environmental Duty* – which is set to transform environment protection regulation. The General Environmental Duty states:

“A person who is engaging in an activity that may give rise to risks of harm to human health or the environment from pollution or waste must minimise those risks, so far as reasonably practicable.”

The new state-wide planning directions help guide the LWMP to:

- Respond to climate change by building climate resilience into irrigation farming systems;
- Mitigate or offset salinity impacts of irrigation;
- Improve productivity to optimise the returns from irrigation water use;
- Improve water quality and minimise salinity risks in Mallee landscapes;
- Increase Aboriginal and irrigation community understanding and management of irrigation risks; and
- Support a healthy environment, a prosperous economy and thriving communities.

These state-wide planning directions have influenced and are reflected in this LWMP's objectives, targets and programs. The LWMP also seeks to be adaptive and capable of responding to external pressures. Rather than focussing only on performance against targets, the annual progress reports will also include a description of the changes brought about by external factors such as the Basin Plan, commodity prices, and storage inflows. This will enable the five-year review process and the LWMP renewal process to be flexible and to adjust its recommendations in line with emerging risks.

2.5 Future changes, challenges and opportunities

This LWMP focuses on the changes, challenges and opportunities that the Victorian Mallee irrigation region is likely to experience over the next ten years. In order to show how the identified issues are connected, this plan groups them together for ease of understanding into five subsections:

- 1 Dealing with low and variable water availability and deliverability;
- 2 Ensuring sustainable water delivery methods to irrigated properties;
- 3 Increasing the uptake of best management irrigation practices;
- 4 Protecting the quality of the region's water resources; and
- 5 Monitoring the cumulative effects of irrigation water use.

The sequence of these sub sections, in essence, follows the water downhill from the storages to the pumps that divert the water for delivery on farms, from the pumps to the irrigated crops, and then from the crops down through drainage systems, and groundwater recharge, into the river or into Mallee floodplains where there is a growing awareness of the level of salt accumulating in the landscape and the need for action.

Considering water deliverability issues

The LWMP addresses Victorian Mallee irrigators' concerns about water deliverability issues and how best to adapt to drought and climate change risks by building irrigator resilience.

Similarly, it considers risk that the total irrigation requirements of existing horticultural plantings, once they mature, may exceed the total volume of water available at 100 per cent allocations. In this context, it also considers how to minimise or avoid the risk of non-compliance with the regulations governing water use.

The Victorian Minister for Water issued a direction to Lower Murray Water and Goulburn-Murray Water to refer all Murray River Work (extraction) Licence applications in the lower Murray River to the Minister for assessment for a 12 month period from June 2019. In light of this, this LWMP considers how to address the limits to water delivery below the Barmah Choke, while also considering how to account for delivery capacity under the new irrigation development guidelines. This is done in ways consistent with how water corporations are managing delivery shares within irrigation districts. The aim is to support irrigators' access to water when they need it.

Minimising environmental impact of water diversions

The environmental impacts of water diversion are also considered. For example, the LWMP looks at opportunities to minimise the impacts on fish populations from irrigators' suction lines. It seeks to ensure that the Victorian Mallee Irrigation Development Guidelines regarding works licences remain relevant and contemporary. Ongoing reviews of work licences conditions will help to minimise their environmental footprint and to address cultural heritage and environmental obligations. They will also help to maintain irrigators' social licence to operate by reassuring the general community that irrigation diversions in the Victorian Mallee are being well managed.

The LWMP 2020-2029 also ensures that the irrigation development guidelines regarding water-use licences remain relevant and contemporary. In doing so they ensure that Ministerial Water-use Objectives, Standard Water-use Conditions and Policies for Managing Water-use Licences in Salinity Impact Zones or any Ministerial Determinations made in relation to salinity are reflected in licence conditions.

Compliance with water use licence conditions needs to be maintained so that irrigators can continue to assure the broader community that their activities make an important contribution to the economy while minimising or avoiding environmental impacts. This is particularly important with regard to compliance with individual Irrigation and Drainage Plans. The cumulative impacts of increased water use in the Victorian Mallee will also be monitored in order to consider whether there is any need to modify or amend those conditions.

Establishing a resilient irrigation community

The LWMP builds on contemporary knowledge to support irrigation modernisation, productivity improvements, climate change adaptation and irrigator awareness of opportunities and challenges. The aim is to build a resilient irrigation community in a potentially changing climate and to ensure seasonal adjustment processes for the annual use limits on water use licences remain relevant and contemporary.

Addressing landscape salinity impacts

At a broader regional scale, it is important to better understand the risk of waterlogging and its effects on biodiversity, particularly in private diversion areas where the total extent of installed and actively managed drainage is not as well understood as it is in irrigation districts. Similarly, it is important to better understand, monitor and mitigate or offset salt accumulation in the landscape particularly on floodplains due to irrigation and changed river operations. The ability to address landscape salinity impacts, including floodplain impacts, is, therefore, being built into the salinity management

framework. In part, gaining this improved understanding and addressing impacts will involve maintaining and upgrading groundwater monitoring, and irrigation drainage monitoring assets.

Realising biodiversity benefits

The opportunities that spring from previous work in land and water management are also being pursued. For example, the biodiversity buffers and offsetting works that have accompanied each new irrigation development since 1994 need to be better understood as a network of potentially connected corridors. Doing this will help to optimise those biodiversity benefits associated with new irrigation developments.

Recognising and understanding cultural heritage values

Under this LWMP, communication materials and cultural awareness training materials related to Indigenous cultural values, as well as Native Title and the protection of cultural heritage will be further developed for irrigation areas. Collaborative arrangements between irrigators and the First People of the Millewa Mallee, Barengi Gadjin Land Council Aboriginal Corporation as well as other Traditional Owners, will continue to help recognise cultural heritage values in accordance with existing obligations.

Maximising the region's productivity

Finally and importantly, all these biophysical changes, challenges, and opportunities need to be understood in the context of healthy, productive and sustainable Mallee communities. For example, every effort must be made to coordinate and streamline regulatory activities to minimise costs while enabling sustainable and productive irrigation enterprises that empower innovation. Irrigation best management practices that improve returns to the community must be enabled and supported.



Almond blossoms.

Part 3

Development of the Plan



3.1 Regional collaboration

This LWMP is the result of close regional collaboration. It was developed by a Steering Committee comprising representatives from the Mallee CMA Land and Water Advisory Committee, the Mallee CMA Aboriginal Reference Group, Mallee CMA, Grampians Wimmera Mallee Water (GMMW), Lower Murray Water (LMW), DELWP and Agriculture Victoria. Input was also sought, where required, from the Murray-Darling Basin Authority and Goulburn-Murray Water.

3.2 Community engagement

The Mallee CMA released a draft version of this LWMP for public consultation in December 2019 to seek broader community input and feedback to inform this final Victorian Mallee Irrigation Region Land and Water Management Plan. The draft provided an opportunity for the community to help determine what needs to be done to support the continued role of productive and sustainable irrigation in the Victorian Mallee. Consultations closed at the end of February 2020. The feedback received through formal submissions from industry groups and landholders helped to refine this final plan.



Discussing pump sites used for irrigation on the Murray River.

Part 4

Land and water management in the Victorian Mallee



4.1 Traditional land and water management

The Victorian Mallee region has been occupied for tens of thousands of years by Aboriginal people. In fact, the regional geographic term Mallee comes from an Aboriginal word ‘mali’ meaning water, which was extracted from the roots of mallee trees during times of reduced water availability. The region is recognised nationally and internationally for the diversity and uniqueness of its natural and cultural landscapes. In particular, the sheer abundance of cultural sites, stories and song lines which are of deep spiritual significance to the oldest living culture in the world. Traditional Owner groups of the region continue to have an enduring connection to lands, skies, waters, plants and animals.

The Traditional Owner groups of the region include, but are not limited to: Latji Latji; Wadi Wadi; Wamba Wamba; Tati Tati; Jari Jari; Kureinji; Nyeri Nyeri; Ngintait; Ngarkat; and Barengi Gadjin Land Council Aboriginal Corporation – Wotjobaluk, Jaadwa, Jadawadjali, Yupagalk, and Wergaia.

At the time of publishing, there were two Registered Aboriginal Parties in the Mallee CMA Region. The Barengi Gadjin Land Council Aboriginal Corporation in the southern Mallee covers an area that encompasses part of the Murrayville Groundwater Management Area. The First People of the Millewa-Mallee Aboriginal Corporation in the northwest of the region covers an area encompassing the Murray River irrigation areas north and west of Nangiloc.

We also acknowledge the many Aboriginal and Torres Strait Islander people living in the Mallee whose traditional land may be outside the Mallee Region and those whose families have lived in the area for many generations, who are not part of a Traditional Owner group, yet have a strong interest in caring for Country.

Victorian Government agencies and organisations in the Mallee have a proud history of working with Traditional Owners and the Aboriginal and Torres Strait Islander Community to implement a range of plans, projects and programs to improve and protect our natural and cultural resources. This plan continues to promote collaboration between the irrigation community, Traditional Owners and the wider Aboriginal community in the Mallee to protect cultural heritage values and support productive, sustainable and resilient irrigation communities.

The connection to land, water, and resources on Country is important to the health and wellbeing of Aboriginal people. In some cases, reconnecting to water can revive culture and contribute to an improved sense of identity and allow Traditional Owners a voice in land and water management.

Accordingly, this LWMP strives to build the capacity for government agencies, local communities and Aboriginal people to work in partnership to:

- Recognise Aboriginal values of water;
- Include Aboriginal values and traditional ecological knowledge in water planning;
- Support Aboriginal access to water for economic development;
- Build capacity to increase Aboriginal participation in water management.

Our Local, State and Commonwealth Governments, as well as other bodies and agencies, will partner with Registered Aboriginal Parties, Traditional Owners and the Aboriginal Community to ensure that our rich Aboriginal culture and heritage is protected and celebrated, and that Aboriginal traditional ecological knowledge is recognised and can contribute to the success of this LWMP.

4.2 A short history of irrigation in the Victorian Mallee

Modern irrigation in the Victorian Mallee region was established by William and George Chaffey at Mildura in 1887. Government sponsored irrigation districts followed in Merbein (1910), Nyah (1910) and Red Cliffs (1921). The final government-sponsored irrigation district, Robinvale, was developed in 1947.

The first groundwater bore was drilled in Murrayville in 1929 to provide the township with reliable water. Deep well pumps were installed on several properties in the early 1950s to irrigate small dairies, most of which stopped operating in the late 1960s. In the early 1990s irrigation expanded considerably with 515 hectares of potatoes being grown under centre-pivot irrigation and

30 hectares of olives under drip irrigation. In 2018 potatoes accounted for 1,670 hectares, field crops 660 hectares and olives 45 hectares.

Successful private diversion began at Nangiloc in the 1920s, but it started in earnest when electricity was brought to that area in 1957. It expanded rapidly during the 1960s and 70s.

The biggest wave of irrigation development began with the introduction of water entitlement trade in 1994. Since 1997, when the first of the triennial horticultural crop reports was conducted, the total irrigated area in the Victorian Mallee has more than doubled.

4.3 Irrigation today

Irrigation in the Victorian Mallee Irrigation Region extends along the Murray River from Nyah to the South Australian border (see Figure 2). It encompasses the:

- pumped irrigation districts of Mildura, Merbein, Red Cliffs, Robinvale and Nyah;
- private diverters – those families and corporations operate their own pumps and water delivery systems on the riverfront between Nyah and the South Australian border; and
- groundwater-based irrigation developments around the town of Murrayville.

The major irrigated crops in the region are shown in Figure 3. Almonds, 99 per cent of which are grown by private diverters, have become the single largest crop by area and by water demand. While almond plantings continue to expand in the private diversion areas, inside the irrigation districts there has been a resurgence of irrigated grapevines – mostly table grapes.

The total area covered by water-use licences along the Murray was 81,150 hectares in 2018, up from 40,325 hectares in 1997 (and 76,245 hectares in 2015). The total licensed area around Murrayville in 2018 was 2,375 hectares, up from 585 hectares in 1997.

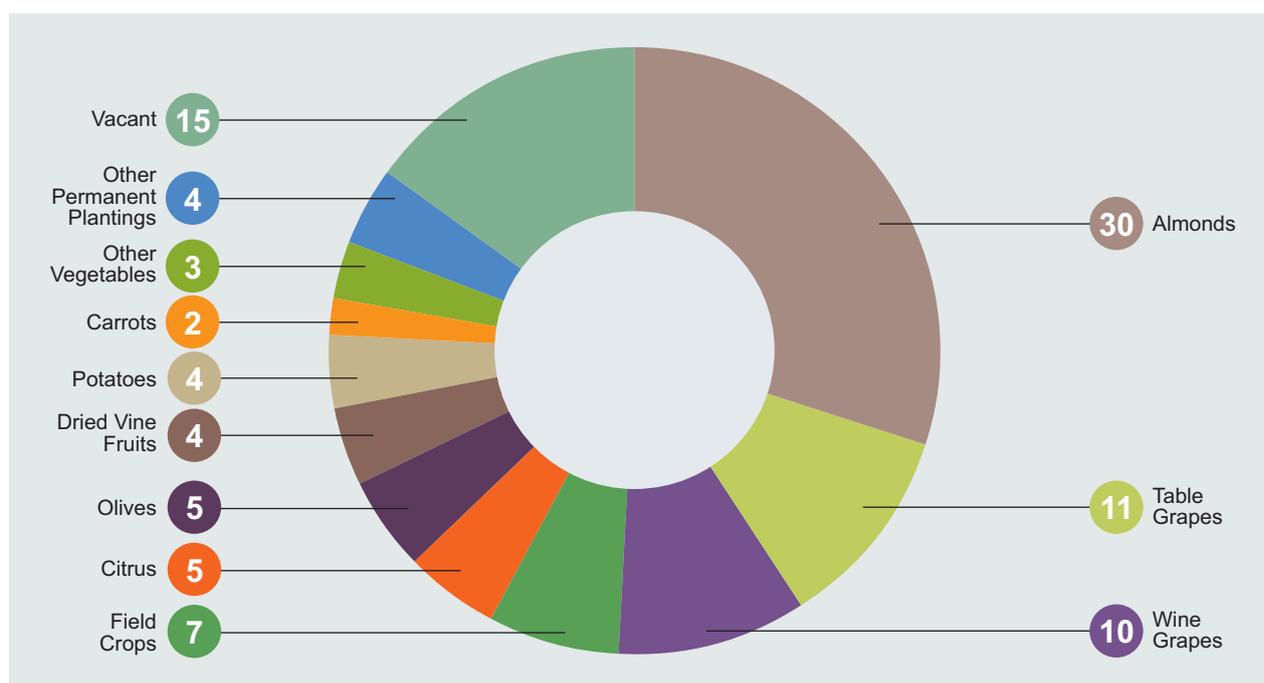


Figure 3 | Major irrigated crops in the Victorian Mallee by area (%), 2018.

4.4 Irrigation values

The Australian Bureau of Statistics estimated the Gross Value of Irrigated Agricultural Production in the Victorian Mallee irrigation Area at \$964 million in 2017/18. This was 20 per cent of the total for the whole of Victoria. The other large contributors were Goulburn-Broken (\$1,328 million), North Central (\$777 million) and Port Phillip and Western Port (\$770 million).

Fruit and nuts (excluding grapes) accounted for 49 per cent of the value of irrigated production in the Victorian Mallee, while grapes accounted for 35 per cent and vegetables 6 per cent.

Even though irrigation only accounts for around two per cent of the arable land mass in the Mallee CMA region, it accounts for 53 per cent of the Gross Value of Agricultural Production, with dryland agriculture accounting for 47 per cent based on 2017/18 data.

4.5 Irrigation threats

At 2,190 millimetres per year, mean annual evaporation recorded at Mildura Airport is in the order of seven and half times greater than the mean annual rainfall of 288 millimetres per year. In such semi-arid environments, salt accumulates in the landscape. This is because the salt dissolved in river and rainwater becomes more concentrated as the water is transpired by crops or evaporated from the soil surface.

Sustainable irrigation depends on salt being leached away from crop rootzones. To do this, some water must be applied in excess of crop water requirements to achieve rootzone drainage. Ideally, rootzone drainage should be kept to a maximum of five to ten per cent of total applied water. Unless it is properly managed, whatever water is applied in excess of crop requirements can cause waterlogging, salinity and nutrient pollution problems.

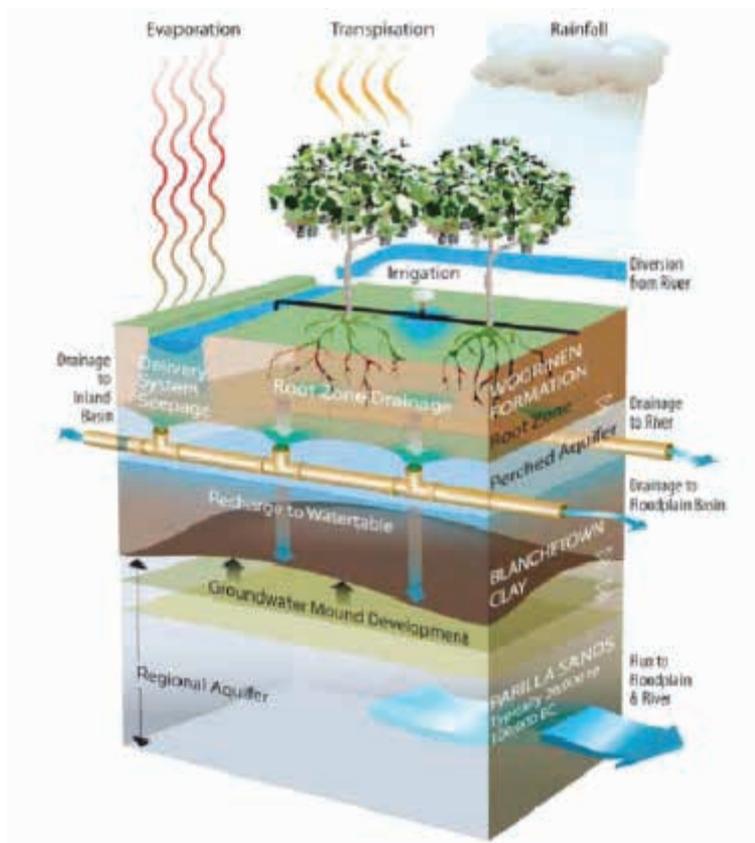


Figure 4 | A schematic representation of the causes and effects of rootzone drainage. (Source – AWE 2015: RISI Review)

As demonstrated by Figure 5, improvements in irrigation management over the past 30 years have decreased subsurface drainage flows to the river, to the floodplain and to inland drainage basins. They have also decreased the groundwater mound under the older irrigation areas, and this, in turn, has decreased saline groundwater flows to the river and the floodplain.

The task for this LWMP is to drive the improvements necessary to keep drainage and rootzone drainage as low as possible well into the future.

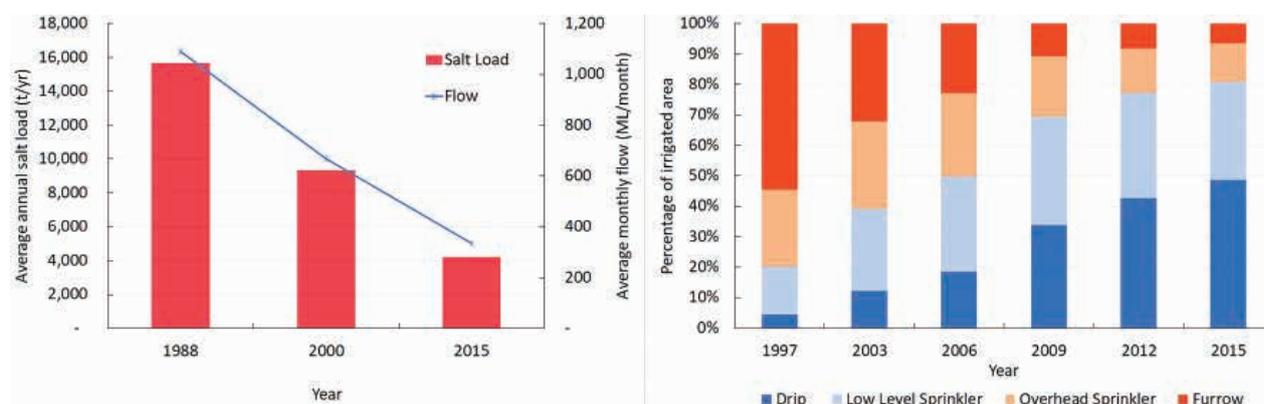


Figure 5 | Mildura, Merbein and Red Cliffs Irrigation Districts a) Average annual salt loads and average monthly flows from sub-surface tile drains, and b) Percentage of total irrigated area watered by irrigation method. (Source – DELWP 2019 Victorian Irrigation Drainage Program).

4.6 Trends in river salinity management

Since the original community driven salinity management plans were put in place, the trend over time, from Swan Hill to Lock 6, has seen a decrease in river salinity and an improvement in water quality (see Figure 6).

connected to the river and dissolve salt accumulated on floodplains. As river levels recede after the flood, the recharged groundwaters recede more slowly and dissolved salts in surface waters drain to the river. Groundwater levels remain above river levels, forcing the saline aquifer to flow slowly towards the floodplain and the Murray River discharging salt.

Within that trend, spikes in salinity are generally seen following major floods, such as 1993, 1999, 2011 and 2016. Floods recharge the saline groundwater aquifers

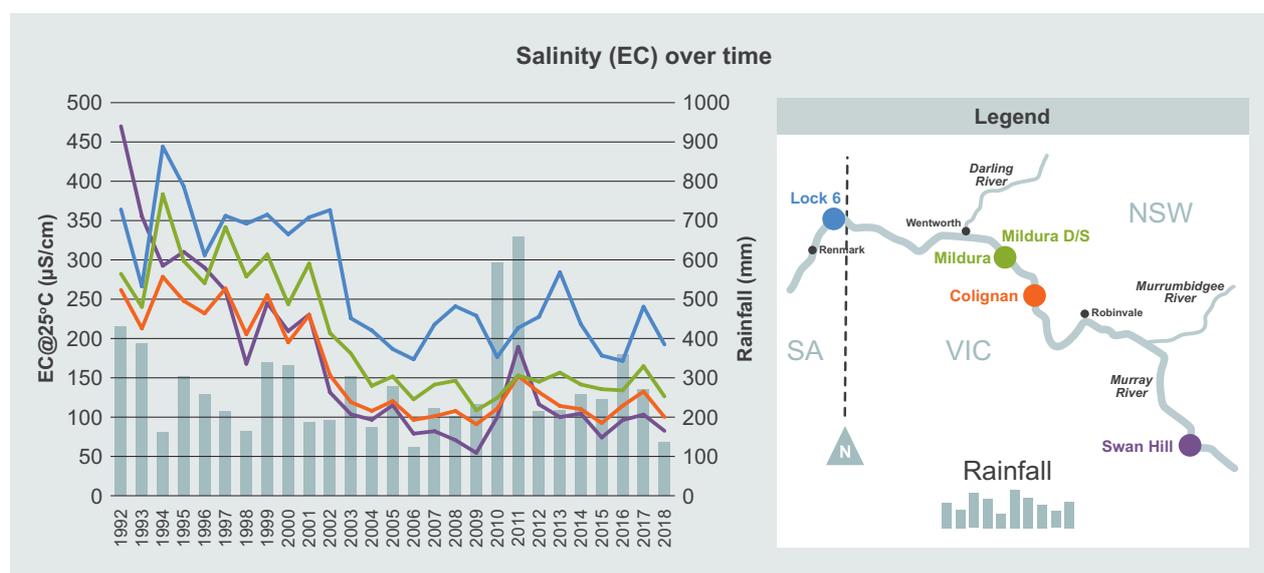


Figure 6 | Changes in Murray River salinity impacts over time.

The background Murray River salinity levels are maintained in a similar way by rootzone drainage. The water that moves past rootzones adds to groundwater levels and forces more salt into the river. A large decrease in salinity can be seen during the Millennium Drought of the early 2000s where there was reduced irrigation supply and substantial investment in improved irrigation efficiencies. This led to a lowering of groundwater levels. Post the Millennium Drought the trend towards reduced salinity continued, reflecting the benefits of the improved more efficient irrigation practices.

The Mallee (NSW, Vic and SA) is recognised as the greatest salinity threat to water quality in the Murray Darling Basin. As demonstrated in Figure 6, salinity

levels increase as water advances downstream. This is because the Murray River as it advances downstream has progressively carved through the impeding clay layer to expose the river to the saline regional aquifer below.

Over the 25-year period shown in Figure 6, the area of irrigation has more than doubled in the Victorian Mallee Irrigation Region. Whilst irrigation development has expanded rapidly, its salinity impact has been more than offset by targeted actions including support for more efficient irrigation methods (see figure 5), salt interception schemes, encouragement of development in low impact zones and a co-ordinated rigorous development assessment process using best practice irrigation development guidelines.

4.7 The challenge of climate change

The Bureau of Meteorology (BoM) describes the climate zone of the Victorian Mallee region as having hot, dry summers and cold winters. BoM identifies the region as lying within a seasonal rainfall zone characterised by a wet Winter and low Summer rainfall.

The future climate of the Victorian Mallee is projected to be warmer than it is today. By 2030, average annual temperatures are expected to be around 0.6 to 1.3°C warmer, with a higher frequency of hot days and longer duration of warm periods. This change will present significant challenges to irrigated horticulture.

While average annual rainfall totals are not expected to be significantly different, rainfall characteristics are expected to change by 2030, with a shift towards

more rain in the warmer months rather than Winter and Spring. Increasing intensity of rainfall events is leading to a high percentage of run-off, resulting in less soil moisture retention. The frequency and duration of drought periods are also expected to increase, and projected changes to temperature and rainfall may result in greater irrigation supply requirements to meet crop water demand and cooling.

Recent examples of weather extremes in the Mallee include the “Millennium Drought” which had severe impacts on the region between 2002 and 2010; and the La Nina rains of the 2010/11 summer that followed the drought and caused significant flooding and widespread property damage. The Murray River also experienced a minor flood event in 2016 in the Victorian Mallee region.



Flooded agriculture from rain event, Red Cliffs, 2011.

Part 5

Water availability and delivery risks framework



5.1 Dealing with low and variable water availability and delivery risks

Irrigators in the Mallee are concerned that continued horticultural expansion in the Mallee regions of NSW, South Australia and Victoria is increasing the risk that river operators will be unable to deliver water to them in a timely fashion during heatwaves. They also want to understand the limits to water availability, and therefore the limits to expansion, and how they will be enforced. There is also concern around the risk of drought and low water allocations in the face of climate change.

of the total volume of water entitlements available for irrigators to use in the Mallee regions of NSW, South Australia and Victoria. Water moves between these regions as a result of the interstate water market that operates in the southern-connected Murray-Darling Basin. That market is framed around trading rules, which governs the trade between different trading zones (Figure 7). The zones are defined in terms of the physical connections between different zones and how freely water can travel through those connections.

5.1.1 Water entitlement volumes available from the Murray system

The volume of water available for irrigation along the Murray in the Victorian Mallee is ultimately a function

The Mallee regions of NSW, South Australia and Victoria are generally treated as being freely connected with each other¹, but they are seen as being relatively isolated from upstream areas because there is a limit to how much water can be traded from upstream to downstream of

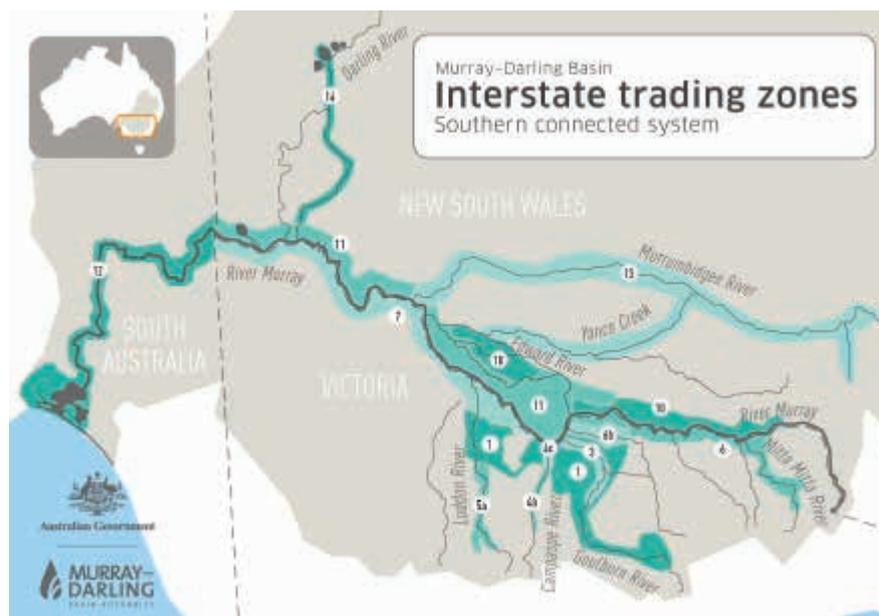


Figure 7 | Trading zones in the southern Murray Darling Basin. (Source: <https://www.mdba.gov.au/managing-water/water-markets-trade/interstate-water-trade>)

¹ There is a limit on trade from NSW to Victoria to mitigate against increased spill risks when Victoria's risk of spill is high.

the Barmah Choke to manage delivery risks. The total volume of high-reliability water entitlement available for irrigation use in each of the Mallee trading zones is shown in Table 2.

In addition to the water entitlements held downstream of the Barmah Choke (Table 2), water can be traded in to the Murray from the Goulburn and Murrumbidgee Valleys. Water managers use Inter-Valley Trade (IVT) accounts to track the traded water that is 'owed' to the Murray and yet to be delivered.

The current Goulburn to Murray trade rule limits the volume of water that can be traded from the Goulburn, Broken, Campaspe and Loddon systems to the Victorian Murray and interstate when the Goulburn IVT account balance is greater than 200 GL. Water is added to the Goulburn IVT account through allocation trade, tagged use and legacy commitments. The legacy commitments can be up to about 140 GL each year – these reflect about 100 GL of legacy “exchange rate” trade of entitlements from the Goulburn to the Murray in the 1990s, and about 40 GL recovered under the Snowy

Water Initiative. A total of more than 300 GL has been delivered from the Goulburn IVT account in some recent years. This resulted in high sustained unseasonal flows and environmental damage to the Lower Goulburn River which prompted the Victorian Minister for Water to announce the Goulburn to Murray trade review. This review is currently underway, with public consultation on proposed new trading rule options due to be commence in late 2020.

The Murrumbidgee IVT account has also in the past supplied significant volumes to the Murray River, most notably at the height of the Millennium Drought (2002- 2010). However, increased plantings of horticultural crops and cotton on the Murrumbidgee means not much water was traded out of the Murrumbidgee in 2017/18 and 2018/19. Nonetheless the high market prices for allocations in the low-allocation 2019/20 irrigation season, did see significant volumes traded to the Murray (156 GL was delivered from the Murrumbidgee IVT account). The Murrumbidgee IVT can have a maximum of 100 GL in it at any given time.

Table 2 | Water entitlements available for irrigation below the Barmah Choke (not including Victorian Zone 7 Low Reliability Water Shares or those held by environmental water holders).

Water entitlements available for irrigation below the Barmah Choke	Total Volume available at 100% allocations (GL)
Victorian Zone 7 High Reliability Water Shares	658
South Australian Zone 12 entitlements	410
NSW Zone 11 High Security Licences	167
NSW Zone 14 High Security Licences	4
Subtotal (for all entitlements available for irrigation in trading zones below the Barmah Choke)	1,239
Goulburn IVT (not including 100 GL legacy of “exchange rate” trade)	100
Murrumbidgee IVT	100
Total	1,439

In the long run, total permanent plantings in the Lower Murray cannot exceed the volume of water that is available below the Barmah Choke.

The best available information about total horticultural plantings below the Barmah Choke comes from the irrigated crop area data for the Lower Murray-Darling 2003 to 2018 (MDBA 2019). It outlines the total plantings in the Mallee regions of NSW, South Australia and Victoria.

Building on that work, in 2019 and further updated in 2020 the Victorian Government released an assessment of water supply and demand from perennial horticulture in the southern Murray-Darling Basin (Aither 2020). It identified increasing challenges for horticultural plantings in the lower Murray region to meet their water needs in

dry years and that any new plantings could exacerbate water supply risks (Figure 8). Irrigated agriculture in the southern-Murray Darling Basin will need to adapt and evolve in response to water availability, commodity prices and industry trends. If irrigated horticulture continues to expand, and existing irrigated horticulture demands do not reduce from industry restructure and transition, there will be increased risk to water supply for existing businesses, and increased competition in the water market.

Given that 186 GL of Zone 7 High Reliability Water Shares were still tied to land in the Torrumbarry Irrigation Area in 2018, and that water use in that district in the same year was 278 GL, it is clear that the competition for water is going to intensify in the future.²

² Updated Trends in Northern Victorian Water Trade 2001-2018, DELWP, 2019 accessed on 11 June 2019 at https://waterregister.vic.gov.au/images/documents/Water-Market-Trends-Update-2018_web.pdf

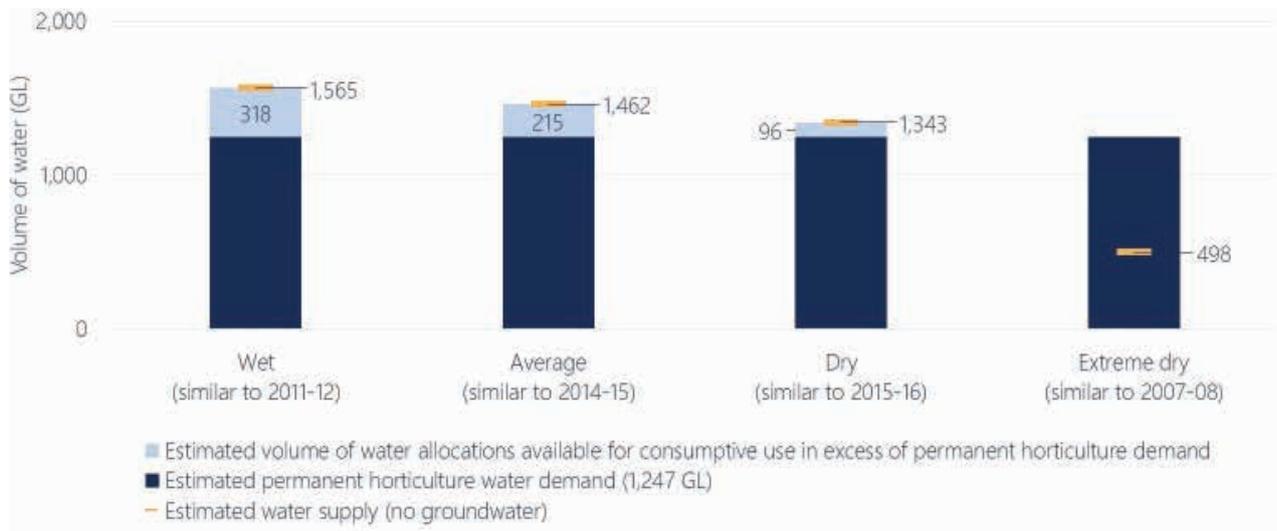


Figure 8 | Water availability scenarios and existing permanent horticulture water demand (permanent plantings at full maturity), lower Murray region. (Source Aither 2020)

Action	Timeframe	Priority	Lead Agency
1. Investigate the relationships between Mallee crop plantings and water availability. Communicate any identified risks.	Short term	High	DELWP, Ag Vic
2. Develop Victorian Mallee Crop Reports on a regular basis to support planning and management.	Ongoing	High	Mallee CMA
3. Encourage the development of a whole of Mallee irrigated landuse crop report.	Short term	High	DELWP

5.1.2 Water availability issues

Victoria's water entitlements offer entitlement holders a share of the water available in the water storages on a particular river system. In wet years entitlement holders receive 100 per cent allocations against their water share. In dry years their allocations are lower. The lowest allocations on record in the Victorian Mallee so far were 35 per cent. The water available for irrigation varies with the weather.

As outlined in the *Mallee Natural Resource Management Plan for Climate Change*, in early 2015 the CSIRO and BoM released updated national and regional assessments of projected future climate changes, compared against the climate of the 20-year reference period 1986-2005, over the remainder of the 21st century. One of the regions they assessed was the Murray Basin.

According to that assessment, there is high confidence that in the Murray Basin in 2030, natural climate variability will remain the major driver of rainfall differences from the climate of 1986-2005. In other words, climate change is not expected to strongly influence changes in annual or seasonal rainfall totals between now and 2030.

However, by 2090, under both a low and a high emissions scenario, there is high confidence that cool season rainfall will decline. There is medium confidence that warm season rainfall will remain stable. The intensity of heavy rainfall events, however, is projected to increase (high confidence). There is medium confidence that the time spent in drought, and the frequency of extreme drought, will both increase over the course of the century under a high emissions scenario.

Total horticultural plantings in the Victorian Mallee have increased since 2008/2009 when allocations against high-reliability water shares on the Murray hit a record low of 35 per cent.

In the event of a drought with a sustained period of allocations well below 100 per cent, horticulturalists below the Barmah Choke would be dependent on allocation purchases from above the Choke (assuming the Choke trading rule is relaxed, as it was in the Millennium Drought) and from within the Goulburn IVT. This will be insufficient to meet their total needs. Consequently, much more horticultural land is likely to be dried-off than was the case in the Millennium Drought.

Whether or not there would then be a return to plantings sustained by 100 per cent allocations would depend on irrigation developers' attitudes to risk. It would then be clearly understood what the risks were. Equally those developers with plantings in other parts of the world may see their Australian plantings as an important hedge against the risks of drought in those other areas. Therefore, they might knowingly return to such planting levels.

In this context, there has been growing interest in exploring the opportunities and constraints associated with desalination of water from some of the less saline aquifers below the Mallee. Some irrigators are already producing commercial quantities of climate independent water with the aid of solar power. Other organisations are investigating commercial opportunities.

It is important to note that while the BoM's capacity for long term forecasts has improved, predicting the intensity and duration of droughts is imprecise. Nonetheless, as outlined above, the frequency and duration of drought periods are expected to increase with climate change.

Even without a drought, if the total horticultural plantings were to require more than 100 per cent allocations to sustain them, it would be important to have strong

compliance measures to ensure that total use did not exceed available allocations. As recent incidents in the northern Basin have shown, significant non-compliance corrodes the social-licence to operate, upon which all irrigators depend.

Developers are responsible for their own risks if they choose to plant crops without owning the water entitlements necessary to sustain them. The people who own water entitlements are free to choose whether they use the allocations against those entitlements on their own crops or if they sell them on the water market. Irrigators must not use more water than their allocation accounts allow, and the broader community must be assured that irrigators are only using water that they are authorised to take.

Water Corporations' past investments in a telemetry network to monitor actual water use in real time provides a strong foundation to provide that assurance. This now needs to be backed up by a compliance and enforcement approach that is consistent with the Basin Compliance Compact.

Action	Timeframe	Priority	Lead Agency
4. Investigate the impact of climate change and supply constraints on water availability in the Mallee and investigate the opportunities and constraints associated with producing climate-independent water resources in the Victorian Mallee.	Short term	High	DELWP, Water Corps & Ag Vic
5. In collaboration with regional partners, develop and maintain strategies to address priority water availability issues.	Short term	High	Water Corps, DELWP & Ag Vic
6. Manage the unauthorised take of water consistent with compliance and enforcement policy.	Short term	High	Water Corps & DELWP
7. Work with the MDBA to investigate the likelihood and consequence of delivery shortfalls, and communicate those risks to affected parties.	Short term	High	DELWP & Ag Vic



Vineyard irrigation.

5.1.3 Water deliverability issues

Delivering water in the Murray system has always been challenging due to the long distances. It takes three weeks to deliver water from the Hume Dam to Sunraysia.

River operators have a strong track record in actively managing the system to deliver water to where it is wanted. However, shortfalls can occur when river operators aren't able to deliver people their water – including irrigators and the environment – where and when they want to use it. A shortfall can happen, if there is either:

- a heatwave and a sudden spike in demand; or
- not enough capacity in the system to supply water to meet all downstream needs in summer and autumn.

There have been significant changes across the connected Murray-Darling Basin over the last 10-20 years. Changes in both demand (more water being delivered to the lower Murray) and supply (reduced capacity) have increased the challenge of delivering water to users where and when it is needed without damaging the environmental health of our waterways.

River operators must forecast expected demands based on climatic data which are adjusted for their expectations about whether they are operating in a wet, average, or dry year. They also consider actual usage in previous years, after allowing for seasonal conditions, and increasingly they are allowing for the maturation of recently planted crops. Nonetheless, despite all those considerations, if it turns out that there is heavy rain in Mildura at the time the irrigation water arrives, it will not be diverted for irrigation.

In those circumstances, river operators will endeavour, if possible, to capture the unused irrigation water in Lake Victoria, where it can be redirected for other purposes, including downstream irrigation. If this is not possible it may mean a reduction in overall allocations in the next year, or a missed opportunity to increase allocations in the current year. If Lake Victoria is full and it cannot serve this role, the river operators must decide whether or not to err on the side of caution.

On the other hand, if a heatwave has developed while the irrigation water is on its way to Mildura, the risk is that there will not be enough water in the river to meet total demands when it arrives. In this situation, as the weather forecasts become clearer, river operators may draw down on weir pools (such as Euston Weir, which, during the irrigation season, may be surcharged by up to 200 mm to provide extra storage capacity) or the Victorian Mid Murray Storages including Lake Boga, Kangaroo Lake and Kow Swamp.

The continued expansion of horticultural plantings in the Mallee regions of the three states has concentrated irrigation demand and shifted water use further away from the major dams.

Delivery challenges can also arise when there is not enough channel capacity through the Barmah Choke to supply all downstream demands from the Murray River when demands increase unexpectedly without enough time for additional water to be released from dams to users.

A shortfall occurred in March 2002 resulting in water use being temporarily rationed in an effort to share the available water fairly between all users. During a 16-day heatwave in January 2018, river operators scrambled to meet demands in the Victorian and NSW Mallee; substantial draw down occurred in weir pools, even though rationing was avoided.

The challenge of supplying peak demand is likely to become more difficult if peak irrigation continues to increase as existing horticultural plantings mature and new permanent horticultural plantings are established in the Mallee regions of Victoria, NSW and South Australia. This will likely be exacerbated by a substantial increase in the temperature reached on the hottest days, the frequency of hot days, and the duration of warm spells, that are all projected with very high confidence in the climate change assessments.

5.1.4 Increasing irrigation community involvement in actions to deal with low and variable water availability and deliverability

Irrigators dealing with the risks of low and variable water availability or deliverability need information, tools and skills if they are to make informed decisions in managing those risks. The information and prices revealed through the Victorian Water Register are an important part of those calculations.

Similarly, tools such as carryover will also help irrigators to manage variability (provided they understand the upside and downside) of the risks of using those tools. DELWP and the water corporations have ongoing roles in helping irrigators to evaluate their options before making decisions.

River Murray States and the MDBA are working together at the direction of their Water Ministers to better understand the risks of delivery shortfalls in the Murray System. Outputs from this work will be communicated to water users to inform them about the potential delivery risks.

When shortfall events occur, water use in the affected reach needs to be rationed. The River Murray States have different methods for rationing and are working together to make sure there are coordinated plans for implementing in place should a shortfall occur.

Mallee irrigators have a strong history of working together when necessary to share understanding and to develop fair ways to deal with difficult problems.

The makeup of the irrigation community has changed in recent years and this may affect how problems are resolved in the future. It is possible that delivery shortfalls may never occur, but caution dictates that river operators

and water corporations must continue working with these communities to provide information, to listen to concerns and to collaborate on management approaches.

Action	Timeframe	Priority	Lead Agency
8. Increase community understanding of the risks associated with low and variable water availability due to drought and changes in water supply and demand issues.	Ongoing	High	DELWP & Water Corps
9. Improve community capacity to adapt to low and variable water availability.	Ongoing	High	Mallee CMA, Ag Vic & Water Corps
10. Engage irrigators to identify options and develop solutions to manage delivery shortfalls.	Short term	High	DELWP, River Operators with support of Water Corps

5.1.5 Water entitlement volumes in the Murrayville Groundwater Management Area

Water availability in Murrayville is managed through the Murrayville Groundwater Management Area (GMA) Local Management Plan. The groundwater resource is in an aquifer that has limited or no natural recharge. In effect, it is “fossil” water, trapped underground over the course of geologic time.

Because the resource is shared between Victoria and South Australia, its use is subject to the *Groundwater (Border Agreement) Act 1985*, which provides the mechanism for managing, sharing and protecting

the groundwater resources in the designated area established by the agreement. The Border Designated Area is a 40-kilometre wide strip centred on the border of South Australia and Victoria, and divided into several management zones. The agreement includes management prescriptions which define the permissible annual volumes, permissible rate of groundwater level lowering and permissible level of salinity for each zone.

Under the Victorian *Water Act 1989*, the Water Minister declares the Permissible Consumptive Volume that can be taken for an area or water system, for a defined period of time. The Permissible Consumptive Volume for the Murrayville GMA is 11,005 ML/year (declared July 2017). This does not include domestic and stock use.

Action	Timeframe	Priority	Lead Agency
11. Monitor the sustainability of Murrayville groundwater resources and adjust management arrangements, if necessary.	Ongoing	Medium	GWMW



Irrigation channel.

5.2 Ensuring sustainable water delivery methods to irrigated properties

Given the continued expansion of horticulture, and the Minister for Water's policies for managing works licences, this LWMP considers how best to account for delivery capacity under the irrigation development guidelines. Similarly, it also considers the best ways to manage delivery shares inside the irrigation districts. The aim is to support irrigators' access to water when they need it.

The Irrigation Development Guidelines' aim is to minimise the environmental impacts of pumping arrangements. Building on that aim, this LWMP looks at opportunities to minimise the impacts on fish populations from irrigators' suction lines. It also seeks to ensure that the Victorian Mallee Irrigation Development Guidelines regarding works licences remain relevant and contemporary. Ongoing reviews of work licences conditions will help to minimise their environmental footprint and to address cultural heritage and environmental obligations. They will also help to maintain irrigators' social licences to operate by reassuring the general community that irrigation diversions in the Victorian Mallee are being well managed.

5.2.1 Extraction shares for irrigators who pump directly from the river

Every works licence held by LMW and GMW customers includes a condition that relates to the licence holder's share of the available capacity in the river in the event that there is a delivery shortfall. This condition defines their "extraction share". At the time of unbundling in 2007, it was expected that a market in extraction shares might help to manage delivery shortfalls.

As outlined in the actions in section 5.1.4, the main task now in preparing for the potential for rationing events is to work with irrigators to test the potential to develop rules to help manage the challenge of any future delivery shortfalls. It is possible that markets in extraction shares might be part of those arrangements. To date, water corporations have issued extraction shares commensurate with the annual use limits on the associated water-use licences.

Recent delivery shortfall “drills” involving MDBA, DELWP and water corporations has shown that this has led to some customers holding more extraction share than necessary, while others do not hold enough, as different crops have different demand patterns and different peak demands. The current formula of “six per cent of total annual use limit per seven days” does not account for the differences in crop types and varieties. A market in extraction shares could help to make any necessary adjustments.

5.2.2 Delivery shares for irrigators inside irrigation districts

All irrigators in Victorian irrigation districts have a delivery share, which is defined as an entitlement to have water delivered at specified volumes during specified periods. In LMW irrigation districts, each irrigator’s delivery share is defined as a unique volume of water (in ML) that can be delivered over a seven-day period during peak demands. A delivery share does not entitle individual irrigators to always have that volume of water delivered at the specified rate. Rather, it entitles them to a share of the total available capacity in proportion to their fraction of the total volume of delivery shares – in that system. If water deliveries must be limited, all affected delivery shares must be affected to the same proportion.

The current rejuvenation of the Red Cliffs, First Mildura and Merbein Irrigation Districts involves a trend towards higher water-use crop-management systems. Irrigation

demands in those districts are therefore increasing so much so, that it is nearing capacity during peak season on some spur delivery lines. Individuals’ demands for flow rates and delivery times is therefore also becoming increasingly competitive.

In the 1990s, the Robinvale Irrigation District faced a similar challenge. Volumetric restrictions were introduced there in 1999/2000, with the support of the irrigation community, and their historical problems are now being well managed. LMW is now planning to work with its customers in the other districts to implement a system of priority volumetric access arrangements, which would be linked to delivery shares. This is being done as part of DELWP’s review of delivery shares in all Victorian irrigation districts.

Delivery shares are not well understood in irrigation communities. Irrigators often exceed their delivery share allowances during the peak of the irrigation season. Whether they do so knowingly or unknowingly, on tight parts of the delivery system it affects other irrigators within the system.

Through extensive consultation with the irrigation community in 2017, LMW received clear messages about irrigators’ future expectations of delivery shares. In general, people felt everyone should have appropriate delivery share volume, there should be the same rules for all, and the initial focus needs to be on problem pipelines, where the current water-ordering rules are enabling individual advantage.

Action	Timeframe	Priority	Lead Agency
12. Work with district irrigators to implement priority volumetric access linked to delivery shares across all districts, as part of actively identifying and managing deliverability risks and capacity constraints.	Short term	High	LMW
13. Support and implement recommendations from the DELWP Delivery Share Review.	Mid term	Medium	Water Corps

5.2.3 Conditions on works licences and bore licences

Under the *Water Act 1989*, the Minister has set policies for managing works licences and bore licences. In accordance with those provisions, the Victorian Mallee Irrigation Development Guidelines 2017 call for a Works Plan to be produced as part of the application process. The purpose of a Works Plan is to protect the aesthetic, archaeological, cultural and conservation values of the riverine and riparian environment and public land areas.

Accordingly, pumps, pump houses, pipelines, access tracks and associated water diversion works must meet the standards necessary to minimise their impacts on other persons and the environment. This involves an assessment of local conditions and the appropriate

siting, construction, operation and maintenance of water diversion works. Once that assessment has been completed, conditions are placed on the licence to ensure that the Works Plan is followed into the future.

Similarly, bore licences (Murrayville GMA) include conditions to ensure that other users of the groundwater resource are not adversely affected by the operation of the bore.

As technologies advance, practices improve, and as environmental and cultural obligations become clearer, the Victorian Mallee Irrigation Development Guidelines must be continuously improved. Under this LWMP, those parts of the guidelines that relate to works licences and bore licences should continue to be reviewed and updated every three years.

It is important for the broader community to be assured that the conditions on works licences are being met. Works licences on the river are renewed every five years. LMW has arranged for the licence holders to be grouped into five river reaches. Each year all the works licences in one of the reaches come up for renewal at the same time. The conditions on works licences can be amended at the time of renewal. This process provides an opportunity to demonstrate ongoing compliance with licence conditions.

One recent potential advancement in pumping technology has been the development of fish-friendly

suction screens. These help to prevent native fish being killed or diverted away from the river. This technology should be investigated to determine if it meets a requirement for future developments under the Irrigation Development Guidelines, and explore ways to encourage their adoption, potentially during licence renewal programs.

Cost effective ways to satisfy cultural and environmental obligations also need consideration. If possible, the costs of meeting those obligations can be shared across several pump sites at the time of licence renewal.

Action	Timeframe	Priority	Lead Agency
14. Continue to implement a program of rolling 5-year reviews of works licences to ensure alignment and compliance with Ministerial Policies for Managing Works Licences and the Victorian Mallee Irrigation Development Guidelines.	Ongoing	High	LMW
15. Investigate options for fish-friendly suction screens and their application to water diversion in the Victorian Mallee.	Mid term	Medium	Mallee CMA, DELWP & Ag Vic
16. Subject to the outcomes of investigations, support the adoption of fish-friendly suction screens as part of the works licence review program, and if appropriate, incorporate requirements for them in the Irrigation Development Guidelines.	As opportunities arise	Medium	Mallee CMA & Water Corps
17. Support awareness of and compliance with, cultural heritage and environmental obligations associated with irrigation development.	Ongoing	High	Ag Vic
18. Coordinate the case management of private diverter works licence applications through the interagency New Irrigation Development Group, consistent with Ministerial Policies and the Victorian Mallee Irrigation Development Guidelines.	Ongoing	High	Ag Vic



Discussing crops with irrigator.

5.2.4 Water delivery systems

Although a concerted effort has been made to replace and upgrade less efficient on-farm irrigation systems and open earthen delivery channels in irrigation districts, there remains some off farm delivery infrastructure that has been overlooked and continues to present seepage and evaporation losses. This oversight was largely because the water loss in these systems is accounted for as river losses and not part of the landowner’s water entitlement or the LMW loss allowance.

In 2016, LMW conducted a feasibility study (GHD 2016) to replace earthen irrigation channels near the Murray River. The study involved a preliminary estimation of seepage rates, evaporation losses and Murray River salinity impacts. It identified four private channels that warranted further investigations. These four channels collectively constitute a length of approximately 14 km with a surface area of 20.8 ha. The preliminary estimate showed a salinity benefit of 2.1 EC (in the Murray River at Morgan) could be derived if the channels were replaced.

Action	Timeframe	Priority	Lead Agency
19. Prepare business cases to investigate options to upgrade private diversion irrigation channels in Private Diversion Areas and investigate water delivery systems upgrades in pump districts to deliver water efficiencies.	Short term	High	LMW, DELWP & Mallee CMA



Drip irrigation.

5.3 Increasing the uptake of best management irrigation practices

Irrigators in the Victorian Mallee are continuing to assure the broader community that their activities make an important contribution to the regional economy while also minimising or avoiding environmental impacts. In keeping with the Minister for Water’s policies for managing water-use licences, new irrigation developments are required to manage groundwater infiltration, disposal of drainage; minimise salinity; protect biodiversity and minimise cumulative effects of water use. Existing irrigators are encouraged to adopt emerging technologies and practices, where these can help them improve their productivity and profitability.

This LWMP seeks to ensure that the Irrigation Development Guidelines regarding water-use licences remain relevant and contemporary. Water-use licence conditions have no defined renewal period; providing a process for review, particularly for older licences, would help to reassure the general community, maintain irrigators’ social licences and demonstrate that irrigated properties in the Victorian Mallee are being well managed using relevant and contemporary controls.

The LWMP builds on contemporary knowledge to support irrigation modernisation, productivity improvements, climate change adaptation and irrigator awareness of opportunities and challenges. The aim is to build a resilient irrigation community in a changing climate, and to ensure seasonal adjustment processes for the annual use limits on water use licences remain relevant and contemporary.

Stakeholders consulted in developing the LWMP identified a high level of confidence that irrigators are complying with water-use licence conditions, especially with regard to compliance with the individual Irrigation and Drainage Plans attached to water-use licences for properties that have been subject to Irrigation Development Guidelines.

Ideally, that confidence should be backed up with evidence. A key aim of this LWMP is to demonstrate that the cumulative impacts of increased water use in the Victorian Mallee are being monitored to assure the broader community that appropriate responses would be considered if any problems were to emerge.

5.3.1 Ensuring the adoption of best management practices for new irrigation developments

The total area of irrigation in the Victorian Mallee has more than doubled since water entitlement trade was introduced. More than 40,000 hectares has been added since 1994 while avoiding, minimising and mitigating the negative environmental impacts common to large scale irrigation developments in the past.

The Mallee Irrigation Region has been at the forefront in establishing effective processes to manage irrigation development, while also achieving improvements in river salinity. Those processes are designed to meet the Water Use Objectives and the Standard Water-Use Conditions determined by the Minister for Water in accordance with the *Water Act 1989*.

As outlined in the Standard Water-Use Conditions and repeated in the Irrigation Development Guidelines (2017), an application for a new or varied water-use licence must be accompanied by an Irrigation and

Drainage Plan for the area of land being developed. The Irrigation and Drainage Plan must provide the information necessary to demonstrate how the development meets the necessary standards to minimise the impacts of water use on other persons and the environment (in particular water logging, salinity and nutrient impacts).

The Irrigation and Drainage Plan must involve an assessment of local conditions and appropriate design of irrigation systems. The key purpose of an irrigation and drainage plan is to match the way land is irrigated and drainage disposed of, with the characteristics of the land and soil, in order to efficiently meet the objective of minimising harmful side-effects of irrigation.

The Irrigation and Drainage Plan under the Victorian Mallee Irrigation Development Guidelines must include:

- A map of the proposed development clearly identifying the irrigation footprint;
- Topographical survey;
- Soil survey report and maps;
- Irrigation design and management;
- Arrangements for drainage disposal;
- Biodiversity protection arrangements; and
- Hydrogeological assessment(s)

For a new water use licence to be granted, the Irrigation and Drainage Plan must be endorsed by the relevant Water Corporations and a reference to the plan recorded as part of the water-use licence. Conditions are placed on the licence in order to ensure the Irrigation and Drainage Plan continues to help meet the water-use objectives, while also allowing continuous improvement on the land covered by the licence.

The Victorian Mallee Irrigation Development Guidelines (2017) articulate and prescribe the approval processes and the coordinated approach, adopted by regional agencies in responding to applications for water-use licences and the other legal instruments that govern these developments. To assure the public that the guidelines continue to avoid or minimise environmental impacts, it is essential for the guidelines to be regularly reviewed to ensure they remain relevant and contemporary.

Action	Timeframe	Priority	Lead Agency
20. Coordinate and case manage the approval application processes necessary for irrigation development and recommendations for site specific Water-use Licence conditions through the interagency New Irrigation Development Group, consistent with Ministerial Policies and the Victorian Mallee Irrigation Development Guidelines.	Ongoing	High	Ag Vic
21. Ensure emerging knowledge and risks associated with irrigation best practice are incorporated into the review of the Victorian Mallee Irrigation Development Guidelines.	Mid term	Medium	Mallee CMA

5.3.2 Encouraging the adoption of best management practices on existing irrigation developments

A 2018 review of the Victorian Mallee Irrigation Incentive Program found that there were strong public benefits to be achieved by providing irrigators with financial incentives to carry out soil surveys, conduct irrigation system checks, and to purchase and install irrigation scheduling equipment on properties irrigated by pressurised irrigation systems.

The review also demonstrated that the private incentives for adopting those practices were often insufficient for their uptake and there were information failures

that limited their acceptance. Extension programs are therefore necessary to explain and demonstrate their benefits and build capacity.

By contrast, the review found that the private incentives to upgrade from furrow irrigation to pressurised irrigation systems are now so strong as to render further public incentives unnecessary. The review recommended continuation of the upgrade incentive for a limited period as a transition measure for actively furrow-irrigated properties. The recommendations from the review are reproduced in the appendix in section 7.4.1.

Action	Timeframe	Priority	Lead Agency
22. Support best management irrigation practices at existing irrigation developments to deliver water use efficiency and salinity benefit through a Victorian Mallee irrigation incentive program.	Short to mid term	High	Mallee CMA & DELWP
23. Regularly review and update extension programs to ensure they continue to support irrigation modernisation, productivity, adaptability and irrigator awareness of contemporary knowledge and best management irrigation practices for efficient application of irrigation water.	Ongoing	High	Ag Vic & DELWP

5.3.3 Monitoring the effectiveness of water-use licence conditions

Water corporations are accountable for ensuring compliance with, and, if necessary, enforcement of, the conditions on individual water-use licences. However, since water-use licences run with the land there is no renewal period. Unlike works licences, there is no mechanism for regular reviews of the need for new conditions on individual licences. The *Water Act 1989* does, however, include mechanisms to enable changes to water-use licence conditions if there is a demonstrated need to make changes to satisfy the Minister's Water Use Objectives. Those mechanisms are subject to prescribed consultation processes.

This LWMP looks more broadly at the effectiveness of the conditions that have been placed on water-use licences. It does so with a view to continuous improvement in the Irrigation Development Guidelines and the Incentives Program. The aim is to keep building contemporary knowledge about irrigation in the Victorian Mallee.

A three-year remote sensing study recently assessed the efficiency of existing irrigation management practices in the Victorian Mallee. In that study, Agriculture Victoria used satellite imagery, combined with water usage data from the Victorian Water Register, to investigate how much water moves beyond the rootzone of Victorian Mallee crops being irrigated using current irrigation practices.

As outlined in section 4.5, rootzone drainage should be kept to a maximum of five to ten per cent of total applied water. The study suggests that irrigators in the Victorian Mallee are achieving an average of 10 per cent rootzone drainage (MCMA 2018b). This is in line with expectations, and international comparisons suggest that Victorian Mallee irrigators are using best management practices for irrigation (Hornbuckle & Ballester 2019). Among other things, this world-leading study will help to test the current assumptions about the river salinity impact of each additional megalitre of irrigation in the Victorian Mallee. As discussed in more detail in section 5.4.2, this affects the charges paid against each megalitre of annual use limit placed on water-use licences.

As shown in a schedule to the Minister's Standard Conditions on Water-Use Licences, at the time of unbundling in 2007, it was expected that seasonal adjustments would need to be made to annual use limits in two years out of ten on average to allow for extraordinarily high evapotranspiration rates or low rainfall. In practice, seasonal adjustments have been made five years out of seven since 2012.

As outlined in the *Mallee Natural Resource Management Plan for Climate Change*, the projections for potential evapotranspiration indicate increases in all seasons. By 2030, potential evapotranspiration is projected to increase by one to seven per cent. By 2090, the increases are about one to ten per cent in a low emissions scenario and one to 20 per cent in a high emissions scenario.

Given these climate change scenarios, the seasonal adjustment process will be reviewed to ensure it remains relevant and contemporary. Annual use limits are intended to provide irrigators with the flexibility to meet their crops' irrigation requirements without undue constraint, and irrigators are expected to be able to apply for an annual use limit that suits their needs in most years.

The annual use limits on water-use licences are generally within the volume calculated by multiplying the irrigated area by the maximum irrigation application rates (Schedule 2, Standard Water-use Conditions) deemed to be suitable for that crop per unit area. The Mallee CMA recently commissioned a review of application rates for a range of irrigated crops in the Victorian Mallee which will be formally incorporated into the Standard Water-use Conditions.

Action	Timeframe	Priority	Lead Agency
24. Establish a review process for existing water-use licences to ensure licence conditions align with relevant and contemporary risks in accordance with Water for Victoria Action 4.7.3.	Mid term	Medium	DELWP & Mallee CMA
25. Monitor implementation of water-use licence conditions and non-compliance response actions consistent with compliance and enforcement policy.	Short Term	High	DELWP & Water Corps
26. Communicate the outcomes of new learnings to promote wider understanding of contemporary knowledge about efficient water use within the Victorian Mallee irrigation community.	Ongoing	High	Mallee CMA
27. Conduct annual use limit assessments consistent with legislative requirements.	Ongoing	High	Mallee CMA
28. Periodically review seasonal annual use limit adjustment methods to ensure they remain relevant and contemporary.	As needed	Medium	Mallee CMA
29. Periodically review maximum application rates and where appropriate ensure they are incorporated into subordinate legislative instruments.	Short Term	Medium	DELWP



Inspecting irrigation infrastructure.

5.4 Protecting the quality of the region’s water resources

The Victorian Mallee’s salinity management framework has reduced salinity risk, but not removed the threat, which requires ongoing management. Given the need for some rootzone drainage, irrigation in the Mallee will continue to mobilise salt in the landscape. The salinity impacts of irrigation on the water quality of the Murray River must, therefore, be accounted for at the regional level in order to help Victoria maintain compliance with BSM2030.

In the Murrayville GMA, the threat of failed or failing bores is also a major consideration for water quality. Since bores have a limited life, there will always be some at risk of failure.

It is important for each generation of land and water managers to understand these ongoing threats. It is essential for salinity management to continue to be understood, adaptive, supported, relevant and contemporary.

Several initiatives related to the salinity management framework that were started under the previous LWMP will be delivered during the life of this plan. These include:

- an independent review of the salinity impact charges that apply to each extra megalitre of annual use limit applied to water use licences in salinity impact zones as required by *Water for Victoria – Water Plan (2016)*;
- refinements to the models that assess how much salt is driven into the river by each extra megalitre of annual use limit in the different salinity impact zones; and
- review cap and trade arrangements for annual use limits in the high salinity impact zone.

5.4.1 Bore Decommissioning Projects

The Murrayville GMA is threatened by the presence of failed or failing groundwater bores, particularly where the Murray Group Limestone aquifer is overlain by the saline Parilla Sands aquifer. The older stock and domestic bores drilled into the limestone aquifer are likely to deteriorate as the steel casing corrodes, allowing water from the saline Parilla Sands aquifer above to enter the fresher limestone aquifer and cause contamination.

Proper capping and decommissioning of old bores is important to protect the water quality of the Murray Group Limestone aquifer. While decommissioning of failed and redundant bores is the responsibility of landholders, GMMW’s policy is to assist where possible.

The considerable depth to the Murray Group Limestone aquifer, the upwards pressure of the aquifer and the overlying aquitard mean that, other than the threat from failing bores, the Murray Group Limestone aquifer is relatively protected from most vertical processes that could have the potential to affect groundwater quality in the area.

A long-term threat to the Murrayville area is the naturally occurring lateral movement of more saline water from the east. It is possible that pumping for irrigation may increase the water level gradient and therefore increase the rate of groundwater movement. However, monitoring and the current rates of extraction have not provided any evidence of this to date.

The condition of the groundwater resource is monitored by GMMW and DELWP using the State Observation Bore Network. This includes groundwater level monitoring across the management area, as well as salinity monitoring at selected observation bores and some spatially distributed regularly pumped domestic and stock water supply bores. All monitoring data is regularly reviewed by GMMW to ensure management is meeting the objectives of the Murrayville Local Management Plan.

Mallee CMA is proposing to review and rationalise its bore monitoring network. Those bores that are no longer required need to be decommissioned, as do other bores drilled for investigative purposes. In total, an estimated 500 bores require decommissioning.

As is the case in Murrayville, proper capping and decommissioning of old bores is important to guard against groundwater contamination as the saline groundwater in the Parilla Sands Aquifer degrades the steel casing of the old bores. Uncapped bores also cause localised land salinisation and degradation of native vegetation.

Action	Timeframe	Priority	Lead Agency
30. Develop and implement a bore decommissioning strategy for Murrayville Groundwater Management Area and redundant bores in the Mallee Salinity Groundwater Monitoring Network.	Short term	Medium	GMMW, Mallee CMA & DELWP

5.4.2 Independent review of salinity charges

As required by the *Water for Victoria - Water Plan* an independent process is underway to review how salinity charges are set for increases in annual use limits in the low salinity impact zones. The review is being completed in two stages:

- The first stage is a review of the hydrogeological models used to calculate the increase in river salinity caused by additional irrigation in each salinity impact zone.
- The second stage is a review of the cost of offsetting salinity impacts per electrical conductivity (EC) unit.

Together the hydrogeological model and salinity cost reviews are likely to result in changes to the salinity offsetting charges that irrigators pay for an increase

in the number of megalitres that make up the annual use limits on their water-use licences. These changes will need to be communicated carefully to maintain the industry's confidence and support for the Victorian Mallee Salinity Management Framework.

In managing the salinity impacts from irrigation development it is essential to undertake research and ensure the best available information is on hand to support decision making. Action 4.8 in *Water for Victoria – Water Plan* aims to improve salinity management in the Mallee. It commits to invest revenue from salinity charges on an annual basis to update contemporary knowledge of the Victorian Mallee salinity impacts and the cost of offsets consistent with BSM2030.

Action	Timeframe	Priority	Lead Agency
31. Plan to invest revenue from salinity impact charges to update contemporary knowledge of salinity impacts of water use on the Murray River and Victorian Mallee landscape and develop and implement cost-effective plans to use that revenue to mitigate or offset the salinity impacts of irrigation.	Ongoing	Medium	Mallee CMA
32. Amend the Salinity Management Framework to incorporate findings from the model refinement.	Short term	High	Mallee CMA & DELWP
33. Finalise the independent review of salinity impact charges and implement supported recommendations.	Short term	High	DELWP, Mallee CMA & LMW
34. Maintain annual use limits as the preferred unit of account for salinity impact charges and salinity accounting in the Victorian Mallee.	Ongoing	Low	Mallee CMA & DELWP

5.4.3 The cap on annual use limits in the salinity High Impact Zone

Action 4.8 from *Water for Victoria – Water Plan* calls for a review of policies related to the cap on annual use limits in the high salinity impact zone and the trading rules that go with it.

The aim of the project is to analyse and document the policy options for expressing an in-principle agreement to implement a fixed cap in the high impact zone that is consistent with the targets set out in the Nyah to SA Border Salinity Management Plan.

Prior to unbundling in 2007, water entitlements could be traded out of the high impact zone, but not traded in. Since unbundling, it has been annual use limits (replacing water entitlements) that can be traded out of the high impact zone, but not traded in. A proposal to allow annual use limits to be issued to existing water-use licences in the high impact zone, provided the total volume does not exceed an agreed cap, is under consideration. This change would support the Sunraysia Rejuvenation Project.

Action	Timeframe	Priority	Lead Agency
35. Review Victorian Mallee annual use limits High Impact Zone capping policies to support continued rejuvenation of the Sunraysia Irrigation Districts.	Short term	High	DELWP, LMW & Mallee CMA

5.4.4 Managing accountable actions under the basin salinity management strategy – BSM 2030

The Basin Salinity Management (BSM) 2030 Strategy retains the accountability framework established under Schedule B of the Murray-Darling Basin Agreement. It provides for the registering of all actions that are assessed to have a significant effect, 0.1 EC or more, on Murray River salinity at Morgan by 2100.

The framework commits the partner governments to maintain agreed salinity levels and ensure that their actions that increase river salinity are offset by investing in actions to reduce salinity. BSM2030 also retains the Basin Salinity Target to maintain modelled average daily salinity at Morgan at less than 800 EC for at least 95 per cent of the time over an agreed climatic-hydrologic sequence (otherwise known as the 'benchmark period'). The current benchmark period is May 1975 to April 2000.

This target provides a single metric to assess the Basin-scale outcomes of improved land and water management practices and salt interception schemes.

Accountable actions and delayed salinity impacts continue to be recorded in two salinity registers. Register A records all actions taken after 1988 for NSW, South Australia and Victoria. Register B records the delayed impacts of actions taken before 1988 – such as the clearing of deep-rooted native vegetation to enable agriculture in the Mallee – that have had an impact post 2000.

Under BSM2030 a risk-based approach applies to the review of register entries and associated models. Many register entries and their associated models are now mature having been reviewed several times. Given this, the maximum time period between reviews has been extended from five to 10 years. Review periods are set by the MDBA and a shorter review period will be agreed for those register entries and models where there is higher risk, uncertainty, or where there is new knowledge, changes in landuse or operational experience.

The MDBA and the partner governments maintain a four-year register entry and model review plan, with a 10-year outlook. It sets out the frequency of reviews required of each register entry and model. That plan enables partner governments and the MDBA to make pragmatic decisions to focus limited resources on the most significant salinity threats or where there is likely to be significant change or uncertainty. It provides partner governments with a basis for estimating budgetary and resourcing requirements and identifying workloads to inform business planning cycles.

The Mallee CMA is responsible for coordinating the reviews of accountable actions in the Victorian Mallee. It does this in partnership with DELWP and the Victorian Salt Disposal Working Group. As outlined in Table 3, there are eight accountable actions on Register A and two actions on Register B in the Victorian Mallee. More information about the location of these actions is provided in Appendix 7.4.2.

Table 3 | Review schedule for Accountable Actions in the Victorian Mallee.

Accountable Action	Salinity Effect at Morgan 2100 (EC)*	Confidence Rating	Next Review
Register A			
Nyah to the South Australian Border Salinity Management Plan – Irrigation Development	17.3	Medium	2020
Reduced Irrigation Salinity Impact (Stage 1)	-5.4	Medium	2021
Reduced Irrigation Salinity Impact (Stage 2)	-4.7	Medium	2021
Sunraysia Drains Drying Up	-2.2	Medium	2022
Psyche Bend	-2.1	Medium	2022
Lamberts Swamp	-3.0	High	2027
Nangiloc-Colignan Salinity Management Plan	0.4	High	2023
Mallee Drainage Bore Decommissioning	-0.3	Low	TBD
Register B			
Victorian Mallee legacy of History - Dryland	5.9	Low	2019
Victorian Mallee legacy of History - Irrigation	8.3	Low	2019

*Source BSM2030 Register 2018, (-) values are credits, (+) values are debits.

Action	Timeframe	Priority	Lead Agency
36. Continue to accurately account for salinity impacts consistent with contemporary knowledge and support Victoria in meeting obligations under BSM2030, including environmental watering impacts.	Ongoing	High	Mallee CMA
37. Work with Victorian Government and the MDBA to ensure a consistent approach across basin states in the joint management of salinity.	Ongoing	Medium	DELWP & Mallee CMA

5.4.5 Managing irrigation drains

Under Clause 36 of the State Environment Protection Policy (Waters), *irrigation drains must be designed and managed to minimise risks to beneficial uses of receiving waters, so far as reasonably practicable, with particular regard to flow, sediment, nutrients, salt and other pollutants.*

Water corporations that have an irrigation district under the *Water Act 1989* have particular responsibilities with regard to Clause 36. When developing and implementing programs for improved irrigation, drainage and salinity mitigation practices, they must minimise risks to the beneficial uses of receiving waters by participating in implementing regional land and water management plans and setting and ensuring compliance with conditions on water-use licences in accordance with Regional Irrigation Development Guidelines.

When reporting on their management of irrigation drains, water corporations must have regard to the environmental, economic, social and cultural aspects of the catchments they serve.

DELWP also has specific responsibilities. It must maintain, implement, review and periodically renew, for each relevant CMA region, guidelines for the development and implementation of land and water management plans. Under Clause 37 of the State Environment Protection Policy (Waters), those plans must encourage the adoption of on-farm best management practices in order to reduce pollution into irrigation drains. They must also seek to identify and implement cost-effective improvements to the management of outfalls from irrigation drains.

Action	Timeframe	Priority	Lead Agency
38. Investigate opportunities to identify and implement cost-effective improvements to the management of irrigation drains and outfalls.	Mid term	Low	Water Corps & Mallee CMA



Doerings Basin.

5.5 Monitoring the cumulative effects of irrigation water use

The contemporary risks of waterlogging and salinisation in Mallee landscapes is not as well understood as the risks to water quality. However, there is a growing realisation that salt accumulation in landscapes such as floodplains is a compounding issue. In particular, landscape risks are not well understood for private diversion areas; they are better understood inside irrigation districts. At the broader regional scale, it is important to better understand, monitor and mitigate or offset salinity impacts of irrigation – particularly on floodplains. The ability to address landscape salinity impacts needs to be built into the salinity management framework. In part, gaining this improved understanding and address impacts will involve maintaining and upgrading groundwater monitoring and irrigation drainage monitoring assets.

Previous work in land and water management has resulted in unexplored legacies. For example, the biodiversity buffers and offsets required under new irrigation development since 1994 need to be better understood as an opportunity for a network of potentially connected corridors. Doing this will help to optimise the biodiversity benefits associated with new irrigation developments while protecting native vegetation from salinity impacts of irrigation.

Land and water management in the Victorian Mallee must increasingly be understood in the context of healthy, productive and sustainable Mallee communities. Every effort must be made to coordinate and streamline regulatory activities, in order to minimise compliance costs, while also enabling sustainable and productive irrigation enterprises.

Similarly, energy efficiency and the carbon dependency of irrigated Mallee enterprises provide feedback loops to the climate change challenges facing the region. It is prudent therefore to think about opportunities to reduce energy used for irrigation and to consider the potential for greater use of renewable energy.

5.5.1 Successful coordination of irrigation practices and cultural values

Irrigation in the Mallee necessitates infrastructure on floodplains and use of water resources. These landscapes and resources also support diverse and rich cultural assets and values dating back tens of thousands of years. Successful coordination requires a balance, whereby irrigation communities are healthy and productive and the cultural values of waterways are appreciated and protected for generations to come.

To achieve this aim, this plan supports increased collaboration between irrigators and Traditional Owners, including the First People of the Millewa Mallee, and the Barengi Gadjin Land Council, Aboriginal Corporations. The coordination will enable a better understanding of the cultural values and uses of floodplains so these treasures can be protected, used and celebrated by Traditional Owners, Aboriginal and Torres Strait Islander community groups. There are critical knowledge gaps preventing best practice management of productive and cultural landscapes. This plan seeks to close those gaps by encouraging knowledge sharing and communication by all parties with an interest in healthy, productive and culturally rich landscapes.

Action	Timeframe	Priority	Lead Agency
39. Increase the Aboriginal and irrigation community understanding and management of the impacts of irrigation on the region's natural, productive and cultural landscapes.	Ongoing	High	Mallee CMA & DELWP
40. Increase Aboriginal communities' awareness and understanding of the water sector and capacity to participate in the water market and manage Aboriginal Economic Water.	Ongoing	High	Mallee CMA & DELWP
41. Support Traditional Owners to have a voice in land and water management through assistance in defining the cultural values, uses, health and future needs of key waterways.	Ongoing	High	Mallee CMA, DELWP, Ag Vic, LMW & Aboriginal Victoria

5.5.2 Understanding the cumulative effects of irrigation on mallee landscapes

The Mallee CMA has existing obligations to monitor groundwater levels and groundwater quality. Similarly, it has existing obligations to monitor drainage flows and salt loads. Those obligations are supported by an ongoing operation and maintenance budget for the related monitoring assets.

The Mallee CMA has also initiated a study into the extent to which private diverters who have been through the new irrigation development assessment process have activated their drainage contingency arrangements. Failure to adequately manage irrigation induced water logged soils may affect biodiversity on individual properties covered by water-use licences.

Action	Timeframe	Priority	Lead Agency
42. Monitor, review and maintain groundwater monitoring assets to meet BSM2030 obligations and landscape stewardship.	Ongoing	High	Mallee CMA & DELWP
43. Review and maintain irrigation drainage monitoring assets to meet BSM2030 obligations and Victorian environment protection requirements.	Ongoing	High	Mallee CMA, DELWP & Water Corps
44. Investigate implementation of irrigation drainage in private diversion irrigation areas. Maintain a database of drainage development.	Short term	High	Mallee CMA & Ag Vic
45. Monitor the cumulative effects of irrigation water use on the Murray River and Victorian Mallee landscape in order to evaluate, understand, respond and report on impacts in ways consistent with BSM2030 and the Victorian Water Plan.	Short term	High	Mallee CMA & DELWP

5.5.3 Reviewing the biodiversity outcomes of the Irrigation Development Guidelines

As outlined in section 5.3.3, this LWMP considers the broad effectiveness of the conditions that have been placed on water-use licences. The effectiveness of conditions relating to the protection of biodiversity,

buffering arrangements and offsetting requirements are generally considered on a case by case basis consistent with native vegetation protection legislation and the Irrigation Development Guidelines. There are opportunities to enhance the biodiversity benefits from irrigation development by creating strategic linking revegetation corridors across the development area.

Action	Timeframe	Priority	Lead Agency
46. Review the outcomes of biodiversity buffering arrangements and biodiversity offsetting requirements on properties that have been through new irrigation development assessment.	Short term	Medium	Mallee CMA & DELWP
47. Investigate options to maximise biodiversity benefits from irrigation development.	Mid term	Medium	Mallee CMA & DELWP

5.5.4 Protecting the environmental values of wetlands managed for salinity purposes

Several wetlands in the Victorian Mallee are managed for salinity purposes. These include Lake Hawthorn, Lake Ranfurly, Psyche Bend – Woorlong Wetlands

complex, and irrigation drainage lakes in the Nangiloc area. The relationship between salinity management and environmental management are well understood for Lakes Hawthorn and Ranfurly, but less understood for the Psyche Bend – Woorlong Wetlands complex and the drainage lakes around Nangiloc.

Action	Timeframe	Priority	Lead Agency
48. Investigate and develop action plans for wetlands managed for salinity purposes to mitigate or offset salinity impacts of irrigation .	Short term	High	Mallee CMA

5.5.5 Ensuring healthy, productive and sustainable mallee communities

Healthy, productive, and sustainable Mallee communities depend on innovation and adaptive management. Changes in land-use and the adoption of new technologies are driving changes to farming practices and improvements to irrigation management. Climate variability, climate change, consumer preferences and market forces are shaping the future of irrigated enterprises in the Mallee. This LWMP seeks to strengthen the links between land and water management and the social and cultural values of local communities and Traditional Owners.

The actions in this plan will help to provide Mallee communities with assurance that irrigation in the Mallee is not having unacceptable impacts on the Murray River or on Mallee landscapes. In part, this depends on making sure that the Victorian Mallee Irrigation Development Guidelines remain relevant and contemporary, demonstrating effective compliance with and, if necessary, enforcement of licence conditions and using salinity impact charges to effectively mitigate or offset the salinity impact of irrigation.

Using water, energy and nitrogenous fertilisers more efficiently, and generating on-farm renewable energy will help to reduce emissions. This, in turn, will help to manage the feedback loop between irrigation management and the challenges of climate change. Collaborative relationships between irrigators, industry groups, and government agencies, will allow them to learn from each other as they innovate and trial new equipment and practices. Farmer-led irrigator discussion groups to support improvements in farm planning, irrigation efficiency, energy efficiency, and nutrient management will be supported.

Increasing the carbon content of soils would also help to sequester carbon to offset emissions. It would also help to improve the health and water-holding capacity of soils. This could be achieved by investigating ways to retain and recycle organic matter on-farm (e.g. almond hulls and old trees) by reincorporating these orchard ‘waste’ products back into the soil.

Action	Timeframe	Priority	Lead Agency
49. Refine the Victorian Mallee Salinity Management Framework to account for the <i>Water and Catchment Legislation Amendment Act 2019</i> .	Short term	High	DELWP, Mallee CMA & Water Corps
50. Triennially review the Victorian Mallee Irrigation and Development Guidelines to ensure they keep pace with innovations in the irrigation industry and remain relevant and contemporary.	Ongoing	High	Mallee CMA
51. Implement compliance and enforcement policy for all water users to maintain community confidence in Victoria’s entitlement and allocation framework.	Short term	Medium	DELWP & Water Corps
52. Continue to investigate risks and opportunities associated with irrigation practices and invest in building contemporary knowledge to be incorporated in future projects.	Ongoing	High	Mallee CMA & Ag Vic
53. Develop on-farm energy efficiency calculator to assess the potential for systems to be more energy efficient, and explore opportunities to increase the carbon content of soils, to help manage the feedback loop between irrigation management and climate change.	Short term	High	Ag Vic



Walking through vineyard.

Part 6

Implementation

6.1 Action summary

Actions detailed in the LWMP identify a, timeframe priority and Lead agency. The timeframe definitions include; *Short term*: 0 – 2 years, *Mid term*: 2-5 years and *Long term*: 5-10 years. The priorities include *High, Medium, Low, Ongoing* and *As required*.

Table 4 | Action List.

Issue	Action	Timeframe	Priority	Lead Agency
Water availability	1. Investigate the relationships between Mallee crop plantings and water availability. Communicate any identified risks.	Short term	High	DELWP & Ag Vic
	2. Develop Victorian Mallee Crop Reports on a regular basis to support planning and management.	Ongoing	High	Mallee CMA
	3. Encourage the development of a whole of Mallee irrigated landuse crop report.	Short term	High	DELWP
	4. Investigate the impact of climate change and supply constraints on water availability in the Mallee and investigate the opportunities and constraints associated with producing climate-independent water resources in the Victorian Mallee.	Short term	Medium	DELWP, Water Corps & Ag Vic
	5. In collaboration with regional partners, develop and maintain strategies to address priority water availability issues.	Short term	High	DELWP Water Corps & Ag Vic
	6. Manage the unauthorised take of water consistent with compliance and enforcement policy.	Short term	Medium	Water Corps & DELWP
Water deliverability	7. Work with the MDBA to investigate the likelihood and consequence of delivery shortfalls, and communicate those risks to affected parties.	Short term	High	DELWP & Ag Vic
Community understanding of low and variable water availability	8. Increase community understanding of the risks associated with low and variable water availability due to drought and changes in water supply and demand issues.	Ongoing	High	DELWP & Water Corps
	9. Improve community capacity to adapt to low and variable water availability.	Ongoing	High	Mallee CMA, Ag Vic & Water Corps
	10. Engage irrigators to identify options and develop solutions to manage delivery shortfalls.	Short term	High	DELWP, River Operators & Water Corps
Irrigation groundwater availability	11. Monitor the sustainability of Murrayville groundwater resources and adjust management arrangements, if necessary.	Ongoing	Medium	GMMW
Delivery shares	12. Work with district irrigators to implement priority volumetric access linked to delivery shares across all districts, as part of actively identifying and managing deliverability risks and capacity constraints.	Short term	High	LMW
	13. Support and implement recommendations from the DELWP Delivery Share Review.	Mid term	Medium	Water Corps

Continued...

Table 4 | Action List. *Continued...*

Issue	Action	Timeframe	Priority	Lead Agency
Conditions on works licences	14. Continue to implement a program of rolling 5-year reviews of works licences to ensure alignment and compliance with Ministerial Policies for Managing Works Licences and the Victorian Mallee Irrigation Development Guidelines.	Ongoing	High	LMW
	15. Investigate options for fish-friendly suction screens and their application to water diversion in the Victorian Mallee.	Mid term	Medium	Mallee CMA, DELWP & Ag Vic
	16. Subject to the outcomes of investigations, support the adoption of fish-friendly suction screens as part of the works licence review program, and if appropriate, incorporate requirements for them in the Irrigation Development Guidelines.	As opportunities arise	Medium	Mallee CMA & Water Corps
	17. Support awareness of and compliance with, cultural heritage and environmental obligations associated with irrigation development.	Ongoing	High	Ag Vic
	18. Coordinate the case management of private diverter works licence applications through the interagency New Irrigation Development Group, consistent with Ministerial Policies and the Victorian Mallee Irrigation Development Guidelines.	Ongoing	High	Ag Vic
Water delivery systems	19. Prepare business cases to investigate options to upgrade private diversion irrigation channels in Private Diversion Areas and investigate water delivery systems upgrades in pump districts to deliver water efficiencies.	Short Term	High	LMW, DELWP & Mallee CMA
Best management irrigation practices	20. Coordinate and case manage the approval application processes necessary for irrigation development and recommendations for site specific Water-use Licence conditions through the interagency New Irrigation Development Group, consistent with Ministerial Policies and the Victorian Mallee Irrigation Development Guidelines.	Ongoing	High	Ag Vic
	21. Ensure emerging knowledge and risks associated with irrigation best practice are incorporated into the review of the Victorian Mallee Irrigation Development Guidelines.	Mid term	Medium	Mallee CMA
	22. Support best management irrigation practices at existing irrigation developments to deliver water use efficiency and salinity benefit through a Victorian Mallee irrigation incentive program.	Short to mid term	High	Mallee CMA & DELWP
	23. Regularly review and update extension programs to ensure they continue to support irrigation modernisation, productivity, adaptability and irrigator awareness of contemporary knowledge and best management irrigation practices for efficient application of irrigation water.	Ongoing	High	Ag Vic & DELWP
	24. Establish a review process for existing water-use licences to ensure licence conditions align with relevant and contemporary risks in accordance with Water for Victoria Action 4.7.3.	Mid term	Medium	DELWP & Mallee CMA
	25. Monitor implementation of water-use licence conditions and non-compliance response actions consistent with compliance and enforcement policy.	Short Term	High	DELWP & Water Corps
	26. Communicate the outcomes of new learnings to promote wider understanding of contemporary knowledge about efficient water use within the Victorian Mallee irrigation community.	Ongoing	High	Mallee CMA
	27. Conduct annual use limit assessments consistent with legislative requirements.	Ongoing	High	Mallee CMA
	28. Periodically review seasonal annual use limit adjustment methods to ensure they remain relevant and contemporary.	As needed	Medium	Mallee CMA
	29. Periodically review maximum application rates and where appropriate ensure they are incorporated into subordinate legislative instruments.	Short Term	Medium	DELWP
Protecting water quality	30. Develop and implement a bore decommissioning strategy for Murrayville Groundwater Management Area and redundant bores in the Mallee Salinity Groundwater Monitoring Network.	Short term	Medium	GWMW, Mallee CMA & DELWP
	31. Plan to invest revenue from salinity impact charges to update contemporary knowledge of salinity impacts of water use on the Murray River and Victorian Mallee landscape and develop and implement cost-effective plans to use that revenue to mitigate or offset the salinity impacts of irrigation.	Ongoing	Medium	Mallee CMA
	32. Amend the Salinity Management Framework to incorporate findings from the model refinement.	Short term	High	Mallee CMA & DELWP
	33. Finalise the independent review of salinity impact charges and implement supported recommendations.	Short term	High	DELWP, LMW & Mallee CMA
	34. Maintain annual use limits as the preferred unit of account for salinity impact charges and salinity accounting in the Victorian Mallee.	Ongoing	Low	Mallee CMA & DELWP
	35. Review Victorian Mallee annual use limits High Impact Zone capping policies to support continued rejuvenation of the Sunraysia Irrigation Districts.	Short term	High	DELWP, LMW & Mallee CMA

Continued...

Table 4 | Action List. *Continued...*

Issue	Action	Timeframe	Priority	Lead Agency
Meeting obligations under BSM 2030	36. Continue to accurately account for salinity impacts consistent with contemporary knowledge and support Victoria in meeting obligations under BSM2030, including environmental watering impacts.	Ongoing	High	Mallee CMA
	37. Work with Victorian Government and the Murray-Darling Basin Authority to ensure a consistent approach across Basin states in the joint management of salinity.	Ongoing	Medium	Mallee CMA
Managing irrigation drains	38. Investigate opportunities to identify and implement cost-effective improvements to the management of irrigation drains and outfalls.	Mid term	Low	Water Corps & Mallee CMA
Coordination of irrigation practices and cultural values	39. Increase the Aboriginal and irrigation community understanding and management of the impacts of irrigation on the region's natural, productive and cultural landscapes.	Ongoing	High	Mallee CMA & DELWP
	40. Increase Aboriginal communities' awareness and understanding of the water sector and capacity to participate in the water market and manage Aboriginal Economic Water.	Ongoing	High	Mallee CMA & DELWP
	41. Support Traditional Owners to have a voice in land and water management through assistance in defining the cultural values, uses, health and future needs of key waterways.	Ongoing	High	Mallee CMA DELWP, Ag Vic, LMW & Aboriginal Victoria
Cumulative effects of irrigation on Mallee landscapes	42. Monitor, review and maintain groundwater monitoring assets to meet BSM2030 obligations and landscape stewardship.	Ongoing	High	Mallee CMA & DELWP
	43. Review and maintain irrigation drainage monitoring assets to meet BSM2030 obligations and Victorian environment protection requirements.	Ongoing	High	Mallee CMA, DELWP & Water Corps
	44. Investigate implementation of irrigation drainage in private diversion irrigation areas. Maintain a database of drainage development.	Short term	High	Mallee CMA & Ag Vic
	45. Monitor the cumulative effects of irrigation water use on the Murray River and Victorian Mallee landscape in order to evaluate, understand, respond and report on impacts in ways consistent with BSM2030 and the Victorian Water Plan.	Short term	High	Mallee CMA & DELWP
Biodiversity outcomes of the Irrigation Development Guidelines	46. Review the outcomes of biodiversity buffering arrangements and biodiversity offsetting requirements on properties that have been through Irrigation Development Guidelines process.	Short term	Medium	Mallee CMA & DELWP
	47. Investigate options to maximise biodiversity benefits from irrigation development.	Mid term	Medium	Mallee CMA & DELWP
Wetlands managed for salinity	48. Investigate and develop action plans for wetlands managed for salinity purposes to mitigate or offset the salinity impacts of irrigation.	Short term	High	Mallee CMA
Healthy, productive and sustainable Mallee communities	49. Refine the Victorian Mallee Salinity Management Framework to account for the <i>Water and Catchment Legislation Amendment Act 2019</i> .	Short term	High	DELWP, Mallee CMA & Water Corps
	50. Triennially review the Victorian Mallee Irrigation and Development Guidelines to ensure they keep pace with innovations in the irrigation industry and therefore they remain relevant and contemporary.	Ongoing	High	Mallee CMA
	51. Implement compliance and enforcement policy for all water users to maintain community confidence in Victoria's entitlement and allocation framework.	Short term	Medium	DELWP & Water Corps
	52. Continue to investigate risks and opportunities associated with irrigation practices and invest in building contemporary knowledge to be incorporated in future projects.	Ongoing	High	Mallee CMA & Ag Vic
	53. Develop on-farm and off-farm, where relevant, energy efficiency calculator to assess the potential for systems to be more energy efficient, and explore opportunities to increase the carbon content of soils, via sequestration, to help manage the feedback loop between irrigation management and climate change.	Short term	High	Ag Vic

6.2 Prioritising actions

There is strong competition for natural resource management funding. In choosing where to allocate resources, decision-makers consider community interests, environmental values, cultural values, the risks to those values and the benefit-cost relationship of investment. The process that has been used to assess and prioritise the actions agreed to as a result of consultation on this LWMP is summarised in Figure 9.



Figure 9 | The process for assessing and prioritising actions agreed through consultation.

The suite of actions included in the LWMP was then subjected to a benefit cost analysis. This involved each of the LWMP’s 53 actions being grouped into seven categories of similar characteristics.

With regard to costs, the capital and annual operating costs over the 10-year life of the LWMP were discounted to ‘present values’ using a 4% discount rate.

With regard to benefits, many of the benefits of the LWMP do not translate into monetary values. For example, the investigations initiated under the LWMP will provide the grounds for further actions that will lead to monetary benefit, but there is little to no direct monetary benefit in undertaking the investigation.

However, where monetary benefits could be identified they too were discounted at 4% to present values over 30 years except for the benefits of the irrigation incentives program which has been discounted over 20 years to account for the limited economic life of improvements to irrigation systems.

The benefits and costs of each group of actions is summarised in Figure 10.

It is important to note that the total benefits of the irrigation incentives program include both public and private benefits. It yields public benefits in terms of reduced river salinity, improved health for native vegetation, improved health for wetlands, and less road maintenance. It yields private benefits in water savings (assumed 0.5 ML/ha) productivity improvements (assumed 5%).

Similarly, the Irrigation Development Guidance yields private benefits in terms of productivity improvements as a result of better matching soils, plantings and irrigation designs (conservatively assumed to be a 1% improvement in productivity).

If implemented, returning 5,355 ML of annual use limits to the High Salinity Impact Zone could result in 6% more water being diverted through LMW’s infrastructure, which has the public benefit of reducing water usage charges over time (conservatively assumed to be a 1% saving). In summary, recommended actions for each program were prioritised on the basis of the following:

- How well they contribute to the LWMP’s objectives and long-term outcomes;
- The degree of community support for the proposed action;
- Alignment with government policy;
- Relative costs and benefits: a cost-benefit analysis (Figure 10) was undertaken to confirm that the actions to implement the LWMP actions are cost-effective in managing any adverse effects of irrigation; and
- Likely adoption: priorities and management action targets were influenced by consideration of the likely level of the adoption of individual actions. Actions that are unlikely to be attractive to irrigators were either screened out or linked with other actions that would support their adoption.

Action Categories	Financial costs and benefits				Contribution to Management Outcome Targets							
	Costs (\$000s)	Direct Public Benefits (\$000s)	Direct Private Benefits (\$000s)	Total Direct Benefits (\$000s)	An increase in target audiences' awareness and understanding	An increase in target audiences' skills and participation/adoption	Cultural heritage values are maintained	Groundwater resources are managed for optimum benefits	Recovery in landscapes impacted by irrigation induced salinity or offset areas established	An increase in best management practices implemented	Continued compliance with basin salinity obligations	An increase in the uptake of biodiversity requirements integrated into regional and on-farm irrigation planning
Strategic knowledge improvements	5,039			-	✓							
Enable greater self determination by Traditional Owners	422			-	✓✓✓	✓✓✓	✓✓✓		✓✓✓			
Capacity building	3,295			-	✓✓✓		✓✓✓	✓✓				✓✓✓
Irrigation Development Guidance	3,455		6,519	6,519	✓✓✓	✓✓✓	✓✓✓			✓✓✓	✓✓✓	✓✓✓
Water quality monitoring and protection	2,980			-	✓			✓✓✓			✓✓✓	
Improving the management of water for irrigation	5,072	7,688	36,477	44,165	✓✓✓	✓✓✓				✓✓✓	✓✓✓	✓✓✓
Managing salinity in the river and the landscape	2,638	1,111	-	1,111	✓✓✓		✓✓✓	✓✓✓			✓✓✓	✓✓✓
Total	22,900			51,795								

✓	LOW contribution to Management Outcome Target	✓✓	MODERATE contribution to Management Outcome Target	✓✓✓	HIGH contribution to Management Outcome Target
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Figure 10 | Summary of the overall evaluation of LWMP programs.

6.3 Delivery partnerships

Where relevant, projects initiated under this LWMP will be supported by an agreement between partners. This will ensure from the start that each agency is clear about its roles, responsibilities and accountabilities.

6.4 Monitoring, evaluation, reporting and improvement

A critical component of any strategic plan, such as this LWMP, is the capacity for adaptive management. That is, can this LWMP be flexible in the face of new information, unexpected outcomes and the uncertainty that is inherent in natural resource management? A monitoring, evaluation, reporting and improvement (MERI) framework is one way to provide capacity to adapt.

The MERI framework provides a simple mechanism to incorporate the principles of adaptation into the delivery of the LWMP. It will provide the capacity to understand and record the successes (or otherwise) and knowledge gained from LWMP implementation.

The primary intention of the MERI framework is to provide the basis for reviewing and reporting on the LWMP at key points throughout its implementation. The secondary intention is to align it with and to support the associated MERI processes being delivered under the 2013-19 Mallee Regional Catchment Strategy.

A detailed MERI Plan will be developed as a supporting document for the LWMP. It will allow for the annual review of LWMP activities, a mid-term review after five years, and will also facilitate continuous improvement and adaptive management.

6.4.1 Program logic

The key to any MERI framework is a detailed understanding of the anticipated cause and effect relationships between planned actions and expected

outcomes. The Program Logic for this LWMP visualises the expected hierarchy of outcomes that will indicate progress towards our vision, objectives and resource condition targets. The LWMP's Program Logic is informed by a suite of knowledge, science and experience drawn from a regional evidence base and the application of assumptions to produce a theory of change. Examples of some key assumptions applied in the development of the Program Logic include the following.

- The region's strategic management intentions over the life of the LWMP are the right mechanisms and have sufficient scope and scale to contribute meaningfully to the objectives and resource condition targets;
- There are sufficient resources available to the region over the life of the LWMP to implement the proposed actions with sufficient scope and scale to contribute meaningfully to the objectives and resource condition targets;
- There is sufficient information or access to information over the life of the LWMP to evaluate the impact of implementation on resource condition targets; and
- The relationships between proposed actions and expected outcomes are based on a 'typical year'. Adaptation in response to events such as drought, commodity price booms or busts may be required over the life of the LWMP to account for changed conditions or risks.



Almond orchard.

6.4.2 Monitoring

Monitoring activities will collect information to inform evaluation and reporting on the implementation of the LWMP. This will include monitoring of the:

- level of expenditure against regional priorities;
- type, area and location of management activities and outputs implemented in the region;
- short-term impacts of delivery; and,
- long-term impacts of delivery.

New information and research on climatic influences (e.g. drought, frost and hail) and externalities (e.g. land-use change, market conditions, water price, community expectations) that affect implementation of the LWMP will also be collected where appropriate.

6.4.3 Evaluation reporting and improvement

Delivery of the LWMP will be evaluated and reported at key intervals: annually; at five years (mid-point of implementation); and ten years (end-point of implementation). Regional stakeholders will participate in these evaluations as part of already established partnership and engagement mechanisms (e.g. Technical and Community Advisory Committees). The primary intention of undertaking annual reviews of the LWMP is to:

- assess progress towards planned management activities and outputs;
- identify any short-term delivery outcomes;

- consider any new knowledge that may influence future implementation; and
- improve the plan and adapt it to changes in understanding and circumstance (the ongoing reviews built into the actions outlined in the LWMP will help to provide adaptive management).

The results of these annual reviews will be reported as part of the Mallee CMA's obligations under the *Catchment and Land Protection Act 1994* (CaLP Act) which requires CMAs to report annually on the condition and management of land and water resources on behalf of the region. Annual project reports developed to meet specific investor requirements (e.g. financial, spatial, tabular data) will provide further detail and context.

A mid-term review of the LWMP will be undertaken in accordance with DELWP's guidelines for the preparation of Land and Water Management Plans. This review will also evaluate and revise the price structure of the Salinity Impact Charges. LWMP evaluations will be incorporated into reviews of the Regional Catchment Strategy where appropriate.

A report detailing the outcomes of this review will be produced by the Mallee CMA and promoted to all stakeholders. Findings will also be incorporated into associated reviews of the Mallee Regional Catchment Strategy. The review process will be driven by a series of key evaluation questions which provide the background to evaluating the effectiveness, appropriateness, efficiency, impact and legacy of the LWMP and its implementation (see Table 5).

Table 5 | Mallee Irrigation Region Land and Water Management Plan Key Evaluation Questions.

Evaluation Purpose	Evaluation Intervals	Evaluation Questions
Effectiveness	annual / mid-point / end-point	To what extent have the planned activities and outputs been achieved? Why or why not?
Appropriateness	annual / mid-point / end-point	Have the management intervention methodologies employed conformed to 'best practice' throughout the delivery phase? If not, why not?
	annual / mid-point / end-point	To what extent has the LWMP delivered against investor, stakeholder and community needs and expectations?
Efficiency	mid-point / end-point	Did the strategic management interventions delivered through the LWMP produce the expected level of contribution to targets?
	mid-point / end-point	Are there alternative or additional intervention options available to improve the region's contribution to targets?
Impact	annual / mid-point / end-point	What impacts are apparent as a result of the management interventions delivered through the LWMP?
	mid-point / end-point	What progress towards the objectives and goals has been identified? What level of progress can be attributed to the LWMP?
	mid-point / end-point	What, if any, unanticipated positive or negative outcomes have resulted from LWMP implementation?
Legacy	end-point	What is the status of and trend in the condition of land and water in the Mallee?

Part 7

Reference Materials

7.1 References

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7.2 Acronyms

AUL

Annual Use Limit

BoM

Bureau of Meteorology

BSMS

Basin Salinity Management Strategy 2001–2015

BSM2030

Basin Salinity Management Strategy 2015–2030

CMA

Catchment Management Authority

CSIRO

Commonwealth Scientific and Industrial Research Organisation

DELWP

Department of Environment Land Water & Planning

EC Unit

Electrical Conductivity Unit

GMA

Groundwater management area

GMW

Goulburn Murray Water

GWMW

Grampians Wimmera Mallee Water

Ha

Hectare

LMW

Lower Murray Water

LWMP

Land and Water Management Plan

MAT

Management Action Target

MBI

Market Based Instruments

MCMA

Mallee Catchment Management Authority

MDBA

Murray-Darling Basin Authority

MDBC

Murray-Darling Basin Commission (now MDBA)

MERI

Monitoring Evaluation Reporting and Improvement

MIIP

Mallee Irrigation Incentives Program

ML

Megalitre

NRM

Natural Resource Management

RCS

Regional Catchment Strategy

RCT

Resource Condition Target

WUE

Water-use Efficiency

WUL

Water-use Licence

7.3 Glossary

Accountable Actions

An Accountable Action is one where an activity (either on its own or cumulatively) is estimated to have an effect on daily average salinity at Morgan greater than 0.1 EC in the next 100 years (a Significant Effect). Accountable Actions are typically salt interception schemes, changes to river operation and water management including changes to water use efficiency, and new irrigation developments in the Mallee Region.

Annual Use Limit (AUL)

The maximum volume of water that, in any 12-month irrigation season, may be applied to the land specified in a water-use licence.

Aquifer

Porous (sand or gravel) subsurface layer within the Earth's crust capable of containing groundwater.

Aquitard

Clay layer in between groundwater aquifers. Aquitards help to confine aquifers and retard the movement of groundwater between one aquifer and another.

Barmah Choke

A narrow section of the River Murray between Cobram and Echuca that runs through the Barmah-Millewa Forest on the Victorian/NSW Border. Its operating capacity is small relative to other parts of the river. Consequently, when no water is available from the Menindee Lakes to augment supply, the Choke is the main limiting factor in delivering sufficient water to meet peak downstream demands for water use and to meet minimum flow requirements for South Australia.

Basin Salinity Target

Is to maintain the average daily salinity at Morgan at a simulated level of less than 800 EC for at least 95 percent of the time, during the Benchmark Period.

Basin State

Means New South Wales, Victoria, Queensland, South Australia and the Australian Capital Territory.

Benchmark Period

Is an observed climatic sequence over a defined period (determined to be the period 1 May 1975 to 30 April 2000) that is representative of hydrological variability across the Basin.

Delayed salinity impacts

(also referred to as the 'legacy of history') means a salinity impact which occurs after 1 January 2000, but which:

- i. in the case of New South Wales, Victoria or South Australia, is attributable to an action taken or decision made in that State before 1 January 1988; and
- ii. in the case of Queensland or the Australian Capital Territory, is attributable to an action taken or decision made in that State before 1 January 2000.

Delivery Share

The right to have water delivered by a water corporation and a share of the available flow in a delivery system: a share in terms of unit volume per unit of time of the total amount of water that can be drawn from a water system at a certain point.

EC – Electrical Conductivity

Is the measure of total concentration of dissolved salts in water. When salts dissolve in water, they give off electrically charged ions that conduct electricity. The more ions in the water, the greater the electrical conductivity it has. Because there are almost no ions in distilled water, it has almost no electrical conductivity. Hard water contains more salts, and therefore more ions, and has high electrical conductivity. Measuring electrical conductivity provides a fast and convenient way to measure salinity levels. Sea water has a salinity of about 35,000 to 50,000 EC units.

EC at Morgan

Changes in Murray River salinity are expressed as changes in average annual salinity (EC) at Morgan South Australia.

Groundwater

Water that collects or flows beneath the Earth's surface.

Hydrogeology

The study of groundwater systems.

Irrigable area

Land licensed for irrigation water use.

Irrigation application efficiency

The proportion of total irrigation and rainfall that is consumed by the crop through evapotranspiration. The remaining proportion is lost to collected drainage, groundwater recharge, or the landscape.

Joint works or measures

Means physical works or measures that change instream salinity, either through a reduction in salt loads or through a changed flow management regime, for which partner governments have formally agreed to cost sharing.

Market Based Instrument (MBI)

A method of giving a positive reward for proactive involvement in natural resource management. They are another 'string to the bow' adding to the more traditional forms of encouragement and assistance in NRM, such as incentives and grants.

Millennium Drought

A prolonged dry period in much of southern Australia from late 1996 to mid-2010.

Salinity (or salt concentration)

Is the concentration of dissolved salts in water, usually expressed in EC units or milligrams of total dissolved solids per litre (mg/L TDS).

Salinity Cost Effect

Is a change in average salinity costs resulting from an action.

Salinity Credit

Is a reduction in average Salinity Cost Effect.

Salinity Debit

Is an increase in average Salinity Cost Effect.

Salinity Credits and Debits

Are units of salinity accountability and are defined as increases or decreases in average salinity costs since the baseline date.

Salinity Effect

Means a change in river salinity that leads to a Salinity Cost Effect.

Salinity registers

Are a credit and debit based salinity accounting system which tracks all actions that are assessed to have a Significant Effect on river salinity, being a change in average daily salinity at Morgan which will be at least +/-0.1 EC by 2100.

The salinity registers

Provide a primary record of partner government accountability for actions that affect river salinity.

Register A contains details of any actions after 1st January 1988 for NSW, Victoria and South Australia, and 2000 for Queensland and the ACT; that are considered to have a Significant Effect. Register A also brings forward information about works carried out under the former Salinity and Drainage Strategy and the BSMS.

Register B records Delayed Salinity Impacts due to actions taken before 1988 for NSW, Victoria and South Australia, and 2000 for Queensland and the ACT (the 'legacy of history' for which the partner governments accept joint responsibility). It also contains details of the predicted future effects of actions aimed at specifically addressing Delayed Salinity Impacts, including contributions from Joint Works or Measures, and their salinity costs.

Salt load

Is the amount of salt carried in rivers, streams, groundwater or surface run-off, in a given time period. The salt load is often expressed in kg/day, tonnes/day or tonnes/year.

Salt Disposal Entitlements

Entitlements to increase Murray River salinity at Morgan. These are only earned at the state level in return for investments that reduce river salinity by at least the same amount if not more (this term is being phased out and replaced with Salinity Credits and Debits).

Schedule B

Is a schedule to the Murray– Darling Basin Agreement (Schedule 1 to the Water Act 2007 (Cth)) that provides the accountability framework for implementation of the BSM2030 by the partner governments.

Shared water resources

Refer to the water resources of Murray River System as defined in Section 86A(3) of the Water Act 2007 (Cth).

Significant Effect

Is a change in average daily salinity at Morgan which the Authority estimates will be at least 0.1 EC by 2100, or a salinity impact the Authority estimates will be significant.

Victorian Water Register

A public register of all water-related entitlements in Victoria. It records entitlements with integrity, enables proper water accounting, keeps track of the water market and produces crucial information for managing the State's water resources.

The register is shared between an independent Victorian Water Registrar, The Department of Environment Land Water & Planning (Office of Water) and rural water corporations.

Water Share

A legally recognised, secure share of the water available to be taken from a defined water system; a water share is specified as a maximum volume of seasonal allocation that may be made against that share.

Water-use Efficiency (WUE)

Maximising the use of available water resources by applying water efficiently at a time and volume that meets the needs of the crops and ensures the long term sustainability of production levels (DSE & DPI 2004).

Water-use Licence (WUL)

The right to use water on a specific piece of land or;

Water-use Registration (WUR)

An authorisation to use water for purposes other than irrigation.

Works Licence

A licence to construct, operate, alter, decommission or remove works associated with the extraction of water (i.e. bore, pumps, dams)

7.4 Appendices

7.4.1 Recommendations of the review of the Mallee Irrigation Incentives Program

Recommendation 1

A future Mallee Irrigation Incentive Program (MIIP) should cover soil survey, system checking and scheduling for pressurised irrigation systems. System upgrades should not be eligible for incentives, except for actively irrigated furrow irrigation, which will have an incentive to convert to a pressurised system available for a limited period. The definition of actively irrigated will be decided by the Mallee CMA.

Recommendation 2

The incentive for scheduling should require a soil survey and a system check. The incentive to upgrade furrow to pressurised system will require a soil survey.

Recommendation 3

All incentive recipients should require attendance at an irrigation management course, unless the participants have already completed the course and a refresher course.

Recommendation 4

The incentives should be provided on a “rolling call” basis rather than within a limited “expression of interest” period.

Recommendation 5

Recommendation 4 means that there cannot be prioritisation of applications in a round, instead minimum criteria will need to be set for eligibility. In terms of the salinity criteria, applications from high salinity impact zones and low impact zone L4 will be eligible, while applications from the L1, L2 or L3 zones will need to meet the existing \$800/t criteria using the salt load calculator.

Recommendation 6

The level of incentive provided should be 90% of the cost for eligible soil survey, system check and scheduling equipment. For upgrading active furrow irrigation this should be 25%. Existing caps on expenditure per incentive will apply and as per current practice, these can be summed for multiple activities.

Recommendation 7

Innovative methods for system checking and scheduling may be eligible, for example using NDVI (Normalised Difference Vegetation Index derived from remote sensing that can be used to determine crop water use variability), on the condition that this information is available for sharing. Pilots for these methods will be developed by the CMA to assess suitability for incentives.

Recommendation 8

Delivery of extension and the revised MIIP should be coordinated with other industry programs. In some cases, this can be by joint delivery of field days and other events.

Recommendation 9

Fund the program for three years and then review the continuation of incentives based on expected public benefits.

Recommendation 10

The Mallee CMA develop protocols for data capture of soil surveys, system checks, remote sensing and adoption of incentives.

7.4.2 BSM2030 maps of accountable actions in the Victorian Mallee

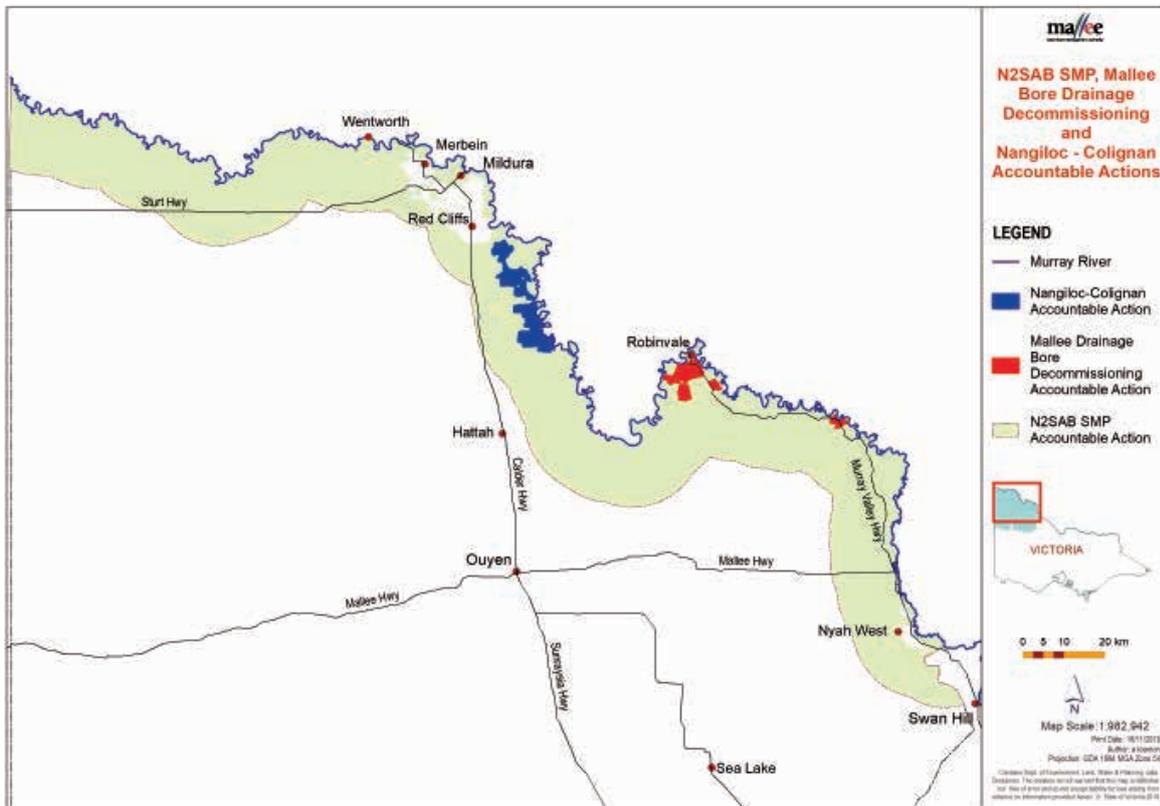


Figure 10 | Nyah to SA Border Salinity Management Plan, Mallee Bore Drainage Decommissioning and Nangiloc Colignan Salinity Management Plan.

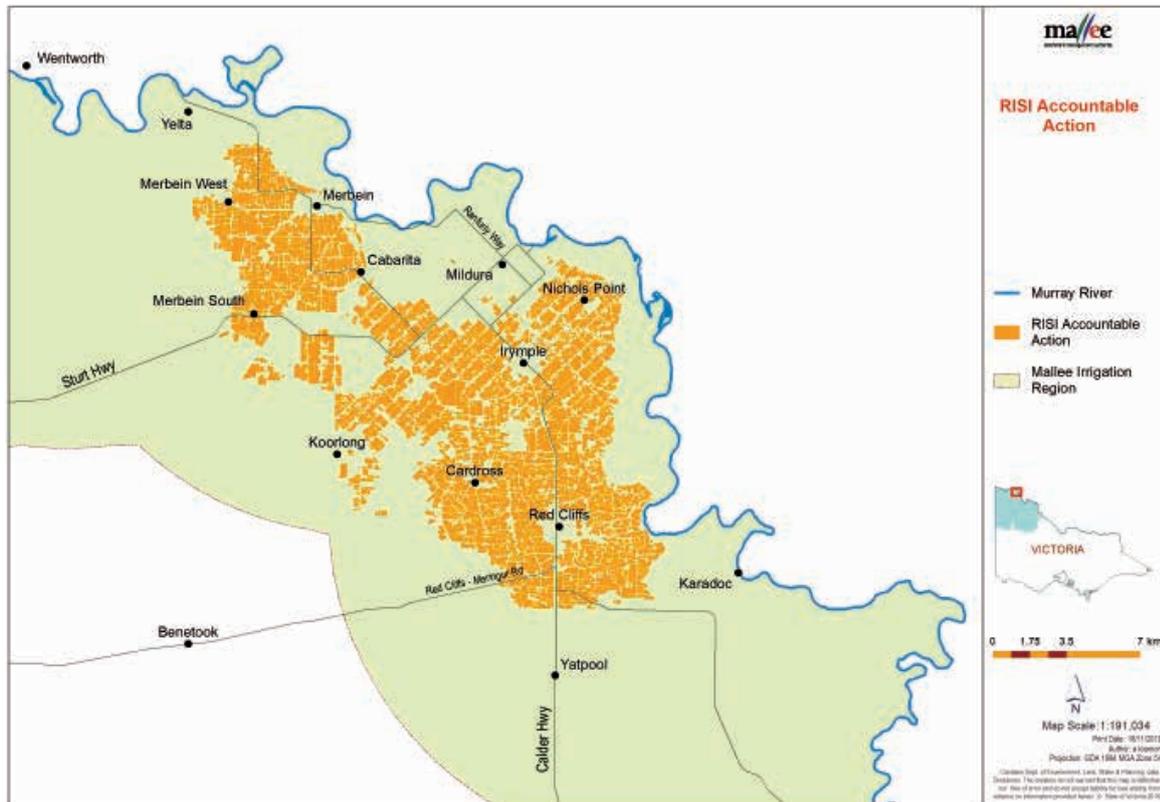


Figure 11 | Reduced Irrigation Salinity Impact.

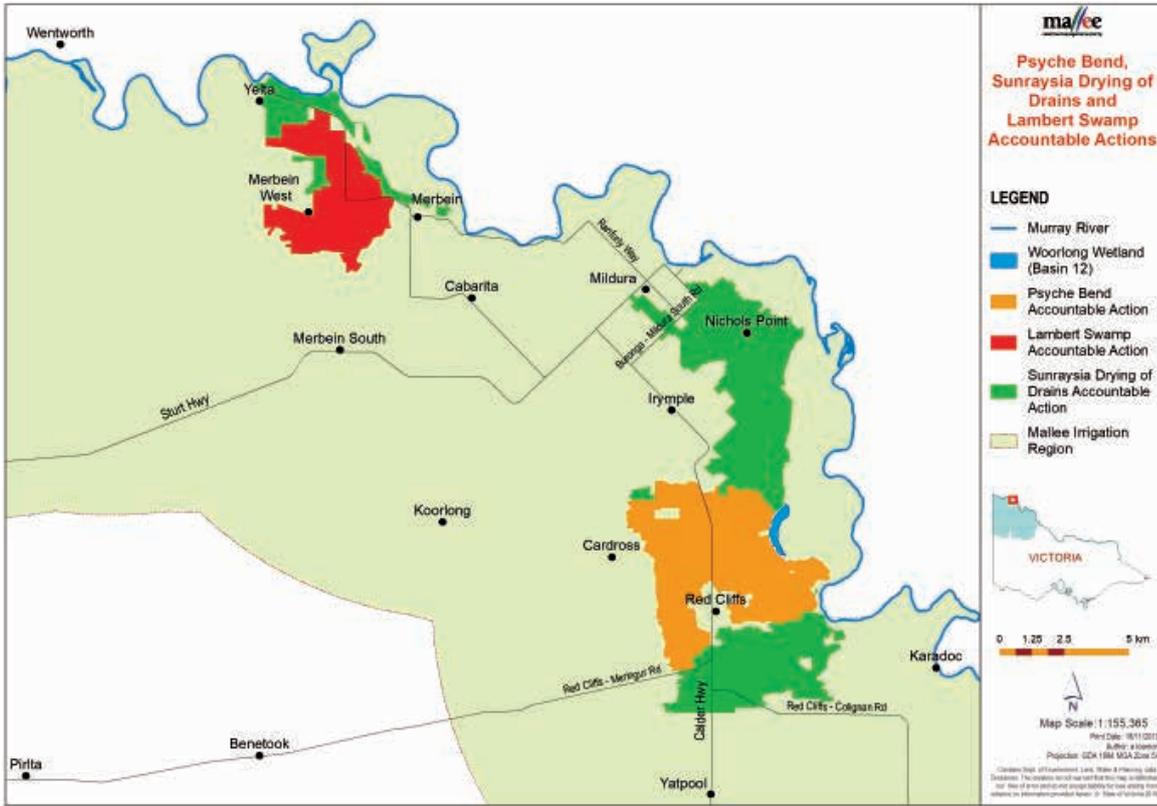


Figure 12 | Psyche Bend, Sunraysia Drying Of Drains, Lamberts Swamp.

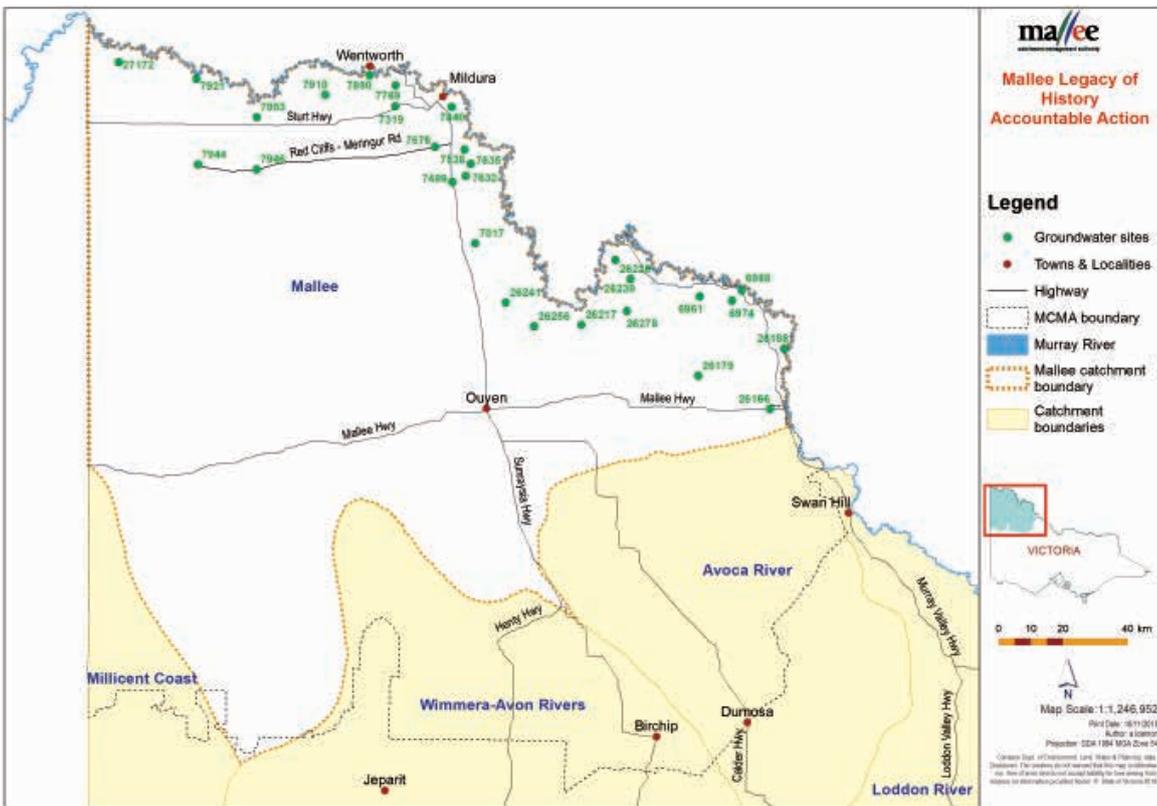


Figure 13 | Mallee Legacy of History.

